

A detailed photograph of a grey squirrel with a black cap and a white stripe down its back, climbing a tree trunk with rough, peeling bark. The squirrel is positioned vertically on the left side of the image, reaching upwards with its front paws. The background is a solid blue gradient.

Travers

bushfire & ecology

Ecological Assessment

Planning Proposal for
Lot 1 DP 1139826
Ralston Avenue, Belrose

APRIL 2017
(REF: A17029F)



Ecological Assessment

Planning Proposal for Lot 1 DP 1139826 Ralston Avenue Belrose

Project Manager	Michael Sheather-Reid
Report Authors	Lindsay Holmes, Corey Mead, Robert Sansom, John Travers and Michael Sheather-Reid.
Plans prepared	Kelly Tucker
Directorial Review	John Travers
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Survey effort has been reduced to provide an indication of the insitu vegetation and fauna habitat present. The 7 part test of significance is based on this survey data and further survey may result in the observation of threatened species not considered in this assessment. Consequently further target threatened species survey may be required by the determining authority. The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy. Consequently, the location of all mapped features is to be confirmed by a registered surveyor.

ABN 64 083 086 677
PO Box 7138
Karingong NSW 2250

38A The Avenue
Mt Penang Parklands
Central Coast Highway
Karingong NSW 2250

t: 02 4340 5331
e: info@traverseecology.com.au
www.traverseecology.com.au

Executive Summary

Travers bushfire & ecology has been engaged to undertake ecological and bushfire assessments for a proposed planning proposal for a residential development within land located off Ralston Avenue, Belrose within Lot 1 DP 1139826.

Studies have been undertaken in over 138.26 ha of lands owned by *Metropolitan Local Aboriginal Land Council (MLALC)*. Following initial constraint assessments between 2008 and 2011 a development precinct was determined and assessed in May 2016 which focused on approximately 23 ha of plateau lands. In late 2016 bushfire asset protection zones were increased. Where relevant, mapping in this report will also include the previously assessed APZ extent to demonstrate the differences. Please note that because the Wyatt Avenue Road corridor and vegetation around the existing residence occur on lands which are not part of the rezoning proposal (but are for the study area), there is a difference in size, ie. 138.26 ha versus 136.62 ha. These additional lands have been taken into consideration as there may be some affectation caused by the proposal even if it is indirectly.

It is proposed that the developable area will be rezoned to accommodate a variety of residential uses that will meet the existing and likely future housing demand within the local area. The balance of the developable area of the site will comprise public open space, stormwater management infrastructure and asset protection zones for bushfire protection.

The concept plan for the site is shown on figure 1. The planning proposal aims to create three (3) distinct land uses;

- **Development precinct** - Rezone approximately a 17.27 ha portion of Lot 1 DP 1139826 for future residential development (Zoned R2). A small park of approximately 0.30 ha in size will be zoned as RE1.
- **Conservation lands** – The conservation lands will be used as a biodiversity offset. The conservation lands will also be zoned as E3 Environmental Management to allow integrated management of the asset protection zones and conservation lands by *Metro Local Aboriginal Land Council*. The proposed offset area is an ecologically significant landscape which is known to contain threatened flora, fauna, ROTAP species and the EEC, Coastal Upland Swamp. It will create a conservation parcel of which would ideally become an addition to Garigal National Park (with dual management with MLALC). A total of 119.05 ha will be dedicated as an E3 zoning.

The previous Biobanking Assessment Report (*EcoLogical Australia*) advised that 94.76 ha will be fully conserved through Biodiversity Certification. The conservation lands also include a further 19.9 ha of retained vegetation within existing easements. The calculations from this report will require updating as well to reflect the additional APZ impacted lands.

- **Asset protection zones** - Asset protection zones which are proposed to be zoned as part of the E3 Environmental Management lands. These lands will be managed as asset protection zones in compliance with NSW Rural Fire Service limitations in regard to APZ management. Habitat retention will be a key priority for the fuel management works given the dual role that the asset protection zones play in buffering the impacts of development on the urban/ bushland interface. Retention of trees, shrubs and surface fuels will be targeted for their intrinsic ecological value with ongoing management specified through a legally applied 'fuel management plan'.

Ecological survey

Ecological survey has been undertaken to identify the presence of listed threatened flora and fauna species, endangered ecological communities (EECs) and threatened fauna habitat.

Initial ecological surveys were undertaken in 2008 to identify potential ecological constraints to future development. More extensive ecological surveys began in late 2011 for the purposes of defining a viable development footprint and were completed in August 2013 including target threatened species survey. Further intensive targeted survey and habitat assessment were also completed in 2015. A full description of survey effort undertaken to date is provided within Section 2 of this report.

Recorded threatened flora, fauna and EECs

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979 (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. These include Giant Burrowing Frog (*Heliophorus australiacus*), Red-crowned Toadlet (*Pseudophryne australis*), Rosenberg's Goanna (*Varanus rosenbergii*), Powerful Owl (*Ninox strenua*), Little Lorikeet (*Glossopsitta pusilla*), Glossy Black-Cockatoo (*Calyptorhynchus lathami*), 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, was recorded.

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
- Two (2) threatened flora species, *Tetratheca glandulosa* (listed as vulnerable) and *Grevillea caleyi*, (listed as endangered) were recorded
- No EECs listed under this act were recorded within the total land parcel.

Specialist reports have been prepared and are considered within the 7 part test of significance for the following threatened fauna species:

- Rosenberg's Goanna (Mr Gerry Swan)
- Giant Burrowing Frog (Prof Michael Mahony)
- Red-crowned Toadlet (Prof Michael Mahony)
- Eastern Pygmy Possum (Dr Ross Goldingay)

Bushfire management, road access and emergency egress

The bushfire protection Assessment Report (*Travers bushfire & ecology 2017*) has found that the site is capable of supporting the required bushfire protection measures and can comply with *Planning for Bush Fire Protection 2006 (PBP)*. The extent of managed land for

asset protection purposes defines the outer extent of the land proposed for development or management.

This sensitive landscape management approach is recognised in the biodiversity certification and the inherent foraging value of a managed APZ landscape for various threatened species has been considered.

Floristic impacts

Target threatened flora searches have been undertaken within the development precinct and the proposed offset lands. Additional survey has been undertaken in July 2013 within the electrical substation lands to identify the extent of *Grevillea caleyi* after the 2012 hazard reduction burn and to clarify the extent of the current local population. *Grevillea caleyi* was again surveyed in July 2015.

Impacts on vegetation communities

The vegetation communities within the proposed development area and offset lands (inclusive of affected road corridors) was initially stratified on the basis on vegetation structure & form including:

- A - Short Heath (to 2.5m tall)
- B - Tall Heath (2.5-5m tall)
- B2 - Damp Tall Heath
- C - Low Open Forest (to 10m tall)
- D - Open Forest (10+m tall)
- E - Cleared, Managed, Landscaped or Weed Plume
- F - Coastal Upland Swamp (EEC)
- G - Sandstone Gully Forest
- H - Riparian Woodland / Forest

For the purposes of biodiversity certification, the aforementioned vegetation communities have been converted to an equivalent biometric vegetation type.

Table 1 provides the estimated loss of each biometric vegetation types (adapted from *EcoLogical* 2015).

Table 1 – Biometric vegetation types and impacts

Zone	PCTID	BVTID	Biometric Vegetation Type	Area	Expected impact	% impact
1	1250	ME012	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	17.79 ha	0.35 ha	2.0%
2	1083	ME014	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	74.75 ha	12.33 ha	16.5%
3	881	ME008	Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux,	8.69 ha	1.12 ha	12.9%

			Sydney Basin Bioregion			
4	978	ME015	Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	3.60 ha	0.89 ha Note that 0.3 ha occurs within an electrical easement subject to management by Transgrid	24.7% Note the % impact is higher due to ongoing management
5	882	ME013	Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	23.99 ha	10.04 ha	41.9%
6	1085	ME039	Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion	1.24 ha	0.61 ha	49.2%
-	-	-	Cleared Lands	8.19 ha	3.57 ha	43.6%
Total				138.26 ha	28.91 ha	20.9%

- EEC - Coastal Upland Swamp (equivalent to ME015 in Table 1 above) occurs mostly within the conserved lands or retained lands within existing easements.
- EEC - Duffys Forest (equivalent to ME039 in Table 1 above) adjacent to the substation which will be partially retained.

If existing road reserves are removed, the total area is reduced, and thus the impact areas will reduce, but not necessarily for each vegetation type. It is noted that the reduction will go from 28.91 ha to 27.36 ha.

The EEC, Coastal Upland Swamp occurs on the southern aspect of Ralston Avenue, as some small patches near the electrical substation, and to the north of the development area near a riparian zone. The area of EEC is estimated as covering a total area of 3.6 ha. 0.89 ha or 25% of the mapped Coastal Upland Swamp will be impacted. 0.59 ha will be subject to APZ management whilst 0.30 already exists within a power line easement that could be managed by Transgrid. Given that this vegetation type is low and doesn't have emergents, the amount of management required has and will be minimal for the additional 0.3 ha area.

A total of 1.24 ha of Duffys Forest EEC occurs within the study area of which a total of 0.63 ha or 51% will be conserved.

Impacts on threatened and rare flora species

The proposed development area, associated road corridors and offset areas provide known habitat for the following threatened flora species and an EEC:

- *Tetratheca glandulosa* one hundred and fifty one (151) plants mostly within the proposed residential zone.
- *Grevillea caleyi* one (1) plant which was killed off by fire and hasn't been seen since 2013. Four (4) regrowth specimens noted in 2015 during the last thorough survey for them within the study area.

In addition, the study area also contains two (2) populations of rare or threatened Australian plants (ROTAP) listed threatened species:

- *Eucalyptus luehmanniana* – 3,796 plants within study area including offset lands, although difficult to estimate because of lignotubers and multi-stemmed trunks.

- *Angophora crassifolia* – estimated 1,208 plants within study area, including offset lands).

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

Following ecological surveys in May 2008 and December 2011, target survey for potential threatened flora species was undertaken in October (spring) 2012. *Pimelea curviflora* var. *curviflora* has not been detected within the proposed residential zone. *Tetratheca glandulosa* and *Grevillea caleyi* were resurveyed in October 2012 to ascertain their full coverage across the development site. Target surveys in August 2013 were conducted in the offset lands and the substation lands adjoining the development area to ascertain the extent of the *Grevillea caleyi* population. Additional target surveys for *Grevillea caleyi* were undertaken in July 2015 and for *Tetratheca glandulosa* in September 2015. The impact of the proposed development on *Tetratheca glandulosa* is discussed in the Biodiversity Assessment Report and Biodiversity Certification Strategy (EcoLogical Australia 2015).

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

Grevillea caleyi – 4 specimens recorded (alive), 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% loss to be offset, 0.01% on the regional population)

Eucalyptus luehmanniana – Estimated population is 3,796, 1,100 will be impacted by the development and APZ (approximately 29.0% loss)

Angophora crassifolia – Estimated population is 1,208, 254 will be impacted by the development and APZ (approximately 23.7% loss)

Fauna impacts

A total of ten (10) threatened fauna species have been recorded within, or in close proximity to, the development area during surveys or site investigations to date. The recorded threatened fauna 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*),
- Little Lorikeet (*Glossopsitta pusilla*),
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*),
- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Helicophrynus australiacus*)

Although not recorded within the proposed development area during surveys, it is considered that the proposed development area has varying potential for the following additional threatened fauna species to occur and offer constraints to development:

- Southern Brown Bandicoot (*Isodon obesulus*),
- Spotted-tailed Quoll (*Dasyurus maculatus*), and
- New Holland Mouse (*Pseudomys novaehollandiae*) (EPBC Act Listed species).

Target surveys for Southern Brown Bandicoot in accordance with the Draft Referral Guidelines for this species (SEWPAC 2011) have been undertaken as part of updated surveys. This species has not been recorded on site to date also including other previous target trapping effort. Likewise Spotted-tailed Quoll (*Dasyurus maculatus*), has not been detected within the site.

With regards to New Holland Mouse (*Pseudomys novaehollandiae*) it has suitable habitat and potential to occur within the site. It has not been positively identified within the site but following recent observations of mouse activity from surveillance camera surveys, and for the purposes of an EPBC referral, targeted trapping survey for New Holland Mouse is recommended to confirm the mouse species identification. However it is noted that given the extent of suitable habitat being provided the loss of habitat within the development area is not likely to be significant.

Based on the observation or recording of threatened fauna species, four (4) recorded threatened fauna species were considered to have potential to offer a constraint to development within the proposed residential area due to a dependence on the habitat in part within, and extending beyond, the proposed development area. These are:

- Rosenberg's Goanna (*Varanus rosenbergi*),
- Eastern Pygmy Possum (*Cercartetus nanus*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Heleioporus australiacus*).

Specialist advice was sought for each of these species; the following is a summary of their assessment reports provided in Appendices 5, 6 & 7.

Eastern Pygmy Possum

A specialist report has been prepared by Dr Ross Goldingay (University of Southern Queensland).

Eastern Pygmy Possum was initially observed opportunistically by Council within a hollow during a site inspection in June 2013. A second Atlas database record from three months later as well as a number of recordings to date by *Travers bushfire & ecology* suggests that parts of the subject site are utilised by Eastern Pygmy Possum for foraging in the banksia dominated communities and nesting within suitable hollows.

