



## Sutton Forest Quarry

## EPBC Act Referral Additional Information

11 October 2022

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# 1 Native vegetation

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## 1.1 Field investigation of biodiversity values

A systematic biodiversity assessment was conducted between October 2020 and April 2022 under the terms of Biosis' Scientific Licence issued by the EES under the *National Parks and Wildlife Act 1974* (SL100758, expiry date 31 March 2023). Fauna survey was conducted under approval 11/355 from the NSW Animal Care and Ethics Committee (expiry date 31 January 2023).

Assessment in accordance with the BAM was carried out and overseen by Accredited Assessor Callan Wharfe (BAAS 18138).

The development site was surveyed in accordance with the BAM (DPIE 2020a), which involved:

- The identification and mapping of PCTs according to the structural definitions held in the BioNet Vegetation Classification database, with reference to information provided in *Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands* (Tozer et al 2010).
- Undertaking floristic plots within each vegetation zone in accordance with Section 4 of the BAM (DPIE 2020a), considering varying condition states and avoidance of ecotones, areas of disturbance, and edges.
- The identification of native and exotic plant species, according to the *Flora of NSW* (Harden 1992, 1993, 2000, 2002) with reference to recent taxonomic changes.
- Targeted searches for plant species of conservation significance according to the relevant guidelines; *Surveying threatened plants and their habitats* (DPIE 2020b).
- Incidental observations using the “random meander” method (Cropper 1993).
- Identification of previous and current factors threatening the ecological function and survival of native vegetation within and adjacent to the development site.
- An assessment of the natural resilience of the vegetation of the site.
- Identifying and mapping fauna habitats (e.g. hollow-bearing trees, rock outcropping etc.), assessing their condition and value to threatened fauna species, and considering threatened species' habitat constraints.
- Observations of animal activity and searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and diggings).
- Targeted surveys for threatened fauna species.

The conservation significance of plant species and plant communities was determined according to:

- BC Act for significance within NSW.
- EPBC Act for significance within Australia.

Detailed field mapping and collection of GPS point locations were conducted using hand-held (uncorrected) tablet units (Samsung Galaxy Tab X) running the ArcGIS Field Maps application, using the inbuilt GPS, and aerial photo interpretation. Spatial locations are therefore considered to have an accuracy of generally  $\pm 5$  metres.

Table 1 and Table 2 describe the EPBC Act listed vegetation communities recorded within the subject and.

**Table 1 PCT 1078 Prickly Tea-tree - sedge wet heath**

PCT 1078 Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion	
<b>Common name</b>	Prickly Tea-tree - sedge wet heath
<b>Vegetation formation</b>	Freshwater Wetlands
<b>Vegetation class</b>	Coastal Heath Swamps
<b>Extent within subject land</b>	Approximately 0.60 hectares of PCT 1078 occurs within the subject land adjacent to Long Swamp Creek in the north-western portion of the site. None of the PCT 1078 vegetation within the subject land will be directly impacted by the project.
<b>Condition</b>	The community is generally in high condition with little evidence of weed invasion, substantial erosion and/or sedimentation
<b>Description</b>	PCT 1078 is dominated by graminoids such as Button Grass <i>Gymnoschoenus sphaerocephalus</i> , <i>Lepidosperma limicola</i> , <i>Baumea rubiginosa</i> , and <i>Empodisma minus</i> with a patchy shrub cover comprising species such as Prickly Tea-tree <i>Leptospermum juniperinum</i> , Tantoon <i>Leptospermum polygalifolium</i> , Mountain Baeckea <i>Baeckea utilis</i> , <i>Pultenaea divaricata</i> and Swamp Heath <i>Epacris paludosa</i> . A low to moderately patchy cover of Pouched Coral Fern <i>Gleichenia dicarpa</i> is also present.
<b>Survey effort</b>	No BAM plot was collected within the PCT due to its occurrence outside the development footprint, however the vegetation was subject to targeted PCT and TEC confirmation to ensure accuracy in assessment of any potential indirect and prescribed impacts.
<b>Justification of PCT</b>	The vegetation occurs as freshwater wetland dominated by Button Grass over a build-up of humic and peaty soil layers. The vegetation differs from the adjacent PCT 1256 as being generally drier and less permanently waterlogged, further from the watercourse itself, and exhibits a different floristic assemblage. The PCT supports a range of species noted as characteristic in BioNet, on the correct soils and within the expected altitudinal range
<b>TEC Status</b>	<b>Commonwealth EPBC Act:</b> Temperate Highland Peat Swamps on Sandstone <b>NSW BC Act:</b> Coastal Upland Swamp in the Sydney Basin Bioregion <b>Justification:</b> The vegetation supports flora species characteristic of the BC Act and EPBC Act TECs, occurs in the correct geographic location, and occurs as a swamp community supported by areas of impeded drainage.
<b>Estimate of percent cleared value of PCT (BioNet)</b>	5 % (OEH 2017b)