Dr Goldingay initially concluded that important areas of foraging habitat and breeding habitat will be affected by the proposed development and further hollow surveys and habitat assessment were required to determine the adequacy of the offset for breeding before a conclusion of significance can be made. Dr Goldingay also suggested that opportunities for individuals to disperse east and west across the Forest Way should also be investigated.

Under the guidance of Dr Goldingay further habitat assessment quadrats were undertaken in areas mapped as Low Open Forest (LOF) by TBE. These areas were found to provide most suitable habitat given both presence of *Banksia ericifolia* and hollows particularly within Scribbly Gum trees. Further habitat assessment has found that suitable hollows do exist within the offset areas for Eastern Pygmy Possum to support the expansive available foraging resources however based on hollow quadrat data these, hollows do appear to be at lower density.

During habitat surveys further records of Eastern Pygmy Possum activity were obtained from both the development landscape as well as confirmed presence within the proposed conservation lands.

As a result of the habitat assessment described in his attached specialist report, 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*". The mitigation measures as recommended by Dr Goldingay are included in his specialist report (Goldingay 2015).

Rosenberg's Goanna

The noted expert Mr Gerry Swan was engaged to undertake a site study which resulted in the location of one (1) termite mound in the proposed conservation area with a juvenile exit point and several more burrows (see Appendix 5 - Specialist Report on Rosenberg's Goanna - *Cygnnet Surveys and Consultancy* November 2012). All observed burrows by Mr Swan were located outside of the proposed development area. Further burrows have been identified in suitable habitat areas to the north and north-west of the proposed development area with one of these located in outer fringe of the APZ.

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 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. Mr Swan has also verbally confirmed that the APZs, resembling a managed native vegetation landscape, are likely to be used for foraging purposes (Gerry Swan *pers.com*. 31 July 2013).

Given that additional impacts on identified important habitat areas for Rosenberg's Goanna (as identified by Mr Swan) were impacted by the more recent APZ amendments, Mr Swan was subsequently notified of the changes. Following a site inspection of the new APZ extents Mr Swan has provided a revised letter in Appendix 5 indicating that his conclusion of a not significant impact on the species remains unchanged.

Red-crowned Toadlet and Giant Burrowing Frog

Prof Michael Mahony, noted frog specialist, was engaged to undertake target survey; habitat assessment and advice in respect to Red-crowned Toadlet and Giant Burrowing Frog (Appendix 6). Several breeding locations for Red-crowned Toadlet and one breeding location for Giant Burrowing Frog were identified during the period of his assessment.

In respect to Giant Burrowing Frog, Prof Mahony concluded that 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 Giant Burrowing Frog breeding habitat such that it is not likely that the proposal will significantly impact on the local viable population of the Giant Burrowing Frog.

Eastern Pygmy Possum habitat assessment surveys in 2015 also opportunistically recorded a second Giant Burrowing Frog breeding location closer to the development but still 240m north of the development boundary. Prof Mahony was notified of this new breeding location but confirmed that this observation does not alter his conclusion.

Prof Mahony discussed that the issue relevant to development and long-term residential occupation on the plateau are to maintain the hydrological integrity of the water that feeds off the plateau. In this case, water volume (and discharge rates) and the potential release of nutrients to the natural waterways are the matters that need to be effectively mitigated as part of the proposed development.

In respect to Red-crowned Toadlet, Prof Mahony concluded that four (4) breeding locations have been identified within the subject site and twelve (12) breeding locations were identified within the study area outside the subject site. Another two breeding locations were observed within the conservation lands during more recent fauna surveys. The observed locations

support that movement of the Red-crowned Toadlet will mostly be concentrated in the escarpment and mid-slope areas of the proposed conservation lands.

Prof Mahony concluded that development of the plateau will not have a significant impact on the local population due to any removal of habitat or the breaking of corridors. The potential for impact on the population of the Red-crowned Toadlet, as with Giant Burrowing Frog, 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.

Ongoing management of ecological resources

A detailed fuel management plan (FMP) has been prepared for the E3 zoned portion of land only (10.15ha) with its implementation and ongoing management of ecological resources being the responsibility of the community association set up under the community title development framework.

The community association will arrange for fuel management works to be undertaken by a competent professional organisation.

Amendments to this FMP will be the responsibility of the community association and approved by Northern Beaches Council under the relevant development application process and or amendments.

The proposed R2 land will be managed by the owners of the individual allotments and these lands will not be subject to an integrated management regime as for the E3 lands. Rather they will be managed by the individual land owners and are therefore not discussed further within this report.

The implementation of the APZs will require modification of 10.64ha of the E3 land (including *TransGrid* Easements). Attention has been given to the varying landscape character and the need to provide habitat function through the retention of various landscape elements such as trees, shrubs, sandstone outcrops, etc.

In addition, a prescribed burning program is proposed in land entitled the Strategic Fire Advantage Zones (SFAZ) and Land Management Zones (LMZ). Hazard reduction burning is to be undertaken in consultation with surrounding landholders (MLALC & National Parks).

It is envisaged that some APZ works will occur by the development contractors at project start up whilst more sensitive works would be undertaken. For example, roadway and in-lot setback (5.18ha) would be undertaken by contractors, whilst E3 lands APZ (10.15ha) would be undertaken by *Community Association*. APZ management is detailed in Figure X3.

- The APZ located on E3 lands (10.15ha) and an additional 2.34ha internal to E3 lands will be managed by *Community Association* (69.5%)
- the public roadway comprises 19.3% (3.46ha) of the APZ
- the private allotments comprise 9.6% (1.72ha) of the APZ and are managed by the private allotment owners.
- the portion of RE1 lands comprise 1.7% (0.3ha) of the APZ and is managed by council as an open space park.

Conclusion

The proposed development is in a location of ecological sensitivity and the level of ecological investigation including specialist reports reflects this sensitivity. It must be noted however

that the proposed offset areas provide a major contribution to the adjoining national park estate.

The adequacy of the planning proposed was assessed as part of a biocertification assessment undertaken by *EcoLogical Australia* in late 2015, which provided commentary on the offsetting proposal. That report's calculations will require updating to accommodate recent plan changes largely from expansion of APZ's.

Indirect impacts such as caused by stormwater have been considered at a high level and modelling is yet to be completed that demonstrates that the proposed urban landscape can adequately incorporate measures that achieve a no net change in the quality and quantity of runoff and groundwater discharge into the surrounding landscape.

The 7 part test of significance assumes that appropriate quality and quantity targets can be achieved to avoid a significant impact on the recorded threatened frog species to avoid significant indirect impacts.

The 7 part test of significance has considered the impacts of the 2017 APZ. The 7 part test of significance considers that APZ areas will be of no value for biodiversity calculations. Despite this the areas will be used by a variety of species.

The proposed development is not expected to have a significant impact on any remaining matters of national environmental significance (NES).

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

Authorised:

John Travers *BaSc / Ass Dip / Grad Dip*
Managing Director – **Travers bushfire & ecology**

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
CLUMP	conservation land use management plan
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from April 2007)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from October 2009)
DECCW	NSW Department of Environment, Climate Change and Water (superseded by OEHS from April 2011)
DEWHA	Commonwealth Department of Environment, Water, Heritage & the Arts (superseded by SEWPAC)
DOEE	Commonwealth Department of Environment and Energy
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	<i>Environmental Planning and Assessment Act</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act</i>
EPP	Eastern Pygmy Possum
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	<i>Fisheries Management Act</i>
FMP	fuel management plan
GBF	Giant Burrowing Frog
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Primary Industries
OEHS	Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet)
OPA	outer protection area
PBP	<i>Planning for bushfire protection 2006</i>
POM	plan of management
RCT	Red-crowned Toadlet
RF Act	<i>Rural Fires Act</i>
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	<i>State Environmental Protection Policy No 44 – Koala Habitat Protection</i>
SEWPAC	Commonwealth Dept. of Sustainability, Environment, Water, Population & Communities (superseded by DOEE)
SIS	species impact statement
SULE	safe useful life expectancy
TBE	<i>Travers bushfire & ecology</i>
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	<i>Threatened Species Conservation Act</i>
VMP	vegetation management plan

Table of Contents

SECTION 1.0 – INTRODUCTION.....	1
1.1 Aims of the assessment.....	1
1.2 Statutory requirements.....	2
1.2.1 <i>Threatened Species Conservation Act 1995 (TSC Act)</i>	2
1.2.2 <i>Fisheries Management Act 1994 (FM Act)</i>	2
1.2.3 <i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	2
1.3 Planning proposal	3
1.4 Site description	7
SECTION 2.0 – SURVEY METHODOLOGY	8
2.1 Information collation, technical resources, desktop assessments, specialist identification and licences	8
2.2 Flora survey methodology	9
2.3 Fauna survey methodology	10
2.4 Field survey effort	11
2.5 Site specific survey techniques	18
2.5.1 <i>Diurnal birds</i>	18
2.5.2 <i>Nocturnal birds</i>	18
2.5.3 <i>Arboreal mammals</i>	18
2.5.4 <i>Terrestrial mammals</i>	20
2.5.5 <i>Bats</i>	21
2.5.6 <i>Amphibians</i>	21
2.5.7 <i>Reptiles</i>	22
2.6 Survey limitations	23
SECTION 3.0 – SURVEY RESULTS.....	25
3.1 Flora results	25
3.1.1 <i>Flora species</i>	25
3.1.2 <i>Vegetation communities</i>	32
3.1.3 <i>Biometric vegetation units</i>	41
3.2 Fauna results	42
SECTION 4.0 – ECOLOGICAL ASSESSMENT	50
4.1 Previous surveys reviewed	50
4.2 Flora	50
4.2.1 <i>Local / regional flora matters</i>	50
4.2.2 <i>State legislative flora matters</i>	51
4.2.3 <i>Matters of national environmental significance - flora</i>	55
4.2.4 <i>Conserved and impacted vegetation within study area</i>	56
4.3 Fauna	58
4.3.1 <i>Fauna habitat</i>	58
4.3.2 <i>Habitat trees</i>	59
4.3.3 <i>Local fauna matters</i>	59
4.3.4 <i>State legislative fauna matters</i>	59
4.3.5 <i>National environmental significance - fauna</i>	62
4.4 Vegetation connectivity	68
SECTION 5.0 ECOLOGICAL IMPACTS & CONSTRAINTS	70
5.1 Recorded threatened species and endangered ecological community	70
5.2 Ecological impacts of the proposed planning scheme	70
5.2.1 <i>Rosenberg's Goanna</i>	72
5.2.2 <i>Giant Burrowing Frog</i>	72
5.2.3 <i>Red-crowned Toadlet</i>	72
5.2.4 <i>Eastern Pygmy Possum</i>	72
5.2.5 <i>Concluding comments</i>	73

5.3	Ecological constraints	73
5.3.1	<i>Flora constraints</i>	73
5.3.2	<i>Fauna constraints</i>	75
SECTION 6.0 BIODIVERSITY OFFSETS.....		79
6.1	Background	79
6.2	Offset security	80
6.3	Principles for use of biodiversity offsets in NSW	80
6.4	Offset Ratios	82
SECTION 7.0 – CONCLUSIONS & RECOMMENDATIONS		84
7.1	Conclusions	84
7.2	Recommendations	86
BIBLIOGRAPHY		90

Figures

Figure 1 – Plan of proposed development Lot 1 DP1139826	5
Figure 2 – Study area inclusive of development lands within Lot 1 DP1139826	6
Figure 3a – Vegetation communities & flora survey results within Lot 1 DP1139826.....	45
Figure 3b – Vegetation communities & flora survey results within the subject site (zoom)...	46
Figure 3c – Biometric vegetation types	47
Figure 4a – Fauna survey effort within the subject site	48
Figure 4b – Fauna survey results within the subject site	49
Figure 5 – Rosenberg’s Goanna – Important habitat and observations	65
Figure 6 – Giant Burrowing Frog and Red-crowned Toadlet – Important habitat and observations	66
Figure 7 – Eastern Pygmy Possum – Important habitat and observations	67
Figure 8 – Vegetation connectivity	69
Figure 9 – Options for fauna overpass locations adjacent to national parks.	89

Tables

Table 1.1 – Site features	7
Table 2.1 – Flora survey effort	11
Table 2.2 – Fauna survey effort	12
Table 3.1 – Flora observations for the study area	25
Table 3.2 – Fauna observations for the study area	42
Table 4.1 – State listed threatened flora species with suitable habitat present	51
Table 4.2 – Nationally listed threatened flora species with suitable habitat present.....	55
Table 4.3 – Biometric vegetation types conserved and impacted	56
Table 4.4 – State listed threatened fauna species with suitable habitat present	60
Table 4.5 – Nationally listed threatened fauna species with suitable habitat present.....	62
Table 6.1 – Biometric vegetation types conserved and impacted	82
Table A2.1 – Threatened flora habitat assessment	101
Table A2.2 – Threatened fauna habitat assessment	113
Table A2.3 – Migratory fauna habitat assessment.....	130

Appendices

Appendix 1 – TBE fauna survey methodologies

Appendix 2 – Threatened & migratory species habitat assessment

Appendix 3 – 7 part test of significance

Appendix 4 – Matters of National Environmental Significance - Significant impact criteria

Appendix 5 – Rosenberg’s Goanna Specialist Report (Gerry Swan)

Appendix 6 – Giant Burrowing Frog & Red-crowned Toadlet Specialist Report
(Prof Michael Mahony)

Appendix 7 – Preliminary and Final Eastern Pygmy Possum Specialist Reports
(Dr Ross Goldingay)



Introduction

1

Travers bushfire & ecology has been engaged to undertake ecological and bushfire assessments for a proposed residential development of land located off Ralston Avenue, Belrose within Lot 1 DP 1139826.