**PCT 1078 Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion**

**PCT 1078 in high condition**



**Table 2 PCT 1256 Tableland swamp meadow**

**PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion**

<b>Common name</b>	Tableland swamp meadow
<b>Vegetation formation</b>	Freshwater Wetlands
<b>Vegetation class</b>	Montane Bogs and Fens
<b>Extent within subject land</b>	Approximately 3.12 hectares of PCT 1256 occurs within the subject land within and adjacent to Long Swamp Creek in the north-western portion of the site. None of the PCT 1256 vegetation within the subject land will be directly impacted by the project.
<b>Condition</b>	The community is ranges from areas of high condition with little evidence of weed invasion, to low condition areas where Willows <i>Salix</i> spp have become a dominant overstorey species.
<b>Description</b>	PCT 1256 comprises a dense layer of graminoids such as <i>Baumea rubiginosa</i> , <i>Eleocharis gracilis</i> , Button Grass, <i>Lepidosperma limicola</i> , with a patchy shrub and fern layer comprising numerous Tea-tree species including Prickly Tea-tree, Woolly Teatree <i>Leptospermum lanigerum</i> , <i>Leptospermum obovatum</i> , Tantoon <i>Leptospermum polygalifolium</i> and Peach Blossom Tea-tree <i>Leptospermum squarrosom</i> , with <i>Blechnum ambiguum</i> , Pouched Coral Fern and Coral Fern also present. The PCT also supports a population of the BC Act and EPBC Act listed Broad-leaved Sally <i>Eucalyptus aquatica</i> , which occurs as dense stands in portions of the PCT
<b>Survey effort</b>	No BAM plot was collected within the PCT due to its occurrence outside the development footprint, however the vegetation was subject to targeted PCT and TEC confirmation to ensure accuracy in assessment of any potential indirect impacts.

**PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion**

**Justification of PCT**

The vegetation occurs as freshwater wetland with a dominance of more water-tolerant, soft-leaved sedges and forbs. The vegetation differs from the adjacent PCT 1078 in having wetter more permanently water-logged soils, occurring more within the watercourse itself rather than on the drier banks, and exhibits a different floristic assemblage. The PCT supports a range of species noted as characteristic in BioNet, on the correct soils and within the expected altitudinal range

**TEC Status**

**Commonwealth EPBC Act:** Temperate Highland Peat Swamps on Sandstone  
**NSW BC Act:** Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions  
**Justification:** The vegetation supports flora species characteristic of the BC Act and EPBC Act TECs, occurs in the correct geographic location, and occurs as a swamp community supported by areas of impeded drainage.

**Estimate of percent cleared value of PCT (BioNet)**

85 % (EES 2022)

**PCT 1256 in high condition with Board-leaved Sally present**



## 1.2 Threatened ecological communities

Vegetation within the subject land was found to represent two TECs listed under the NSW BC Act, and one TEC listed under the Commonwealth EPBC Act, as outlined in Table 3 and Table 4 below.

**Table 3 Summary of BC Act TECs within the subject land**

BC Act TEC	Listing status	Area (Ha)
<i>Coastal Upland Swamp in the Sydney Basin Bioregion</i>	Endangered	0.60
<i>Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions</i>	Endangered	3.12

**Table 4 Summary of EPBC Act TECs within the subject land**

EPBC Act TEC	Listing status	Area (Ha)
<i>Temperate Highland Peat Swamps on Sandstone</i>	Endangered	3.72

As outlined in Table 1 and Table 2 above, there will be no direct impacts to these TECs as a result of the project. However the potential for indirect impacts associated with alterations to hydrological process is outlined below.