Studies have been undertaken in over 138.26 ha of lands owned by *Metropolitan Local Aboriginal Land Council (MLALC)*. Following initial constraint assessments between 2008 and 2011 a development precinct was determined and assessed in May 2016 which focused on approximately 23 ha of plateau lands. Since then, bushfire asset protection zones have been amended. Please note that because the Wyatt Avenue Road corridor and vegetation around the existing residence occur on lands which are not part of the rezoning proposal (but are for the study area), there is a difference in size, ie. 138.26 ha versus 136.62 ha. These additional lands have been taken into consideration as there may be some affectation caused by the proposal even if it is indirectly.

It is proposed that the developable area will be rezoned to accommodate a variety of residential uses that will meet the existing and likely future housing demand within the local area.

The balance of the developable area of the site will comprise public open space, stormwater management infrastructure and asset protection zones for bushfire protection. The proposed development landscape is identified within Warringah Local Environmental Plan (LEP) 2011 as 'deferred land' and as such LEP 2000 applies until a review of deferred lands is complete and a rezoning occurs.

The study area, including the entirety of the offset lands, is identified in Figures 2 and 3.

1.1 Aims of the assessment

The aims of the flora and fauna assessment are to:

- Carry out a botanical survey to describe the vegetation communities and the constituent species; and the condition of the community
- Carry out a fauna survey for the detection and assessment of species and their habitats
- Complete target surveys for threatened species, populations
- Prepare a flora and fauna impact assessment in accordance with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, the *Threatened Species Conservation Act 1995 (TSC Act)*, the *Fisheries Management Act 1994 (FM Act)* and *Threatened species assessment guidelines, the assessment of significance* (DECC 2007).

1.2 Statutory requirements

1.2.1 Threatened Species Conservation Act 1995 (TSC Act)

The specific requirements of the *TSC Act* must be addressed in the assessment of impacts on threatened flora and fauna, populations and ecological communities. The factors to be taken into account in deciding whether there is a significant effect are set out in Section 5A of the *Environmental Planning and Assessment Act 1979 (EP&A Act)* and are based on a 7 part test of significance. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, a species impact statement (SIS) is required to be prepared.

1.2.2 Fisheries Management Act 1994 (FM Act)

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

1.2.3 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

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

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

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

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

A threshold criterion apply to specific NES matters which may determine whether a referral is or is not required, such as for the *EPBC Act* listed ecological communities. Consultation with DOEE may be required to determine whether a referral is or is not required. If there is any doubt as to the significance of impact or whether a referral is required, a referral is generally recommended to provide a definite decision under the *EPBC Act* thereby removing any further obligations in the case of not controlled actions.

A significant impact is regarded as being:

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

Source: EPBC Policy Statement

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

1.3 Planning proposal

The concept plan for the site is shown on figure 1 and the proposed zoning is shown on Figure 2. The planning proposal aims to create three (3) distinct land uses;

- **Development precinct** - Rezone approximately a 17.27 ha portion of Lot 1 DP 1139826 for future residential development (Zoned R2). An open space park of approximately 0.30 ha in size will be zoned as RE1.
- **Conservation Lands** – The conservation lands are proposed be used as a biodiversity offset to satisfy the majority of offset requirements as assessed using the biodiversity certification assessment process as reported by Ecological Australia (2015). The conservation lands will be zoned as E3 Environmental Management to allow integrated management of the asset protection zones and conservation lands by Metro Local Aboriginal Land Council. The proposed offset area is an ecologically significant landscape which is known to contain threatened flora, fauna, ROTAP species and the EEC, Coastal Upland Swamp. An additional internal Duffys Forest Conservation area (0.7ha) has also been provided and forms part of the biodiversity offset. A total of 119.05 ha will be zoned E3.
- **Asset protection zones** – proposed to be zoned as part of the E3 Environmental Management lands. These lands will be managed as asset protection zones in full compliance with NSW Rural Fire Service limitations in regard to APZ management. Habitat retention will be a key priority for the fuel management works given the dual role that the asset protection zones play in buffering the impacts of development on the urban/ bushland interface. Retention of trees, shrubs and surface fuels will be targeted for their intrinsic ecological value with ongoing management specified through a legally applied 'fuel management plan'.

Powerline easement APZ's - The areas of APZ to be assessed for ecological impacts have recently extended across to also include powerline easements running across the study area from the adjacent Transgrid substation. This has come out of a recent bushfire assessment review for the site. These areas may however be managed for APZ and access purposes at any time by Transgrid either prior to or post the proposed development works. In effect, these impacts are already subject to the existing infrastructure, but have been included as APZ managed lands in Biometric calculations with consideration to the total of natural habitat retained in offset areas.

The lands owned by MLALC (138.26 ha) will be termed the 'study area' for the purposes of this report. The development precinct including the APZ will be referred to as the 'subject site' for the purposes of this report.

Outside of Lot 1 the study area includes the existing house and land within Lot 2634 DP 752038; and unformed road corridors, including Wyatt Avenue.

Lot 1 DP 1139826 includes lands immediately;

- Adjacent to the electrical substation DP752038 (various lots)
- Peripheral to the insitu residential dwelling on Lot 2634 DP752038
- Peripheral to Council Lot 1 DP602729
- Adjacent to Belrose Waste Management Facility Lot 2 DP1144741

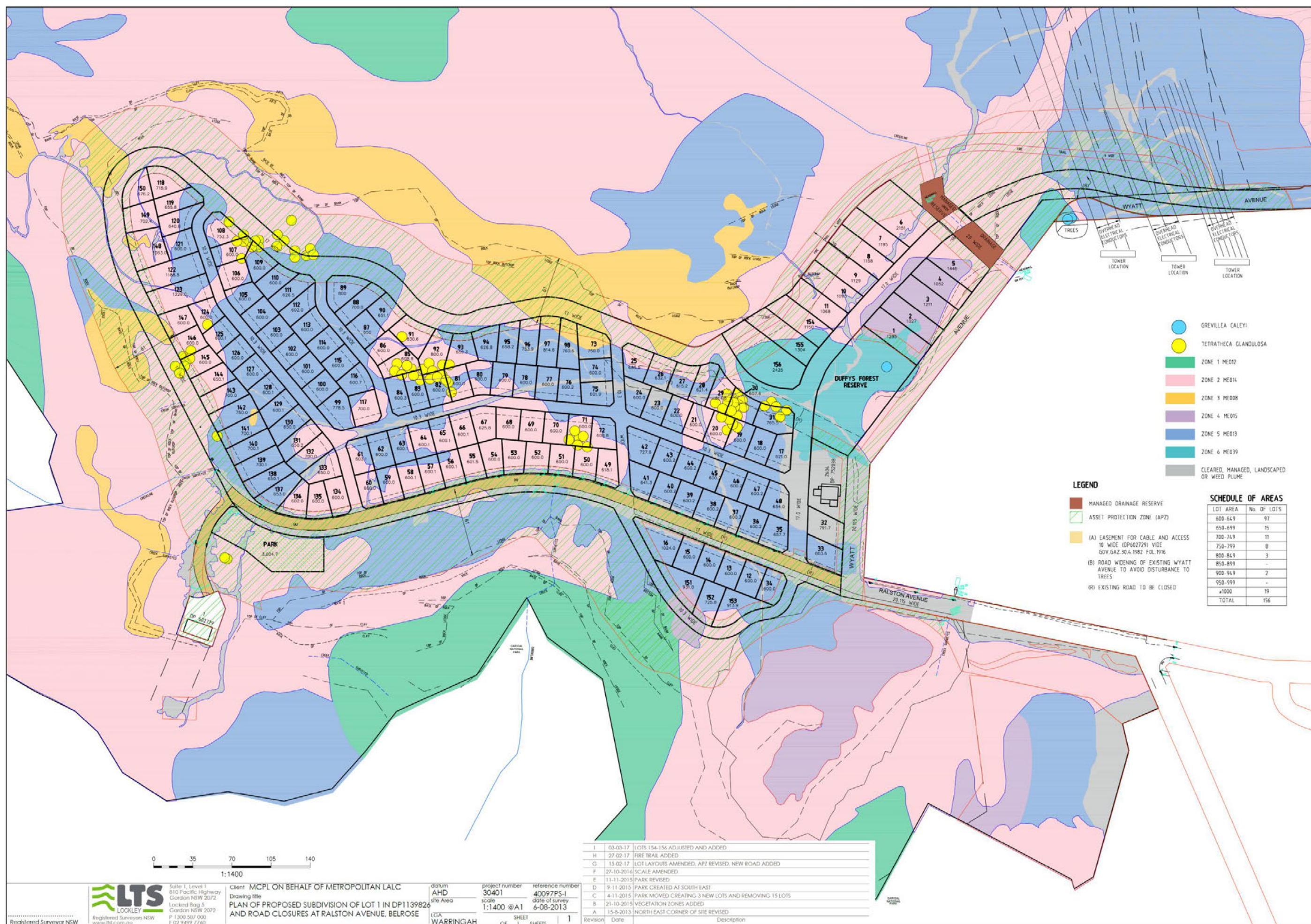


Figure 1 – Plan of proposed development Lot 1 DP1139826

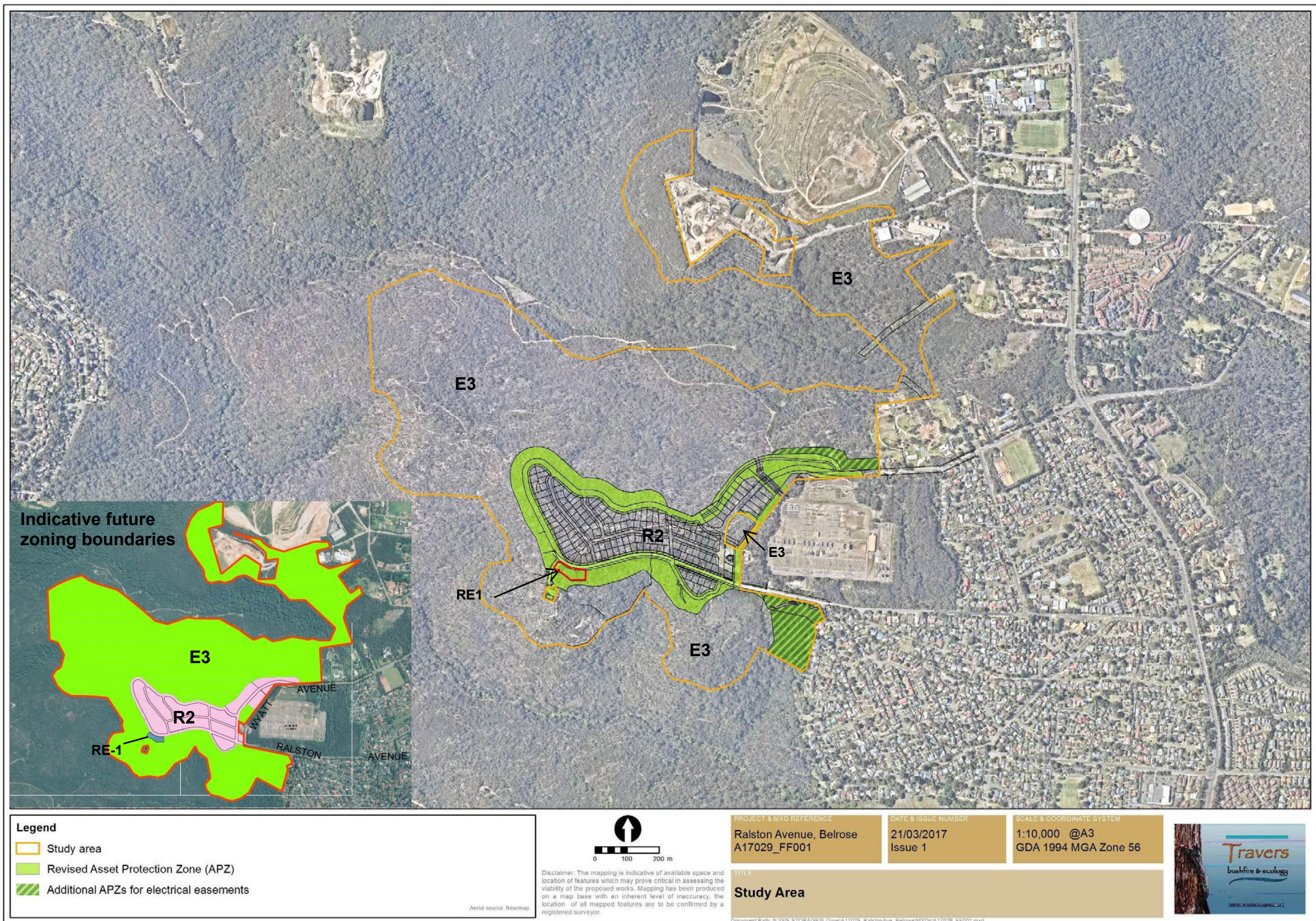


Figure 2 – Study area inclusive of development lands within Lot 1 DP1139826

1.4 Site description

Table 1.1 provides a summary of the planning, cadastral, topographical, and disturbance details of the subject site.

Table 1.1 – Site features

Location	Part of Lot 1 DP 1139826
Size	Approximately 17 ha development area plus asset protection zones around the development and under transmission towers
Local government area	Northern Beaches (formerly Warringah)
Grid reference	333600E 6266800N
Elevation	Approximately 150-170m AHD
Topography	Situated upon a sandstone plateau area with minor peripheral slopes, increasing near the northern and southern development boundary.
Geology and soils	Geology; sandstone Soils; Lambert Soil Landscape, Somersby Soil Landscape and Hawkesbury Soil Landscape
Catchment & drainage	French's Creek (to the south) and Fireclay Creek (to the north) into Middle Harbour Creek.
Vegetation	Predominately Coastal Sandstone Heath and Sydney Sandstone Ridgetop Woodland
Existing land use	Crown Land and part residential
Clearing	Clearing for the existing residence and APZs, as well as road, track and existing electrical structures.



Survey Methodology

2

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

A review of the relevant information pertinent to the subject site was undertaken.

Client documents reviewed include:

- Plan of proposal prepared by *Lockley Land Title Solutions*

Standard technical resources utilised:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- Aerial photographs (*Google Earth Pro / Spatial Information Exchange / NearMap*)
- Topographical maps (scale 1:25,000)
- *Threatened Species Conservation Act 1995 (TSC Act)*
- *Fisheries Management Act 1994 (FM Act)*
- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*
- Rare or threatened Australian plants (ROTAP).

Desktop assessment:

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

- ***A literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.
- ***A data search*** – A search of the *Atlas of NSW Wildlife* (OEH 2017) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the DOEE protected matters search tool website to generate a report to help determine whether matters of NES or other matters protected by the *EPBC Act* are likely to occur in the area of interest. The search was broadened to a 10km radius in accordance with the *Atlas of NSW Wildlife* search. These two searches combined, enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables A2.1, A2.2 and A2.3).

Accuracy of identification:

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

Egg shells, scats, feathers, hair samples were sent to identification expert, Barbara Triggs, for identification. A juvenile captured frog specimen was sent to the Australian Museum for DNA analysis. Tadpole photos were sent to Marion Anstis for identification. Bandicoot surveillance camera images were sent to Dr David Paull of the University of NSW for confirmation identification. Eastern Pygmy Possum suspected nesting bedding was confirmed during the 2015 site visit by Dr Ross Goldingay.

Licences:

Individual staff members of *Travers bushfire & ecology* are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Sections 120 & 131 of the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: SL100848.

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

2.2 Flora survey methodology

Aerial images from *Spatial Information Exchange* and *Google EarthPro* were utilised in the field to aid in the identification of the various vegetation communities. This was then ground-truthed from foot traverses. Each quadrat and transect was marked using *Trimble* GPS that has an accuracy of within 1-2m.

Many quadrats have been undertaken within the proposed development area and study area with various sets of quadrats used to confirm the presence or absence of EEC vegetation types (Duffys Forest and Coastal Upland Swamps).

Target threatened flora searches have been undertaken thoroughly and extensively throughout the proposed development area in winter, spring, summer and autumn. Additional target searches were undertaken within the offset lands, however, many of the observations were more incidental and may not reflect the full extent (population) of the various species due to the size of the area being covered, seasonal survey and limitations of accessibility. The approximate distribution of known threatened flora occurrences is mapped on Figure 3.

Target searches were undertaken for those listed threatened species known to occur, or with habitat potential within the local area.

Field survey in 2011 was conducted over a three (3) day period which included refinements to the vegetation mapping undertaken in 2008, target searches for threatened species, a further eleven (11) quadrats undertaken and general random plots within tall heath or Open Forest to test further for the presence of Duffys Forest EEC utilising Smith and Smith's Duffys Forest Index.

In March 2012, flora survey was undertaken to the north east of the proposed development area, off Wyatt Avenue.

In August and September 2012, studies were undertaken within the offset areas to assist in defining vegetation communities and threatened species potential, with incidental and additional target survey of threatened species.

In October 2012, target threatened species survey was undertaken for (primarily) *Tetradlea glandulosa*, *Haloragodendron lucasii*, *Lasiopetalum joyceae*, *Microtis angusii*, *Persoonia hirsuta*, *Pimelea curviflora* var. *curviflora*, *Grevillea caleyi*, *Angophora crassifolia* and *Eucalyptus luehmanniana*.

In July-August 2013, a biocertification analysis was undertaken by *EcoLogical Australia*. As most of the quadrats within the development area were undertaken by Braun-Blanquet or similar styled methodology, additional quadrats using the biometric methodology was required. Twelve (12) additional quadrats were undertaken and a brief survey for *Grevillea caleyi* was undertaken in the north eastern portion of the development area. It was noted that seven (7) stems were present after the 2012 Rural Fire Service (RFS) hazard reduction burn, all within a 2m radius of the main clump. No new locations were present.

Target survey within the substation lands for *Grevillea caleyi* was undertaken on 5 of August 2013. This resulted in the recording of thirty eight (38) individuals as post-burn specimens.

On 6 August, 2013, target survey for *Grevillea caleyi* and *Tetradlea glandulosa* was undertaken throughout some parts of the offset area, north of the development precinct. No specimens were sighted immediately south of Challenger Drive. Between the development and the Heath Track, a total of thirteen (13) *Tetradlea glandulosa* specimens were observed. Early August is outside the peak flowering season for this species and thus likely to only be representative of a small proportion of potential numbers within the offset area.

On 4 & 5 November, 2013, more target survey for *Tetradlea glandulosa* was undertaken in the northern offset area.

Survey effort for 2015 has included *Grevillea caleyi* survey in potential habitat areas to the north and west of the electrical substation which had been previously burnt, as well as within the Transgrid lands on 1 July. On 23 July and 5 August, further quadrats were undertaken to determine vegetation boundary adjustments (if required) for Duffys Forest and Coastal Upland Swamp.

A final *Tetradlea glandulosa* survey was conducted on 25 September 2015 in the proposed offset areas largely within 100-200m from the outer extent of the APZ.

During October 2015, additional survey and analysis was undertaken to define the boundary of the Duffys Forest EEC near the north-western edge of the electrical substation. This work was done partly in conjunction with *EcoLogical Australia*.

2.3 Fauna survey methodology

Site fauna survey effort accounting for techniques deployed, duration, and weather conditions are outlined in Table 2.2 and are depicted on Figure 4a.

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

2.4 Field survey effort

Tables 2.1 and 2.2 below detail the flora and fauna survey effort undertaken for the subject site.

Table 2.1 – Flora survey effort

Flora survey	Survey technique(s)	Dates
Vegetation communities	Aerial photographic interpretation and ground-truthing	7 May 2008 6 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 23-24 October 2012 23 July 2015 5 August 2015 14 October 2015
Stratified sampling	20x20m quadrats in all existing vegetation communities excluding landscaped areas and two (2) flora transects. The inclusion	5-7 May 2008 6-8 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 23-24 October 2012 4 July 2013 23 July 2015 5 August 2015
Target searches	Target searches in known habitats	6-7 May 2008 6-8 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 17, 19, 23-24 October 2012 4 July 2013 5-6 August 2013 1 July 2015 25 September 2015

Table 2.2 – Fauna survey effort

Fauna group	Date	Weather Conditions	Survey Method	Survey Effort / Time (24hr)
Diurnal birds	1/05/08	7/8 cloud, light NE wind, no rain, temp 18°C	Diurnal opportunistic	3hrs 55min 1005 - 1400
		8/8 cloud, no wind, no rain, temp 19.5°C	Diurnal opportunistic	1hr 20min 1440 - 1600
	2/05/08	0/8 cloud, no wind, no rain, temp 24°C	Diurnal opportunistic	4hrs 30min 1300 - 1730
	12/12/11	8/8 cloud, moderate gusty SE wind, early showers, temp 18-20°C	Diurnal opportunistic	4hrs 30min 1345 - 1815
		8/8 cloud, light SE wind, no rain, temp 18°C	Diurnal opportunistic	1hr 35min 1845 - 2020
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Diurnal opportunistic	9hrs 45min 1035 - 2020
	14/12/11	8/8 cloud, light-mod SE wind, no rain, temp 18-20°C	Diurnal opportunistic	4hrs 50min 1040 - 1530
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Diurnal opportunistic	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Diurnal opportunistic	35mins 1600 - 1635
	16/12/11	6-8/8 cloud, no wind, no rain, temp 17-21°C	Diurnal opportunistic	6hrs 55min 0950 - 1645
	15/10/12	0/8 cloud, no wind, no rain, temp 27-20°C	Diurnal opportunistic	6hrs 30min 1300 - 1930
	16/10/12	5/8 cloud, light NE wind, no rain, temp 23-34°C	Diurnal opportunistic	7hrs 30min 0900 - 1630
	17/10/12	3/8 cloud, light NE wind, no rain, temp 22-28°C	Diurnal opportunistic	8hrs 20min 0750 - 1610
	18/10/12	8-4/8 cloud, no wind, no rain, temp 18-26°C	Diurnal opportunistic	6hrs 20min 0740 - 1400
	19/10/12	8-2/8 cloud, no wind, no rain, temp 17-28°C	Diurnal opportunistic	3hrs 40min 0800 - 1140
		2/8 cloud, no wind, no rain, temp 28°C	Diurnal opportunistic	2hrs 50min 1220 - 1510
	20/10/12	0/8 cloud, no wind, no rain, temp 18-30°C	Diurnal opportunistic	4hrs 25min 0735 - 1200
	21/10/12	7/8 cloud, no wind, no rain, temp 17-24°C	Diurnal opportunistic	2hrs 20min 0740 - 1000
	22/10/12	8/8 cloud, mod SE wind, showers, temp 13-18°C	Diurnal opportunistic	8hrs 10min 1040 - 1850
	23/10/12	2/8 cloud, no wind, no rain, temp 16-22°C	Diurnal opportunistic	4hrs 10min 1050 - 1500
		1/8 cloud, no wind, no rain, temp 19-15°C	Diurnal opportunistic	3hrs 15min 1600 - 1915
	24/10/12	0/8 cloud, light SW wind, no rain, temp 18-28°C	Diurnal opportunistic	4hrs 50min 0930 - 1420
	25/10/12	0/8 cloud, light NE wind, no rain, temp 17-29°C	Diurnal opportunistic	4hrs 40min 0750 - 1230
Nocturnal birds	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	Owl call playback and spotlighting	2hrs 15min 1815 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting	1hr 5min 2035 - 2140
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 2050
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 2050
	23/10/12	3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 1940
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 1940

Arboreal mammals	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	Spotlighting + call playback (Koala)	2hrs 15min 1815 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting	1hr 5min 2035 - 2140
			Call playback (Koala and Yellow-bellied Glider)	Commenced @ 2110
		8/8 cloud, none-light wind, no rain, temp ~15°C	<i>Elliott</i> trapping	15 trap nights
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
			Call playback (Koala and Yellow-bellied Glider)	Commenced @ 2110
		8/8 cloud, light SE wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
	14/12/11	8/8 cloud, no wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
	15/12/11	8/8 cloud, no wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
	22/10/12	8/8 cloud, mod SE wind, previous showers, temp >9°C	Hair tubes (alternating large & small)	45 trap nights
	23/10/12	no wind, no rain, temp >9°C	Hair tubes (alternating large & small)	45 trap nights
		3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
			Call playback (Koala and Yellow-bellied Glider)	commenced @ 1955
	24/10/12	light SW wind, no rain, temp >12°C	Hair tubes (alternating large and small)	45 trap nights
	25/10/12	light NE wind, no rain, temp >15°C	Hair tubes (alternating large and small)	45 trap nights
		0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
			Call playback (Koala and Yellow-bellied Glider)	commenced @ 1955
	4/5/15	8/8 cloud, light S wind, no rain, temp 19-20°C	Hollow searches in APZ	5hrs 1000-1500
	6/5/15	0/8 cloud, no wind, no rain, temp 21°C	Hollow searches in APZ	6hrs 0900-1500
	7/5/15	0-4/8 cloud, light W wind, no rain, temp 22°C	Hollow searches in APZ	7hrs 15min 1030-1745
	21/5-28/7/15	Various	Denning tubes (Eastern Pygmy Possum) x50	3,000+ tube nights
	21/5/15	2/8 cloud, no wind, no rain, temp 23°C	Habitat assessment quadrats (Eastern Pygmy Possum)	7hrs 1000-1700
	26/5/15	8/8 cloud, light S wind, no rain, temp 18°C	Habitat assessment quadrats (Eastern Pygmy Possum)	6hrs 15min 1045-1700
	4/6/15	1-4/8 cloud, no wind, no rain, temp 20°C	Habitat assessment quadrats (Eastern Pygmy Possum)	6hrs 50min 1010-1700
	28/7/15	0/8 cloud, no wind, no rain, temp 24°C	Habitat assessment (Eastern Pygmy Possum)	6hrs 1100 - 1700
	29/7/15	0/8 cloud, no wind, no rain, temp 16-23°C	Habitat assessment (Eastern Pygmy Possum)	6hrs 45min 0815 - 1500
	5/8/15	8/8 cloud, no wind, no rain, temp 18°C	Habitat assessment (Eastern Pygmy Possum)	8hrs 35min 0910 - 1745
	7/8/15	8/8 cloud, no wind, no rain, temp 16-24°C	Habitat assessment (Eastern Pygmy Possum)	8hrs 25min 0730 - 1555