## 1.3 Impacts to Groundwater Dependent Ecosystems (GDEs)

### 1.3.1 Background

Wetlands identified as being groundwater dependent can be either ephemeral or permanent systems that have a continuous or seasonal connection with groundwater (Howe et al. 2007). (Kuginis et al 2016). This saturation may be caused by ponding of surface flows, flooding or by groundwater discharge (Le Maitre et al. 1999). Although rainfall is considered to be the dominant source of water for nearly all wetland systems, groundwater plays a role in many of Australia's wetlands (Hatton and Evans 1998; Kuginis et al 2016).

Groundwater dependent wetlands exist at the boundary between surface and groundwater systems with interactions grouped into three categories:

- Losing or recharge systems: water seeps from a wetland into the groundwater.
- Gaining or discharge systems: water leaves the groundwater system and enters the surface waters of a wetland.
  - Long Swamp Creek is an example of a gaining system (EMM 2022).
- Flow-through systems: water seeps through the upslope side and base of the wetland, and seeps back to the groundwater from the down slope side of the wetland. (Serov et al 2012).

It is important to note that the dominance of shallow rooted vegetation in wetlands means that wetlands are more susceptible to water table declines than phreatophytic (terrestrial) vegetation (Dillon et al. 2009). A decline in water tables can result in the loss of water tolerant species and their gradual replacement by terrestrial species with broader ecohydrological ranges. (Kuginis et al 2016)

Long Swamp Creek supports areas of Temperate Highland Peat Swamps on Sandstone ecological community and is categorised as a valley infill swamp sub-type, which occur further down the catchment than headwater swamps, in the steeper terrain of incised valleys associated with second- or third-order streams. The steeper incision into the underlying sandstones means the swamps are more likely to intersect water-bearing layers within the horizontally bedded sandstone. The water regime for valley infill swamps therefore combines rainfall and surface water run-off, as well as groundwater inputs (Commonwealth of Australia 2014)

### 1.3.2 GDEs within the subject land

The probability of the vegetation relying on the presence of subsurface groundwater, or the surface expression of that groundwater, depends on the factors outlined below:

- The proximity to of the vegetation to groundwater.
- The plant species root system distribution and depth.
- The location or position of the vegetation in the landscape.
- Various species traits that infer dependence on groundwater. (Kuginis et al 2016)

Kuginis et al (2016) includes a method for the determining the probability of a patch of vegetation being a GDE, which includes a multi-faced analysis of groundwater depth, vegetation community composition and structure, expert / scientific knowledge, and remote sensing technology. These various parameters have been used to build a GIS model that has produced an output of high probability GDEs across the major river catchment in NSW, and includes data specific to the subject land.

Direct use of the outputs from this GIS model were not considered appropriate to determine the likely groundwater dependence of the vegetation within the subject land due largely to the less refined groundwater model used (produced at a much coarser scale than the EMM model described above) and the use of modelled PCT mapping (from the East Coast PCT Revision SVTM layer), which was seen to be inaccurate in many locations.

As such the methods used to develop the GIS model, which are detailed in Kuginis et al (2016), have been replicated, as part of the current assessment, using site specific data to determine the probability of the vegetation within the subject land being a GDE.

Based on an assessment implementing the methodology outlined in Kuginis et al (2016), the probability of the PCT 1256 vegetation within the subject land being a GDE, is definite, as all PCT 1256 (equivalent) vegetation determined as definite GDE in Kuginis et al (2016). This is largely based on the GDE probability aspect of Kuginis et al (2016) based on scientific knowledge and expert opinion.

### 1.3.3 Summary of groundwater assessment (EMM 2022)

#### Existing environment

The main watercourse in the project area is the perennial watercourse, Long Swamp Creek which an estimated mean annual flow of 2,050 ML/year based on a catchment area of 19 km<sup>2</sup> (Larry Cook Consulting 2018). There is a major tributary to Long Swamp Creek to the south and south-west of the subject land, referred to as 'Watercourse D'. There are also unnamed, ephemeral, tributaries to the north of the development footprint, which the subject land, that drain into Long Swamp Creek and unnamed tributaries draining to Hanging Rock Swamp Creek located south of the Hume Highway. (EMM 2022)