Terrestrial mammals	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	Spotlighting	2hrs 15min 1815 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting	1hr 5min 2035 - 2140
		8/8 cloud, none-light wind, no rain, temp ~15°C	<i>Elliott</i> trapping	15 trap nights
			Cage trapping (small bandicoot size)	10 trap nights
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
		8/8 cloud, light SE wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
			Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	4 trap nights
	14/12/11	8/8 cloud, no wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
			Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	4 trap nights
	15/12/11	8/8 cloud, no wind, no rain, temp ~16°C	<i>Elliott</i> trapping	30 trap nights
			Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	4 trap nights
	15/10/12	no wind, no rain, temp >15°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
	16/10/12	light NE wind, no rain, temp >19°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
	17/10/12	no wind, no rain, temp >14°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	18/10/12	no wind, no rain, temp >13°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	19/10/12	no wind, no rain, temp >15°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	20/10/12	no wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	21/10/12	no wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	22/10/12	8/8 cloud, mod SE wind, previous showers, temp >9°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	23/10/12	3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights

Terrestrial mammals (cont.)			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	24/10/12	light SW wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
		light NE wind, no rain, temp >15°C	Hair tubes (alternating large and small)	45 trap nights
	6/8/13	2/8 cloud, light W wind, no rain, temp 20-22°C	Habitat assessment & searches for EPP	4hrs 1230 - 1630
	1/5 - 5/6/15	Various	Surveillance cameras x 22	770 camera nights
Bats	25/6 -28/7/15	Various	Surveillance cameras x 4	132 camera nights
	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	<i>Anabat</i> II x3 / spotlighting	2hrs 55min 1735 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting / <i>Anabat</i> active monitoring	1hr 5min 2035 - 2140
		8/8 cloud, none-light wind, no rain, temp ~15°C	Harp (<i>Constantine</i>) trapping	1 trap night
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
		8/8 cloud, light SE wind, no rain, temp ~16°C	<i>Anabat</i> passive monitoring	O'night from 2035
	13/12/11	/8 cloud, light SE wind, no rain, temp ~16°C	Harp (<i>Constantine</i>) trapping	2 trap nights
	14/12/11	8/8 cloud, no wind, no rain, temp ~16°C	Harp (<i>Constantine</i>) trapping	2 trap nights
	15/12/11	8/8 cloud, no wind, no rain, temp ~16°C	Harp (<i>Constantine</i>) trapping	2 trap nights
	16-18/12/11	Various (mostly fine)	<i>Anabat</i> passive monitoring	O'night for 3 nights
	23/10/12	3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	<i>Anabat</i> passive monitoring	O'night from 1925
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
		light NE wind, no rain, temp >15°C	<i>Anabat</i> passive monitoring	2hrs 25min 1925 - 2150

Reptiles	1/05/08	7/8 cloud, light NE wind, no rain, temp 18°C	Habitat search, opportunistic	3hrs 55min 1005 - 1400
		8/8 cloud, no wind, no rain, temp 19.5°C	Habitat search, opportunistic	1hr 20min 1440 - 1600
	2/05/08	0/8 cloud, no wind, no rain, temp 24°C	Habitat search, opportunistic	4hrs 30min 1300 - 1730
	12/12/11	8/8 cloud, moderate gusty SE wind, early showers, temp 18-20°C	Diurnal opportunistic	4hrs 30min 1345 - 1815
		8/8 cloud, light SE wind, no rain, temp 18°C	Diurnal opportunistic	1hr 35min 1845 - 2020
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Opportunistic habitat searches	9hrs 45min 1035 - 2020
	14/12/11	8/8 cloud, light-mod SE wind, no rain, temp 18-20°C	Diurnal opportunistic	4hrs 50min 1040 - 1530
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Opportunistic habitat searches	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Opportunistic habitat searches	35mins 1600 - 1635
	16/12/11	6-8/8 cloud, no wind, no rain, temp 17-21°C	Diurnal opportunistic	6hrs 55min 0950 - 1645
	15/10/12	0/8 cloud, no wind, no rain, temp 27-20°C	Opportunistic / habitat searches	6hrs 30min 1300 - 1930
	16/10/12	5/8 cloud, light NE wind, no rain, temp 23-34°C	Opportunistic / habitat searches	7hrs 30min 0900 - 1630
			Funnel trapping	24 trap days
	17/10/12	3/8 cloud, light NE wind, no rain, temp 22-28°C	Opportunistic / habitat searches	8hrs 20min 0750 - 1610
			Funnel trapping	24 trap days
	18/10/12	8-4/8 cloud, no wind, no rain, temp 18-26°C	Opportunistic / habitat searches	6hrs 20min 0740 - 1400
			Funnel trapping	24 trap days
	19/10/12	8-2/8 cloud, no wind, no rain, temp 17-28°C	Opportunistic / habitat searches	3hrs 40min 0800 - 1140
			Funnel trapping	24 trap days
		2/8 cloud, no wind, no rain, temp 28°C	Opportunistic / habitat searches	2hrs 50min 1220 - 1510
			Funnel trapping	24 trap days
	20/10/12	0/8 cloud, no wind, no rain, temp 18-30°C	Opportunistic / habitat searches	4hrs 25min 0735 - 1200
			Funnel trapping	24 trap days
	21/10/12	7/8 cloud, no wind, no rain, temp 17-24°C	Opportunistic / habitat searches	2hrs 20min 0740 - 1000
			Funnel trapping	24 trap days
	22/10/12	8/8 cloud, mod SE wind, showers, temp 13-18°C	Opportunistic / habitat searches	8hrs 10min 1040 - 1850
		1/8 cloud, no wind, no rain, temp 19-15°C	Opportunistic / habitat searches	3hrs 15min 1600 - 1915
			Funnel trapping	24 trap days
	24/10/12	0/8 cloud, light SW wind, no rain, temp 18-28°C	Opportunistic / habitat searches	4hrs 50min 0930 - 1420
			Funnel trapping	24 trap days
	25/10/12	0/8 cloud, light NE wind, no rain, temp 17-29°C	Opportunistic / GPS cotton line to find burrows	4hrs 40min 0750 - 1230
			Funnel trapping	24 trap days
	4/5/15	8/8 cloud, light S wind, no rain, temp 19-20°C	Goanna burrow searches in APZ	5hrs 1000-1500
	6/5/15	0/8 cloud, no wind, no rain, temp 21°C	Goanna burrow searches in APZ	6hrs 0900-1500
	7/5/15	0-4/8 cloud, light W wind, no rain, temp 22°C	Goanna burrow searches in APZ	7hrs 15min 1030-1745
	16/3/17	8/8 cloud, S winds, rain periods, temp 22°C	Extended APZ habitat review with Gerry Swan	1hr 15min 0845-1000

Amphibians	23/10/12	2/8 cloud, no wind, no rain, temp 16-22°C	Opportunistic / habitat searches	4hrs 10min 1050 - 1500
			Funnel trapping	24 trap days
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Opportunistic habitat searches	9hrs 45min 1035 - 2020
		7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting + call Identification	1hr 30min 2045 - 2215
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Opportunistic habitat searches	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Opportunistic habitat searches	35mins 1600 - 1635
	15/10/12	no wind, no rain, temp >15°C	Funnel trapping	24 trap nights
	16/10/12	light NE wind, no rain, temp >19°C	Funnel trapping	24 trap nights
	17/10/12	no wind, no rain, temp >14°C	Funnel trapping	24 trap nights
	18/10/12	no wind, no rain, temp >13°C	Funnel trapping	24 trap nights
	19/10/12	no wind, no rain, temp >15°C	Funnel trapping	24 trap nights
	20/10/12	no wind, no rain, temp >12°C	Funnel trapping	24 trap nights
	21/10/12	no wind, no rain, temp >12°C	Funnel trapping	24 trap nights
	22/10/12	8/8 cloud, mod SE wind, previous showers, temp >9°C	Funnel trapping	24 trap nights
	23/10/12	1/8 cloud, no wind, no rain, temp 19-15°C	Diurnal habitat searches	3hrs 15min 1600 - 1915
		no wind, no rain, temp 15-13°C	Spotlighting /call identification / tadpole searches	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	Funnel trapping	24 trap nights
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting / call Identification / tadpole searches	2hrs 50min 1930 - 2220
	22/4/13	1/8 cloud, no wind, prev. weeks heavy rain, 23-18°C	Red-crowned Toadlet habitat / tadpole searches	2hrs 55min 1505 - 1800
		0/8 cloud, no wind, prev. weeks heavy rain, 18-16°C	Spotlighting /call identification / tadpole searches	2hrs 55min 1800 - 2100
	24/4/13	0/8 cloud, no wind, no rain, 21-17°C	Red-crowned Toadlet habitat / tadpole searches	4hrs 1400 - 1800
		0/8 cloud, no wind, no rain, 4/4 moon, 16-10°C	Spotlighting /call identification / tadpole searches	6hrs 1800 - 2400
	7/5/13	8/8 cloud, no wind, prev. night rain, 18°C	Red-crowned Toadlet habitat / tadpole searches	2hrs 45min 1515 - 1800
		3-7/8 cloud, no wind, no rain, no moon, 17-10°C	Spotlighting /call identification / tadpole searches	4hrs 55min 1830 - 2325
	4/5/15	8/8 cloud, light S wind, no rain, temp 19-20°C	Breeding habitat searches in APZ	5hrs 1000-1500
	6/5/15	0/8 cloud, no wind, no rain, temp 21°C	Breeding habitat searches in APZ	6hrs 0900-1500
	7/5/15	0-4/8 cloud, light W wind, no rain, temp 22°C	Breeding habitat searches in APZ	7hrs 15min 1030-1745
	7/8/15	8/8 cloud, no wind, no rain, temp 16-24°C	Giant Burrowing Frog tadpole searches	30min 1100-1130
	16/3/17	8/8 cloud, S winds, rain periods, temp 22°C	Extended APZ habitat assessment	1hr 45min 0845-1030

2.5 Site specific survey techniques

2.5.1 Diurnal birds

All diurnal bird surveys have been opportunistic observations during other survey methods. This is considered to be adequate based on the high number of diurnal hours spent in the field to date.

2.5.2 Nocturnal birds

Given the suitability of habitat present, Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*) and Barking Owl (*Ninox connivens*) were targeted by call playback techniques.

Observations for large hollows suitable for owls and signs of owl activity, in particular whitewash below perches / roost sites, were undertaken during survey.

2.5.3 Arboreal mammals

Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) were targeted by call playback only from locations identified on Figure 4a.

2011 surveys

Thirty three (33) arboreal Type A *Elliott* traps were used along seven (7) trap-lines indicated on Figure 4a, consisting of five (5) traps each separated by 20-50m. Eastern Pygmy Possum was principally targeted and, accordingly, arboreal traps were placed more commonly in larger flowering *Banksia* trees.

2012 surveys

Arboreal hair tubes were placed along six (6) transect lines indicated on Figure 4a, consisting of five (5) tubes each separated by 20-50m. Again, Eastern Pygmy Possum was principally targeted and accordingly arboreal traps were placed more commonly in larger flowering *Banksia* trees. The honey-water lure sprayed onto the branches and down to the base of the tree was a high honey concentrate.

2013 surveys

Specialist Dr Ross Goldingay was engaged to undertake a preliminary site habitat assessment and advice for Eastern Pygmy Possum. The assessment by Dr Goldingay is outlined within his report within Appendix 6.

Travers bushfire & ecology assisted Dr Goldingay by providing a site introduction and preliminary habitat searches for den locations within the subject site area on 6 August 2013.

2015 surveys

Eastern Pygmy Possum specialist Dr Ross Goldingay required further data collection on the number of suitable hollows present within the offset conservation lands to complete his EPP assessment. Sixteen (16) 20m x 200m habitat assessment quadrats were initially 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. Each quadrat was equivalent to four (x4) biometric quadrats (20m x 50m). 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. 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 myrtaceous tree species.

This habitat data was reviewed and then determined (under the guidance of Dr Ross Goldingay) that the areas of Low Open Forest (LOF) 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 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 compared against similar quadrat data at ten local reference locations within the Northern Beaches 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).

Further quadrat data was then collected to amount 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 included some initial half 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 slightly 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.

Dr Goldingay in his specialist report then applied the calculated areas of high, medium and low quality habitat to his data on EPP habitat considered as high quality habitat within Royal National Park.

Custom built denning/nesting tubes for Eastern Pygmy Possum were also placed within the initial quadrats undertaken in all communities. These were placed at 50m separations (5 tubes per double quadrat) along ten (10) quadrats located in the offset areas to assist in determining the presence of the species in these areas. The ten selected quadrats were all located in Low Open Forest (x7) and Open Forest (x3) communities with none located in the Sandstone Gully Forest quadrats due to containing little banksia representation.

The tubes were constructed of 80mm PVC pipe at lengths of 240mm with PVC caps placed on either end. A 34mm hole is cut into the side at one end. Flyscreen mesh is taped around the tubes to permit climbing access to the entry hole. A 40mm cardboard post pack tube is cut to fit inside and this tube also has the end caps placed on to conceal the inner chamber. Bubble wrap is wrapped around the inside tube for extra insulation. Tubes are tied vertically in trees, preferably flowering banksias, with the entry hole located at the top.

The tubes were placed for a period of nine weeks from the end of autumn accounting for the overlap in flowering of *Banksia ericifolia* and *B. serrata*. Dr Goldingay advised that Eastern Pygmy Possum were readily recorded during early winter surveys in Royal National Park and breeding is driven by the flowering of *Banksia ericifolia*.

Suitable low hollows for EPP were checked for presence or signs of occupation with a video-scope during data collection within habitat assessment quadrats as well as whilst retrieving the EPP tubes. The video-scope allows a tilting video head view projected onto a small screen and allows inspections down to 1.5m deep. Where nesting material was observed photos were taken to analyse the bedding material. One of the local habitat assessment quadrats was undertaken within the adjacent Garigal National Park approximately 600m west of the study area. Several hollows surrounding this quadrat were also checked with the video-scope for any signs of EPP activity that would be part of the same population area.