Flows in Long Swamp Creek and Watercourse D are maintained by groundwater baseflow, direct rainfall and surface water run off. Baseflow is the component of streamflow that originates from groundwater, relevant to gaining streams. Baseflow can be considered as the withdrawal of groundwater from storage and is part of groundwater recession inflow to the stream (Domenico & Schwartz 1990). The groundwater and surface



water elevation data indicates the two systems are hydraulically connected. The slightly higher groundwater elevation supports the conceptualisation that there is a strong baseflow component that comprises of groundwater and that the surface water system is a gaining stream which receives groundwater. (EMM 2022)

The local, friable sandstone groundwater receives direct rainfall recharge and the water table occurs within this unit. The groundwater flow direction is radial, predominantly flowing and discharging either to the north towards Long Swamp Creek or to the south-west towards Watercourse D, together with some downwards flow that recharges the underlying competent sandstone unit. The competent Hawkesbury Sandstone geologic formation hosts the regional groundwater system in the Southern Highlands.

Local groundwater discharge from the Hawkesbury Sandstone occurs at Long Swamp Creek and other perennial watercourses as baseflow. Groundwater discharge via springs is also expected at the contacts between:

- the friable and competent Hawkesbury Sandstone units, where incised and exposed in cliff faces.
- the Hawkesbury Sandstone and the Berry Siltstone around Long Swamp Creek.
- at the Basalt and Wianamatta Shale contact further north in the upper Long Swamp Creek catchment.

### Modelled groundwater

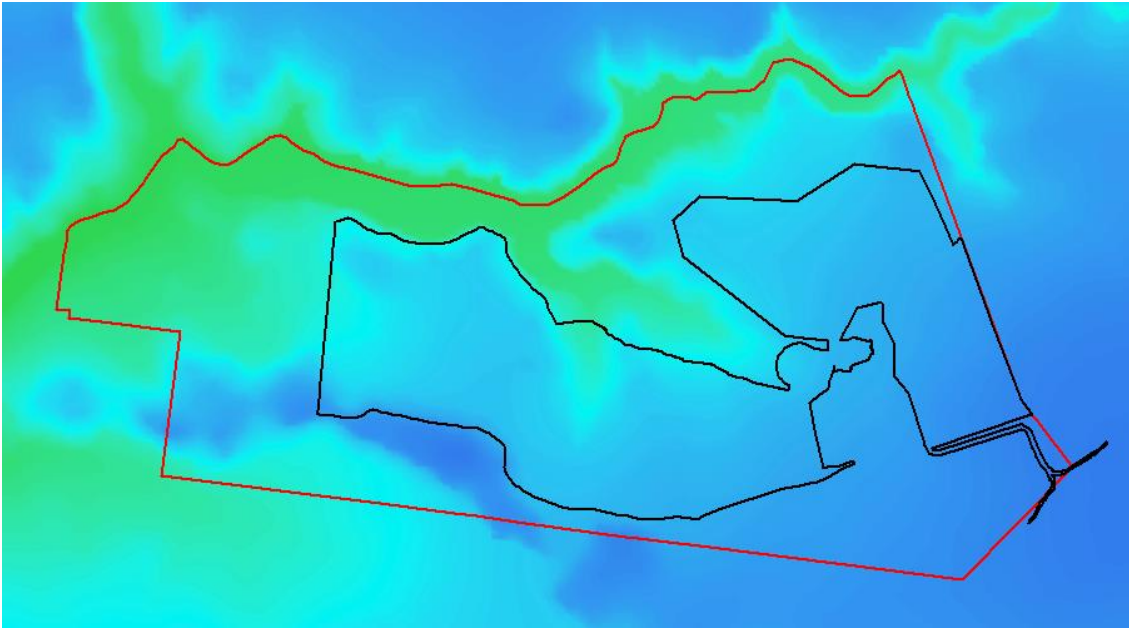
A groundwater monitoring network was established that consists of twenty groundwater monitoring bores that target predominantly the Hawkesbury Sandstone, continuously monitored for a six-month period using in-situ loggers. Manual groundwater level measurements have also been recorded on a monthly basis.

EMM (2022) outlines that the data from these monitoring locations was input into the numerical groundwater model for the project, which is a class 2 model with many elements classified as meeting class 3 requirements. A class 2 model has high confidence in model predictions, and is suitable for use in high value resources or projects with medium to high risk developments. A class 3 has high confidence in model predictions, suitable for use in high value resources and projects such as regional sustainable yield assessments. The numerical model was prepared in accordance with the Australian Modelling Guidelines and peer reviewed using the structure of the 'review checklist' as per the modelling guidelines.

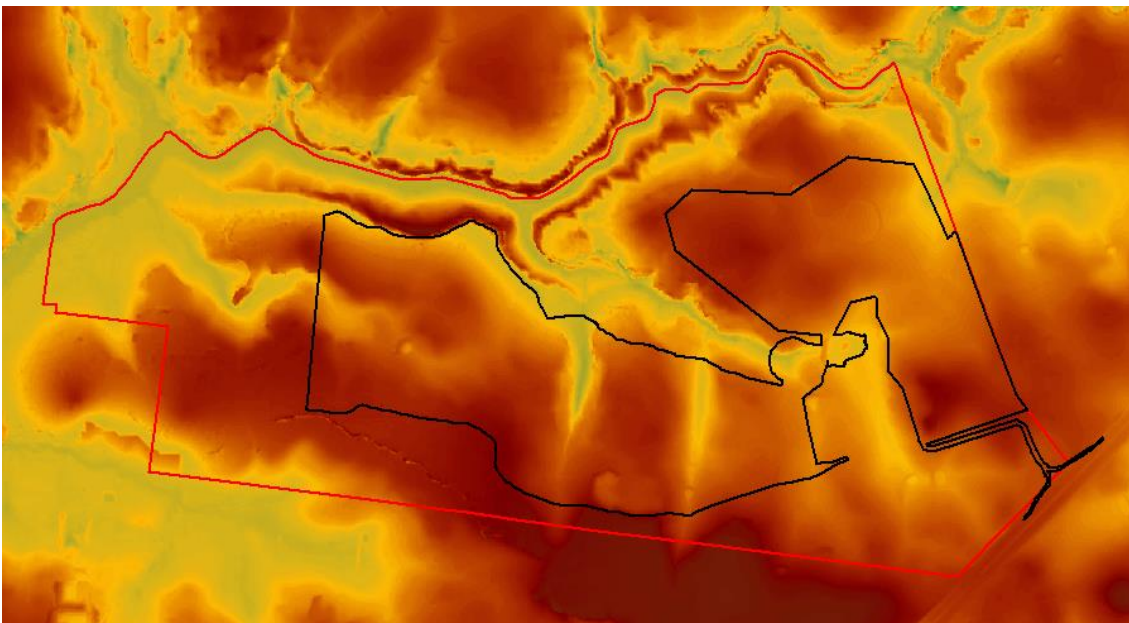
The updated modelling by EMM (2022) has undertaken both:

- History-matching sensitivity analysis to identify ranges in aquifer properties that are consistent with the data available for calibration; and
- A type 1 to type 2 predictive uncertainty analysis (as outlined in the IESC guidance note on uncertainty analysis), thereby closing the deficiency from the previous modelling provided with the EIS.

The model was used to derive the steady state modelled water table which inferred the water table to occur at between approximately 700 metres asl and 615 metres asl within the study area. The depth of groundwater was then derived by subtracting the modelled steady state water table elevation from the surface elevation, derived using a digital elevation model, to show the groundwater occurring at depths of between approximately 25 metre depth and >1 metre depth across the subject land.



**Plate 1** Steady state modelled water table. Darker blue areas represent the water table at higher elevations (i.e. closer to 700 m asl), darker green areas represent the water table at lower elevations (i.e. closer to 615 m asl).



**Plate 2** Modelled water table depth. Darker red areas represent deeper water table (i.e. closer to 25 m depth), greener areas represent shallower water table (i.e. closer to <1 m depth).

### Potential impacts to groundwater and GDEs

Information on GDEs is outlined in the Water Sharing Plans (WSPs) relevant to the subject land, those being the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*, and the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. The WSPs include schedules with lists of high priority GDEs and those listed on the Bureau of Meteorology (BoM) GDE atlas, with those relevant to the subject land are listed as:

- Terrestrial and aquatic ecosystems associated with the creeks, rivers and riparian habitats receiving groundwater baseflow contributions from the Hawkesbury Sandstone and basalt aquifers. These systems are especially reliant on groundwater baseflows during drought periods.
- Vegetation in the gorge areas and cliff lines dependent on groundwater discharging from the Hawkesbury Sandstone aquifer (hanging swamps).
- Terrestrial vegetation on the ridgelines with access to shallow (0-5 mbgl) groundwater in the Hawkesbury Sandstone (friable sandstone) aquifer.