2.5.4 Terrestrial mammals

2011 surveys

Bandicoot sized cage traps were used to target Southern Brown Bandicoot. These were placed along trap lines of five (5) traps baited with the standard bait mix and laced with white truffle oil.

Elliott type B traps were placed along the same trap-lines as arboreal traps. These were baited with the standard bait mix and also laced with white truffle oil as an additional effort towards targeting Southern Brown Bandicoot. This method captured three (3) of the larger Long-nosed Bandicoot.

Large cage traps were used to target Spotted-tailed Quoll. Four (4) traps were placed at the outer limits of the site above sandstone edges. These traps were baited with sardines and nearby trees were smeared with jelly meat cat food as a lure.

Two (2) surveillance cameras were placed within heath vegetation at opposing ends of the proposed development area. The viewing area was baited with standard bait mix, truffle oil and sardines to target the trap shy Southern Brown Bandicoot and the Spotted-tailed Quoll.

2012 surveys

Bandicoot sized cage traps and larger quoll sized cages were used to target Southern Brown Bandicoot. These were placed along trap lines of four to six (4-6) traps (Figure 4a), baited with the standard bait mix and laced with white truffle oil. Five (5) individually placed large cage traps were also placed and baited, targeting bandicoot (see Figure 4a). A total of fifteen (15) quoll sized traps and twenty (20) bandicoot sized traps were placed targeting bandicoot over ten (10) consecutive nights, however five (5) of the large traps were also baited to target Spotted-tailed Quoll and Rosenberg's Goanna in the last four (4) days / nights.

Five (5) large cage traps targeting quoll were used at the outer limits of the site above sandstone edges. These traps were baited with sardines, two-week old dead chickens and nearby trees were smeared with jelly meat cat food as a lure.

Three (3) surveillance cameras were placed within the proposed development area. These cameras were moved after the first five (5) nights to a second location for the next four (4) nights totalling six (6) surveillance camera locations. At four (4) locations the camera was placed facing cage traps to assist in determining trap shy animals on site. Three (3) of these traps were baited targeting both bandicoot and quoll. It should be noted here that Northern

Brown Bandicoot (*Isoodon macrourus*) and Long-nosed Bandicoot (*Parameles nasuta*) have been captured by *Travers bushfire & ecology* on meat baits alone.

The other two (2) camera locations were placed facing bait located on the ground. One (1) of these was the standard bait mix with truffle oil the other also had sardines. See Figure 4a for trap and camera locations.

2015 surveys

OEH has requested further targeted surveys for Southern Brown Bandicoot based on previous survey limitations to the national Guidelines. A review of these Draft Referral Guidelines prepared by SEWPAC (2011) indicated that infra-red cameras are the preferred method of survey and should be undertaken with secondary techniques. Previous camera effort did not account for the required 1 camera per 2 hectares (for affected areas > 10 ha ≤ 30 ha) over two survey periods.

Subsequently the numbers of cameras required for the subject site was calculated at 13. A georeferenced trapping grid was placed over the subject site allowing for 16 camera stations within the subject site and an additional 6 cameras placed in offset areas surrounding the subject site. The camera stations were placed on the grid intersections to ensure an even cover of the survey area and locations were altered where these were over or near roads or trails. The trapping grid and camera locations are shown on Figure 4a.

White truffle oil was poured over a sponge and then placed in a perforated bait tube that was secured to the ground with a steel peg as an attractant for the initial survey period. Cameras were initially left for 35 nights. An inspection of camera footage recorded bandicoot activity at four stations within the subject site; however some images were obscure and could not provide accurate identification. Two separate cameras were then placed at each of these four stations for a second period of 33 nights. Both truffle oil and peanut butter/rolled oats/honey mix were used as bait for the second survey period.

An analysis of these cameras provided more images to confirm the species present. All first and second round bandicoot images were also provided to Dr David Paull, a senior lecturer at UNSW and bandicoot specialist, for confirmation identification.

2.5.5 Bats

2011 surveys

Two (2) harp traps were placed along flyways of internal vehicle trails where an overhanging tree branch could funnel captures into the trap.

Active *Anabat* monitoring and passive recording stations were undertaken.

2012 surveys

Bats were targeted by passive *Anabat* recording, spotlighting and habitat searches.

2.5.6 Amphibians

2011 surveys

Searches for Red-crowned Toadlet were undertaken along located drainage lines; and in response to where a previous recording was made in 2008.

2012 surveys

Diurnal habitat searches were undertaken around the escarpment edge to determine suitable locations for Red-crowned Toadlet and / or Giant Burrowing Frog breeding potential. The survey period followed a dry spring period and most ephemeral drainages were completely dry, including both locations where the species was recorded previously. Where pools were found, tadpole searches were undertaken, as well as during nocturnal surveys. Clapping and yelling was carried out to evoke a call response where suitable habitat was present.

During nocturnal searches along drainage lines, spotlighting was undertaken to search for Giant Burrowing Frog. This species is best spotlighted on wet nights down to 13°C, however, both survey nights were under dry conditions. The first nocturnal surveys were undertaken the night after the only rainy day and night of the survey period. This wet night was however also very windy and generally inappropriate for frog survey.

2013 surveys

Frog specialist Prof Michael Mahony was engaged to undertake additional frog surveys and provide expert advice following the recording of Red-crowned Toadlet breeding locations within and surrounding the subject site and location of a Giant Burrowing Frog juvenile within a funnel trap. Specific survey effort and measures deployed by Prof Mahony are outlined within his report within Appendix 6.

Travers bushfire & ecology assisted Prof Mahony in undertaking targeted habitat searches specifically for Red-crowned Toadlet. The effort by *Travers bushfire & ecology* is provided within Table 2.2. The joint survey effort and habitat assessment is depicted in Figure 6.

2015 surveys

Additional breeding locations for Giant Burrowing Frog and Red-crowned Toadlet were recorded opportunistically whilst undertaking Eastern Pygmy Possum habitat assessments throughout the offset area.

2017 habitat assessment

A recent site visit was undertaken within the extended APZ areas since the May 2016 assessment. This was undertaken predominantly within the large north-eastern and south-eastern APZ extensions below the powerline easements leading from the neighboring substation. Searches were undertaken for suitable breeding habitat specifically for Red-crowned Toadlet and Giant Burrowing Frog within these areas.

2.5.7 Reptiles

2011 surveys

Two (2) surveillance cameras were placed within heath vegetation at opposing ends of the proposed development area. The viewing area was baited with sardines to target Rosenberg's Goanna. Two (2) afternoons (13 & 15/12/11) during the survey week were considered most suitable for Rosenberg's Goanna activity. The species was only opportunistically surveyed at this time.

2012 surveys

Four (4) funnel trap transects were placed within the proposed development area targeting reptiles and frogs. Six (6) funnel traps were placed on either side of the approximately 10-15m long fence line at each transect. Funnel trap transects were located within or near to representations of different vegetation communities.

Five (5) large cage traps targeting Rosenberg's Goanna and Spotted-tailed Quoll were placed at the outer limits of the site, above sandstone edges. These traps were baited with sardines and two week old dead chickens and nearby trees were smeared with jelly meat cat food as a lure.

Three (3) surveillance cameras were faced to baited cages targeting goanna, bandicoot and quoll. One (1) additional camera location was baited with sardines. See Figure 4a for trap and camera locations. Locations indicated with a "Q" on Figure 4 were baited with meat targeting goanna and quoll.

2013 surveys

Reptile specialist Gerry Swan was engaged to undertake additional targeted surveys and to provide expert advice on Rosenberg's Goanna. Survey effort by Mr Swan is summarised within his report in Appendix 5.

2015 surveys

A Fuel Management Plan was prepared by TBE in 2015 to manage habitat features within the proposed APZ. As part of the preparation of this document, habitat searches were undertaken throughout the APZ areas. Habitat searches included the identification of any likely or old burrows for Rosenberg's Goanna. Where burrows or other potential habitat features were identified these were recorded by GPS and mapped for protection. Locations are shown on Figure 4b.

2017 habitat assessment

A site visit was undertaken with reptile specialist Gerry Swan on the 16/3/17 within the recently extended APZ area to the north-east of the subject site. This visit was to inspect approximately 0.82 ha of the APZ that extended into important habitat areas for Rosenberg's Goanna as identified and mapped in Mr Swan's previous assessment.

2.6 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the subject site for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the subject site outside the nominated survey period.

Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Flora survey limitations

- *Tetratheca glandulosa* – Target surveys for the species have been limited in their coverage due to the density of the understorey vegetation and distance from tracks which makes access to some areas very difficult. The upper half of the gullies below the main ridge lines within the offset areas which are not too sheltered would provide some levels of potential habitat for this species. Surveys have been undertaken over two (2) flowering seasons within the subject site. Therefore, there should be no significant limitation to such surveys within the development areas, however, the total population size can only be estimated given the limited surveys undertaken within offset lands.
- *Grevillea caleyi* – whilst post fire burns have been undertaken for this species, the current population noted both on site and in the adjoining Transgrid lands is less than the 2013 survey possibly due to predation by grazing animals on the young fresh growth. *Grevillea caleyi* seed material may last several more years in the seed bank before resprouting and it is known to coppice, therefore it may be difficult to count the true number of plants. This is one of the reasons why the number of specimens reported throughout previous versions of this report has changed / fluctuated.

Fauna survey limitations

Extensive mammal survey effort has been undertaken inclusive of a range of trapping methods targeting threatened fauna species occurrence inclusive of hair tubes, Elliott trapping, cage trapping and surveillance cameras. The Elliott trapping and hair tube effort for small mammals has not been undertaken to satisfy the extensive survey effort of 80 trap nights per hectare required under the national survey Guidelines for detecting mammals listed as threatened under the *EPBC Act* (SEWPAC 2011).

For the purposes of the EPBC Act Assessment, the New Holland Mouse is a nationally listed species that has not been identified present during surveys undertaken to date. There is suitable habitat for this species within the subject site given heath community associations and sandy soils and there are local records of this species including one record from 2001 in the connective landscape approximately 900m to the WSW from the subject site.

A mouse was recorded during most recent 2015 surveillance camera surveys at three survey points within the subject site but its identification could not be confirmed. New Holland Mouse & House Mouse have not been trapped onsite during any trapping surveys undertaken to date. Regardless of trapping deficiencies, the national assessment of New Holland Mouse considers the presence and suitability of habitat within the proposed offset and connective habitats.

For the purposes of an EPBC referral only, terrestrial Elliott trapping effort is recommended to trap and identify mouse species within the site. These may be concentrated around the camera locations that recorded mouse activity until a positive identification is achieved. This survey can be addressed if required for the purposes of an EPBC assessment and referral.

Detailed habitat tree surveys have not been undertaken within the subject site, and such detail is not considered to be of importance for the purposes of impact assessment. Habitat assessment quadrats have been undertaken to support the Eastern Pygmy Possum assessment. Detailed habitat tree surveys within the subject site should however be completed as part of the vegetation clearance operations to ensure all hollow dependent species are effectively recovered prior to removal of habitat. This is particularly important for Eastern Pygmy Possum.



Survey Results

3

Vegetation communities, flora survey effort and results are shown on Figures 3a, 3b & 3c (study area) and fauna survey effort and results are shown on Figures 4a & 4b.

3.1 Flora results

3.1.1 Flora species

A total of two hundred and ninety nine (299) flora species were observed within the study area during the survey. This number comprised 226 native species and 73 exotic species. It should be noted that the majority of exotic species were only recorded adjacent to the Ralston Avenue entrance into the development area, around the existing residence or adjacent to prominent tracks. The remainder of the development area contained very few weeds. During the investigations, two (2) threatened flora species were sighted, *Tetratheca glandulosa* and *Grevillea caleyi*.

The plants observed within the vegetation communities of the study area are listed in Table 3.1. Plants recorded within quadrats in 2015 not previously in the list below have been added.