The most ecologically significant of which would be the BC Act and EPBC Act listed Temperate Highland Peat Swamp TEC present along Long Swamp Creek, which also supports habitat for Broad-leaved Sally (Vulnerable, EPBC Act and BC Act), and Giant Dragonfly (Endangered, BC Act).

EMM (2022) note that potential impacts to Long Swamp Creek and terrestrial GDEs associated with project's interaction with groundwater include:

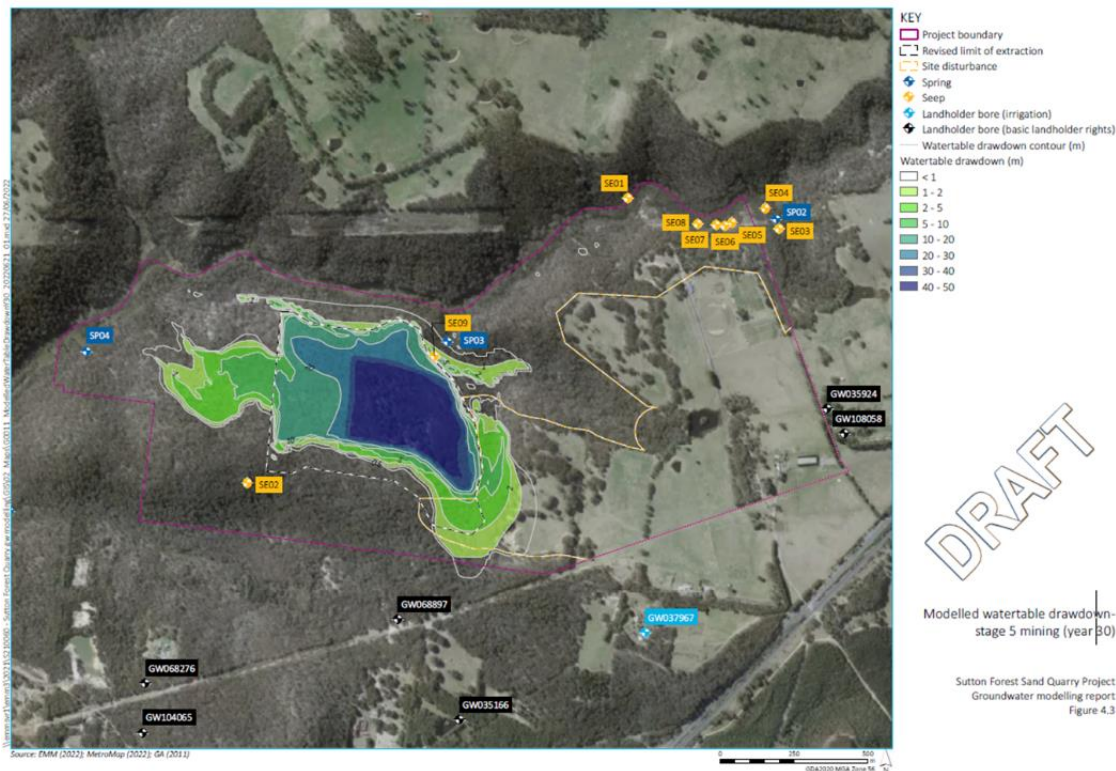
- Dewatering and groundwater take from the friable sandstone aquifer and competent sandstone aquifer leading to localised water table drawdown, aquifer depressurisation, changed groundwater flow paths.
- Pit backfill and infilling with VENM and ENM leading to altered recharge, localised changed groundwater flow paths, or potential groundwater quality changes.
- Pit dewatering and groundwater interception of fresh groundwater that would have otherwise reported as baseflow and to GDEs.
- Wastewater ponds and water storage resulting in leaching of solutes, possible overflows altering surface water quality.
- Groundwater interception and take via dewatering reducing groundwater baseflow contributions, changed groundwater flow paths.
- Diversion/disruption of surface drainage leading to altered flow regimes.
- Partial removal of the friable and competent sandstone aquifers, and backfilling leading to temporary local loss of friable and competent sandstone aquifers, resulting in potential altered hydraulic properties and changes to groundwater flow.