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Mimosaceae	<i>Acacia brownii</i>	-	s
Mimosaceae	<i>Acacia decurrens</i>	Black Wattle	t
Mimosaceae	<i>Acacia floribunda</i>	Sally Wattle	s
Mimosaceae	<i>Acacia longifolia</i> var. <i>longifolia</i>	Sydney Golden Wattle	s
Mimosaceae	<i>Acacia lunata</i>	Box-leaved Wattle	s
Mimosaceae	<i>Acacia myrtifolia</i>	Red Stem Wattle	s
Mimosaceae	<i>Acacia parramattensis</i>	Sydney Green Wattle	t
Mimosaceae	<i>Acacia saligna</i> *	Orange Wattle	s
Mimosaceae	<i>Acacia suaveolens</i>	Sweet Scented Wattle	s
Mimosaceae	<i>Acacia terminalis</i>	Sunshine Wattle	s
Mimosaceae	<i>Acacia ulicifolia</i>	Prickly Moses	s
Polygonaceae	<i>Acetosa saggitata</i> *	Turkey Rhubarb	g
Asteraceae	<i>Actinotus helianthi</i>	Flannel Flower	g
Asteraceae	<i>Actinotus minor</i>	Lesser Flannel Flower	g
Asteraceae	<i>Ageratina adenophora</i> *	Crofton Weed	g
Casuarinaceae	<i>Allocasuarina distyla</i>	Scrub She-oak	s
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-oak	t
Myrsinaceae	<i>Anagallis arvensis</i> var. <i>caerulea</i> *	Blue Pimpernel	g
Poaceae	<i>Andropogon virginicus</i> *	Whisky Grass	g
Myrtaceae	<i>Angophora costata</i>	Smooth-barked Apple	t
Myrtaceae	<i>Angophora crassifolia</i>	-	t
Myrtaceae	<i>Angophora hispida</i>	Dwarf Apple	s
Poaceae	<i>Anisopogon avenaceus</i>	Oat Speargrass	g

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Apocnyaceae	<i>Araujia sericifera</i> *	Mothvine	v
Poaceae	<i>Aristida vagans</i>	Three-awn Speargrass	g
Asparagaceae	<i>Asparagus aethiopicus</i> *	Asparagus Fern	g
Asteraceae	<i>Aster subulatus</i> *	Wild Aster	g
Araliaceae	<i>Astrotricha floccosa</i>	-	s
Poaceae	<i>Austrodanthonia</i> sp.	Wallaby Grass	g
Poaceae	<i>Avena fatua</i> *	Wild Oats	g
Poaceae	<i>Axonopus affinis</i> *	Narrow-leaved Carpet Grass	g
Myrtaceae	<i>Baeckea brevifolia</i>	-	s
Myrtaceae	<i>Baeckea diosmifolia</i>	-	s
Myrtaceae	<i>Baeckea imbricata</i>	-	s
Restionaceae	<i>Baloskion gracile</i>	-	g
Restionaceae	<i>Baloskion tetraphyllum</i>	-	g
Proteaceae	<i>Banksia ericifolia</i> var. <i>ericifolia</i>	Heath-leaved Banksia	s
Proteaceae	<i>Banksia marginata</i>	Silver Banksia	s
Proteaceae	<i>Banksia oblongifolia</i>	-	s
Proteaceae	<i>Banksia serrata</i>	Old Man Banksia	t
Proteaceae	<i>Banksia spinulosa</i>	Hairpin Banksia	s
Cunoniaceae	<i>Bauera rubioides</i>	River Rose	s
Cyperaceae	<i>Baumea juncea</i>	-	g
Asteraceae	<i>Bidens pilosa</i> *	Cobbler's Pegs	g
Pittosporaceae	<i>Billardiera scandens</i> var. <i>scandens</i>	Apple Dumplings	v
Blandfordiaceae	<i>Blandfordia nobilis</i>	Christmas Bells	g
Blechnaceae	<i>Blechnum cartilagineum</i>	Gristle Fern	g
Rutaceae	<i>Boronia ledifolia</i>	Sydney Boronia	s
Rutaceae	<i>Boronia pinnata</i>	Pinnate Boronia	s
Rutaceae	<i>Boronia serrulata</i>	Native Rose	s
Fabaceae	<i>Bossiaea heterophylla</i>	Variable Bossiaea	s
Fabaceae	<i>Bossiaea obcordata</i>	Spiny Bossiaea	s
Fabaceae	<i>Bossiaea scolopendria</i>	-	s
Poaceae	<i>Briza maxima</i> *	Quaking Grass	g
Poaceae	<i>Briza minor</i> *	Shivery Grass	g
Poaceae	<i>Bromus cartharticus</i> *	Prairie Grass	g
Cunoniaceae	<i>Callicoma serratifolia</i>	Black Wattle	t
Myrtaceae	<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush	s
Dicksoniaceae	<i>Calochlaena dubia</i>	Rainbow Fern	g
Lauraceae	<i>Cassytha pubescens</i>	Common Devil's Twine	v
Cyperaceae	<i>Caustis flexuosa</i>	Curly Sedge	g
Cyperaceae	<i>Caustis pentandra</i>	-	g
Gentianaceae	<i>Centaurium erythraea</i> *	Pink Stars	g
Apiaceae	<i>Centella asiatica</i>	Swamp Pennywort	g
Carophyllaceae	<i>Cerastium glomeratum</i> *	Mouse-ear Chickweed	g
Poaceae	<i>Chloris gayana</i> *	Rhodes Grass	g
Restionaceae	<i>Chordifex fastigiatus</i>	-	g
Asteraceae	<i>Chrysanthemoides monilifera</i> subsp. <i>monilifera</i> *	Bitou Bush	s
Asteraceae	<i>Cirsium vulgare</i> *	Spear Thistle	g
Ranunculaceae	<i>Clematis aristata</i>	Old Man's Beard	v
Polygalaceae	<i>Comesperma ericinum</i>	Matchheads	s

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Proteaceae	<i>Conospermum longifolium</i> subsp. <i>longifolium</i>	Smokebush	s
Proteaceae	<i>Conospermum taxifolium</i>	Variable Smoke-bush	s
Asteraceae	<i>Conyza bonariensis</i> *	Flax-leaf Fleabane	g
Asteraceae	<i>Conyza sumatrensis</i> *	Fleabane	g
Asteraceae	<i>Coreopsis lanceolata</i> *	-	g
Poaceae	<i>Cortaderia selloana</i> *	Pampas Grass	g
Myrtaceae	<i>Corymbia gummifera</i>	Red Bloodwood	t
Malaceae	<i>Cotoneaster pannosus</i> *	Cotoneaster (cultivar)	s
Asteraceae	<i>Crassocephalum crepidioides</i> *	Thickheads	g
Orchidaceae	<i>Cryptostylis erecta</i>	Bonnet Orchid	g
Orchidaceae	<i>Cryptostylis subulata</i>	Target Tongue Orchid	g
Cyatheaceae	<i>Cyathea australis</i>	Black Tree-fern	t
Cyatheaceae	<i>Cyathea cooperi</i>	Straw Tree-fern	t
Cyperaceae	<i>Cyathochaeta diandra</i>	-	g
Apiaceae	<i>Cyclospermum leptophyllum</i> *	Slender Celery	g
Poaceae	<i>Cynodon dactylon</i>	Common Couch	g
Cyperaceae	<i>Cyperus eragrostis</i> *	Umbrella Sedge	g
Goodeniaceae	<i>Dampiera stricta</i>	Blue Dampiera	g
Myrtaceae	<i>Darwinia fascicularis</i> subsp. <i>fascicularis</i>	-	s
Asteraceae	<i>Delairea odorata</i> *	Cape Ivy	v
Phormiaceae	<i>Dianella caerulea</i> var. <i>caerulea</i>	Flax Lily	g
Phormiaceae	<i>Dianella caerulea</i> var. <i>producta</i>	Blue Flax Lily	g
Phormiaceae	<i>Dianella prunina</i>	-	g
Poaceae	<i>Digitaria sanguinalis</i> *	Crab Grass	g
Fabaceae	<i>Dillwynia floribunda</i> var. <i>floribunda</i>	Parrot Pea	s
Fabaceae	<i>Dillwynia glaberrima</i>	Parrot Pea	s
Fabaceae	<i>Dillwynia retorta</i> var. <i>retorta</i>	Eggs and Bacon	s
Orchidaceae	<i>Dipodium punctatum</i>	Hyacinth Orchid	g
Asteraceae	<i>Dittrichia graveolens</i> *	Stinkwort	g
Sapindaceae	<i>Dodonaea triquetra</i>	Hop Bush	s
Droseraceae	<i>Drosera peltata</i>	Sundew	g
Droseraceae	<i>Drosera spathulata</i>	Common Sundew	g
Poaceae	<i>Ehrharta erecta</i> *	Panic Veldtgrass	g
Eleocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash	t
Poaceae	<i>Eleusine indica</i> *	Crowsfoot Grass	g
Restionaceae	<i>Empodisma minus</i>	-	g
Poaceae	<i>Entolasia marginata</i>	Bordered Panic	g
Poaceae	<i>Entolasia stricta</i>	Wiry Panic	g
Epacridaceae	<i>Epacris longiflora</i>	Native Fuschia	s
Epacridaceae	<i>Epacris microphylla</i>	Coral Heath	s
Epacridaceae	<i>Epacris obtusifolia</i>	-	s
Epacridaceae	<i>Epacris pulchella</i>	NSW Coral Heath	s
Poaceae	<i>Eragrostis brownii</i>	Brown's Lovegrass	g
Poaceae	<i>Eragrostis curvula</i> *	African Lovegrass	g
Asteraceae	<i>Erigeron karvinskianus</i> *	Mexican Daisy	g
Fabaceae	<i>Erythrina sykesii</i> *	Coral Tree	t
Myrtaceae	<i>Eucalyptus haemastoma</i>	Scribbly Gum	t
Myrtaceae	<i>Eucalyptus luehmanniana</i>	Yellowtop Ash	t

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Myrtaceae	<i>Eucalyptus oblonga</i>	Narrow-leaved Stringybark	t
Myrtaceae	<i>Eucalyptus piperita</i> subsp. <i>piperita</i>	Sydney Peppermint	t
Myrtaceae	<i>Eucalyptus punctata</i>	Grey Gum	t
Myrtaceae	<i>Eucalyptus sieberi</i>	Silvertop Ash	t
Asteraceae	<i>Euchiton sphaericus</i>	Cudweed	g
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry	v
Cyperaceae	<i>Ficinia nodosa</i>	Knobby Club-rush	g
Cyperaceae	<i>Gahnia clarkei</i>	Tall Saw-sedge	g
Cyperaceae	<i>Gahnia melanocarpa</i>	Black-fruit Saw-sedge	g
Cyperaceae	<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge	g
Asteraceae	<i>Gamochaeta spicata</i> *	Cudweed	g
Gleicheniaceae	<i>Gleichenia dicarpa</i>	Pouched Coral Fern	g
Gleicheniaceae	<i>Gleichenia microphylla</i>	Scrambling Coral Fern	g
Euphorbiaceae	<i>Glochidion ferdinandii</i>	Cheese Tree	t
Fabaceae	<i>Glycine microphylla</i>	-	v
Fabaceae	<i>Gompholobium grandiflorum</i>	Golden Glory Pea	s
Fabaceae	<i>Gompholobium latifolium</i>	Broad-leaf Wedge-pea	s
Haloragaceae	<i>Gonocarpus tetragynus</i>	-	g
Haloragaceae	<i>Gonocarpus teuroides</i>	Raspwort	g
Goodeniaceae	<i>Goodenia bellidifolia</i>	Daisy-leaved Goodenia	g
Goodeniaceae	<i>Goodenia dimorpha</i> var. <i>dimorpha</i>	-	g
Goodeniaceae	<i>Goodenia hederacea</i>	Ivy-leaved Goodenia	g
Goodeniaceae	<i>Goodenia heterophylla</i> subsp. <i>heterophylla</i>	-	g
Proteaceae	<i>Grevillea buxifolia</i> subsp. <i>buxifolia</i>	Grey Spider Flower	s
Proteaceae	<i>Grevillea caleyi</i> ^{TS}	-	s
Proteaceae	<i>Grevillea linearifolia</i>	Linear-leaf Grevillea	s
Proteaceae	<i>Grevillea sericea</i>	Pink Spider Flower	s
Proteaceae	<i>Grevillea</i> sp. (cultivar)*	-	s
Proteaceae	<i>Grevillea speciosa</i>	Red Spider Flower	s
Haemodoraceae	<i>Haemodorum corymbosum</i>	Bloodroot	g
Haemodoraceae	<i>Haemodorum planifolium</i>	Bloodroot	g
Proteaceae	<i>Hakea dactyloides</i>	Broad-leaved Hakea	s
Proteaceae	<i>Hakea salicifolia</i>	Willow Hakea	s
Proteaceae	<i>Hakea sericea</i>	Needlebush	s
Proteaceae	<i>Hakea teretifolia</i>	Dagger Hakea	s
Zingiberaceae	<i>Hedychium gardnerianum</i> *	Ginger Lily	g
Lamiaceae	<i>Hemigenia purpurea</i>	Narrow-leaved Hemigenia	s
Dilleniaceae	<i>Hibbertia aspera</i>	Rough Guinea Flower	g
Dilleniaceae	<i>Hibbertia bracteata</i>	-	s
Dilleniaceae	<i>Hibbertia cistiflora</i>	-	s
Dilleniaceae	<i>Hibbertia empetrifolia</i> subsp. <i>uncinata</i>	-	g
Dilleniaceae	<i>Hibbertia linearis</i>	-	g
Dilleniaceae	<i>Hibbertia serpyllifolia</i>	Hairy Guinea-flower	g
Euphorbiaceae	<i>Homalanthus populifolius</i>	Bleeding Heart	s
Fabaceae	<i>Hovea linearis</i>	-	g
Violaceae	<i>Hybanthus monopetalus</i>	Slender Violet-bush	g
Apiaceae	<i>Hydrocotyle bonariensis</i> *	Kurnell Curse / Pennywort	g
Clusiaceae	<i>Hypericum gramineum</i>	Small St Johns Wort	g

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Asteraceae	<i>Hypochaeris glabra</i> *	Smooth Catsear	g
Asteraceae	<i>Hypochaeris radicata</i> *	Flatweed	g
Dennstaedtiaceae	<i>Hypolepis muelleri</i>	Harsh Ground Fern	g
Poaceae	<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass	g
Convolvulaceae	<i>Ipomoea indica</i> *	Coastal Morning Glory	v
Proteaceae	<i>Isopogon anemonifolius</i>	Flat-leaved Drumsticks	s
Proteaceae	<i>Isopogon anethifolius</i>	Round-leaved Drumsticks	s
Fabaceae	<i>Jacksonia scoparia</i>	Dogwood	s
Juncaceae	<i>Juncus articulatus</i>	Jointed Rush	g
Juncaceae	<i>Juncus planifolius</i>	Broad Rush	g
Juncaceae	<i>Juncus usitatus</i>	Common Rush	g
Fabaceae	<i>Kennedia rubicunda</i>	Dusky Coral Pea	v
Myrtaceae	<i>Kunzea ambigua</i>	Tick Bush	s
Myrtaceae	<i>Kunzea capitata</i>	Pink Buttons	s
Proteaceae	<i>Lambertia formosa</i>	Mountain Devil	s
Verbenaceae	<i>Lantana camara</i> *	Lantana	s
Sterculiaceae	<i>Lasiopetalum ferrugineum</i> var. <i>ferrugineum</i>	Rusty Velvet-bush	s
Sterculiaceae	<i>Lasiopetalum parviflorum</i>	-	s
Rutaceae	<i>Leionema diosmeum</i>	-	s
Cyperaceae	<i>Lepidosperma filiforme</i>	-	g
Cyperaceae	<i>Lepidosperma laterale</i>	Variable Sword-sedge	g
Cyperaceae	<i>Lepidosperma limicola</i>	-	g
Restionaceae	<i>Leptocarpus tenax</i>	Slender Twine-rush	g
Myrtaceae	<i>Leptospermum continentale</i>	Prickly Tea-tree	s
Myrtaceae	<i>Leptospermum grandifolium</i>	Woolly Tea-tree	s
Myrtaceae	<i>Leptospermum laevigatum</i>	Coast Tea-tree	s
Myrtaceae	<i>Leptospermum polygalifolium</i>	Lemon Scented Tea-tree	s
Myrtaceae	<i>Leptospermum squarrosus</i>	-	s
Myrtaceae	<i>Leptospermum trinervium</i>	Flaky-barked Tea-tree	s
Restionaceae	<i>Lepyrodia scariosa</i>	Scale Rush	g
Epacridaceae	<i>Leucopogon amplexicaulis</i>	Beard-heath	s
Epacridaceae	<i>Leucopogon esquamatus</i>	-	s
Epacridaceae	<i>Leucopogon lanceolatus</i>	Lance-leaf Beard-heath	s
Epacridaceae	<i>Leucopogon microphyllus</i>	Small-leaved Whitebeard	s
Epacridaceae	<i>Leucopogon muticus</i>	Blunt Beard-heath	s
Oleaceae	<i>Ligustrum sinense</i> *	Small-leaved Privet	s
Liliaceae	<i>Lilium formosanum</i> *	Formosan Lily	g
Lindsaeaceae	<i>Lindsaea linearis</i>	Screw Fern	g
Lindsaeaceae	<i>Lindsaea microphylla</i>	Lacy Wedge-fern	g
Lomandraceae	<i>Lomandra cylindrica</i>	-	g
Lomandraceae	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush	g
Lomandraceae	<i>Lomandra glauca</i> subsp. <i>glauca</i>	-	g
Lomandraceae	<i>Lomandra gracilis</i>	-	g
Lomandraceae	<i>Lomandra longifolia</i>	Spiky-headed Mat-rush	g
Lomandraceae	<i>Lomandra multiflora</i>	Many-flowered Mat-rush	g
Lomandraceae	<i>Lomandra obliqua</i>	Twisted Mat-rush	g
Proteaceae	<i>Lomatia myricoides</i>	River Lomatia	s
Proteaceae	<i>Lomatia silaifolia</i>	Crinkle Bush	s

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Family	Scientific Name	Common Name	Form
Caprifoliaceae	<i>Lonicera japonica</i> *	Japanese Honeysuckle	v
Myrtaceae	<i>Melaleuca armillaris</i>	Bracelet Honey Myrtle	s
Myrtaceae	<i>Melaleuca hypericifolia</i>	-	s
Meliaceae	<i>Melia azedarach</i> var. <i>australasica</i>	White Cedar	t
Euphorbiaceae	<i>Micrantheum ericoides</i>	-	s
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Rice Grass	g
Myrtaceae	<i>Micromyrtus ciliata</i>	-	s
Fabaceae	<i>Mirbelia rubiifolia</i>	-	s
Loganiaceae	<i>Mitrasacme polymorpha</i>	Mitrewort	g
Davalliaceae	<i>Nephrolepis cordifolia</i> *	Fish-bone Fern	g
Apocynaceae	<i>Nerium oleander</i> *	Oleander Bush	s
Olcaceae	<i>Olax stricta</i>	-	s
Rubiaceae	<i>Opercularia aspera</i>	Common Stinkweed	g
Rubiaceae	<i>Opercularia diphylla</i>	-	g
Poaceae	<i>Oplismenus aemulus</i>	Basket Grass	g
Poaceae	<i>Oplismenus imbecillis</i>	-	g
Oxalidaceae	<i>Oxalis exilis</i>	-	g
Asteraceae	<i>Ozothamnus diosmifolius</i>	Ball Everlasting	s
Poaceae	<i>Panicum simile</i>	Two Colour Panic	g
Poaceae	<i>Paspalum dilatatum</i> *	Paspalum	g
Iridaceae	<i>Patersonia glabrata</i>	Leafy Purple-flag	g
Iridaceae	<i>Patersonia sericea</i>	Wild Iris	g
Poaceae	<i>Pennisetum clandestinum</i> *	Kikuyu	g
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed	g
Proteaceae	<i>Persoonia isophylla</i>	-	s
Proteaceae	<i>Persoonia lanceolata</i>	Lance-leaved Geebung	s
Proteaceae	<i>Persoonia levis</i>	Broad-leaved Geebung	s
Proteaceae	<i>Persoonia linearis</i>	Narrow-leaved Geebung	s
Proteaceae	<i>Persoonia oblongata</i>	-	s
Proteaceae	<i>Petrophile pulchella</i>	Conesticks	s
Rutaceae	<i>Phebalium squamulosum</i> subsp. <i>squamulosum</i>	-	s
Euphorbiaceae	<i>Phyllanthus hirtellus</i>	Thyme Spurge	s
Faboideae	<i>Phyllota phyllicoides</i>	Heath Phyllota	s
Phytolaccaceae	<i>Phytolacca octandra</i> *	Inkweed	s
Thymelaeaceae	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	Slender Rice Flower	s
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum	s
Plantaginaceae	<i>Plantago lanceolata</i> *	Ribwort	g
Apiaceae	<i>Platysace ericoides</i>	Heathy Platysace	s
Apiaceae	<i>Platysace lanceolata</i>	Lance-leaf Platysace	s
Apiaceae	<i>Platysace linearifolia</i>	Narrow-leaved Platysace	s
Rhamnaceae	<i>Pomaderris ferruginea</i>	-	s
Rubiaceae	<i>Pomax umbellata</i>	Pomax	g
Euphorbiaceae	<i>Poranthera ericifolia</i>	-	s
Euphorbiaceae	<i>Poranthera microphylla</i>	-	g
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken	g
Cyperaceae	<i>Ptilothrix deusta</i>	-	g
Fabaceae	<i>Pultenaea polifolia</i>	Dusky Bush-pea	s
Fabaceae	<i>Pultenaea scabra</i>	-	s

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Family	Scientific Name	Common Name	Form
Fabaceae	<i>Pultenaea stipularis</i>	-	s
Fabaceae	<i>Pultenaea tuberculata</i>	-	s
Rubiaceae	<i>Richardia brasiliensis</i> *	White Eye	g
Euphorbiaceae	<i>Ricinus communis</i> *	Castor Oil Plant	s
Rosaceae	<i>Rubus fruticosus</i> subsp. agg.*	Blackberry	s
Polygonaceae	<i>Rumex crispus</i> *	Curled Dock	g
Goodeniaceae	<i>Scaevola ramosissima</i>	Purple Fan Flower	g
Cyperaceae	<i>Schoenus apogon</i>	Fluke Bog-rush	g
Cyperaceae	<i>Schoenus brevifolius</i>	Bog-rush	g
Cyperaceae	<i>Schoenus ericetorum</i>	Heath Bog-rush	g
Cyperaceae	<i>Schoenus melanostachys</i>	Black Bog-rush	g
Schizaeaceae	<i>Schizaea bifida</i>	Forked Comb-fern	g
Asteraceae	<i>Senecio madagascariensis</i> *	Fireweed	g
Cesalpinoideae	<i>Senna pendula</i> var. <i>glabrata</i> *	-	s
Poaceae	<i>Setaria parviflora</i> *	-	g
Malvaceae	<i>Sida rhombifolia</i> *	Paddy's Lucerne	g
Smilacaceae	<i>Smilax glycyphylla</i>	Sarsaparilla	v
Solanaceae	<i>Solanum mauritianum</i> *	Wild Tobacco	s
Solanaceae	<i>Solanum nigrum</i> *	Black Nightshade	g
Solanaceae	<i>Solanum sisymbriifolium</i>	-	s
Asteraceae	<i>Sonchus oleraceus</i> *	Common Sow-thistle	g
Anthericaceae	<i>Sowerbaea juncea</i>	Vanilla Lily	g
Poaceae	<i>Sporobolus africanus</i> *	Parramatta Grass	g
Epacridaceae	<i>Sprengelia incarnata</i>	Swamp Heath	s
Stackhousiae	<i>Stackhousia nuda</i>	-	g
Stackhousiae	<i>Stackhousia viminea</i>	-	g
Poaceae	<i>Stenotaphrum secundatum</i> *	Buffalo Grass	g
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	v
Gleicheniaceae	<i>Sticherus flabellatus</i>	Umbrella Fern	g
Stylidiaceae	<i>Stylidium graminifolium</i>	Trigger Plant	g
Stylidiaceae	<i>Stylidium lineare</i>	Trigger Plant	g
Epacridaceae	<i>Styphelia laeta</i> subsp. <i>latifolia</i>	Five Corners	s
Epacridaceae	<i>Styphelia tubiflora</i>	-	s
Asteraceae	<i>Tagetes minuta</i> *	Stinking Roger	g
Asteraceae	<i>Taraxacum officinale</i> *	Dandelion	g
Elaeocarpaceae	<i>Tetradlea ericifolia</i>	Black-eyed Susan	g
Elaeocarpaceae	<i>Tetradlea glandulosa</i> ^{TS}	Black-eyed Susan	g
Elaeocarpaceae	<i>Tetradlea thymifolia</i>	Black-eyed Susan	g
Poaceae	<i>Themeda triandra</i>	Kangaroo Grass	g
Anthericaceae	<i>Thysanotus tuberosus</i>	Fringed Lily	g
Commelinaceae	<i>Tradescantia fluminis</i> *	Wandering Jew	g
Fabaceae	<i>Trifolium repens</i> *	White Clover	g
Verbenaceae	<i>Verbena bonariensis</i> *	Purpletop	g
Verbenaceae	<i>Verbena quadrangularis</i> *	-	g
Fabaceae	<i>Vicia sativa</i> subsp. <i>sativa</i> *	Common Vetch	v
Fabaceae	<i>Viminaria juncea</i>	Native Broom	s
Fabaceae	<i>Wisteria sinensis</i> *	Wisteria	v
Epacridaceae	<i>Woollsia pungens</i>	-	s
Xanthorrhoeaceae	<i>Xanthorrhoea arborea</i>	Broad-leaf Grass Tree	s

Table 3.1 – Flora observations for the study area

Family	Scientific Name	Common Name	Form
Xanthorrhoeaceae	<i>Xanthorrhoea media</i> subsp. <i>media</i>	Forest Grass Tree	g
Xanthorrhoeaceae	<i>Xanthorrhoea resinosa</i>	-	g
Apiaceae	<i>Xanthosia pilosa</i>	Woolly Xanthosia	g
Apiaceae	<i>Xanthosia tridentata</i>	Rock Xanthosia	g
Proteaceae	<i>Xylomelum pyriforme</i>	Woody Pear	t
Xyridaceae	<i>Xyris gracilis</i>	Slender Yellow-eye	g
Araeaceae	<i>Zantedeschia aethiopica</i> *	White Arum Lily	g
Rutaceae	<i>Zieria smithii</i>	Sandfly Zieria	s
t = tree s = shrub g = groundcover v = vine w = water/wetland plant ^{TS} indicates threatened species			

3.1.2 Vegetation communities

Vegetation communities across the study area were originally mapped in 2008 based largely on structural characteristics. That mapping has been carried over with some alterations for additional vegetation communities and minor changes to vegetation polygons. For the purposes of the biodiversity assessment report (*EcoLogical Australia* 2015), some vegetation polygons have been merged or split to be consistent with the equivalent biometric vegetation types.

The following vegetation descriptions based on the structural composition are provided below for:

- A - Short Heath
- B1 - Tall Heath
- B2 - Damp Tall Heath
- C - Low Open Forest
- D - Open Forest
- E - Cleared, Managed, Landscaped or Weed Plum
- F - Coastal Upland Swamp
- G - Sandstone Gully Forest
- H - Riparian Woodland / Forest

Vegetation Community A – Short Heath

Occurrence – In relation to the proposed development area, this community occurs near to the centre of the site to the north of Ralston Avenue. The Low Heath vegetation is most similar to Sydney Coastal Heath as mapped by Smith and Smith (2000).

Structure – Low heath vegetation consisting of many *Fabaceae* plants generally to a height of up to 2.5m, with very occasional emergents. There is a dominance of shrub species and herbaceous groundcovers that are generally very dense. The species diversity within this community is generally lower than the Forest communities.