### **Modelled groundwater drawdown**

Drawdown in the water table has been modelled by EMM (2022) and assessed at four time periods over the life of the project; mid quarrying (year 17), end of quarrying (year 30), 10 years post quarrying (year 40) and 100 years post quarrying (year 130).

At mid quarrying the maximum drawdown in the centre of the pit is modelled to be between 40-50 metres. Drawdown also expected to occur beyond the pit extending west by approximately 300 metres, with the maximum drawdown extending 5-10 metres, although the majority of the drawdown is between 1-5 metres.

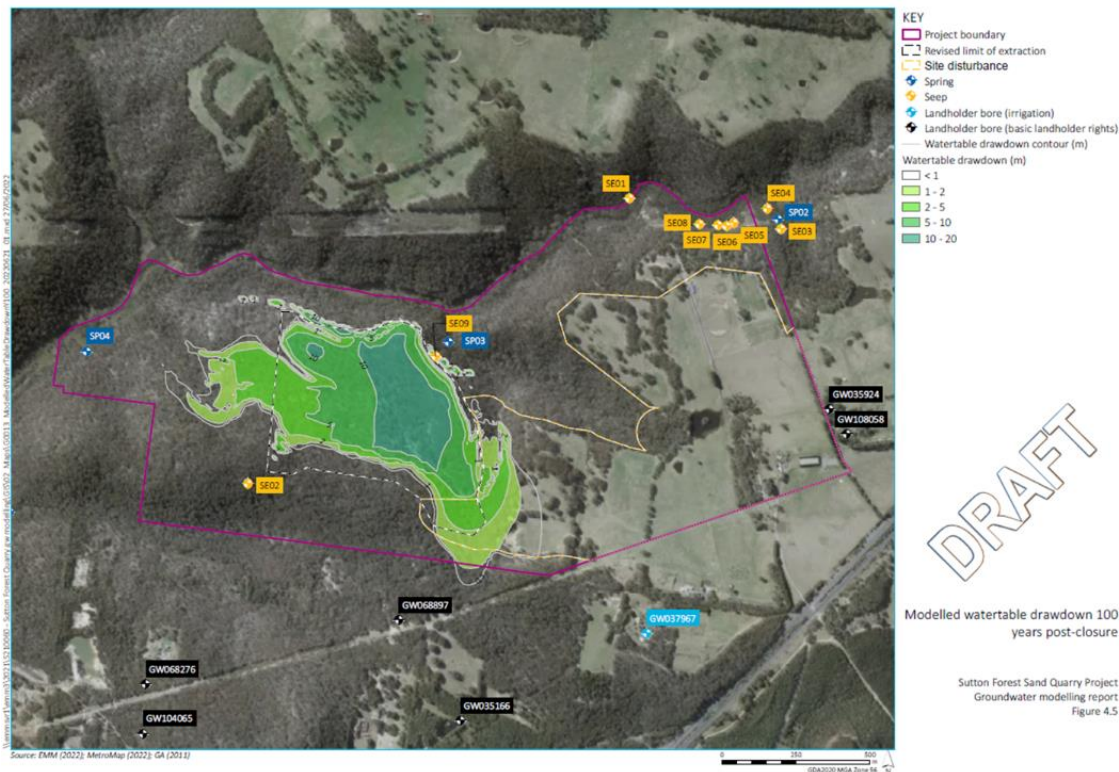
The greatest water table drawdown is modelled as occurring at the end of quarrying. At this time the maximum drawdown in the centre of the pit is modelled to be maintained at between 40-50 metre, with drawdown beyond the pit modelled to extended to the west by approximately 350 metre. The maximum drawdown in this western extension is again expected to be between 5-10 metre. Drawdown is also expected to extend to the east and south-east by approximately 200 metre with the drawdown predominantly being 1-5 metre.



### Plate 3 Maximum modelled groundwater drawdown at end of quarrying - year 30 (EMM 2022)

Groundwater recovery is modelled as likely to have commenced ten years post quarrying, with the maximum drawdown in the centre of the (now rehabilitated) pit being between 10-20 metre. Drawdown beyond the pit remains extended to the west by approximately 350 metre, with drawdown predominantly being 1-5 metre, although a slight recovery in this location could be expected. Modelled drawdown to the east has contracted slightly although the drawdown in the south-east remains and has extended slightly. These areas of drawdown remains between 1-5 metre.

The groundwater level drawdown 10 years and 100 years after quarrying is comparable, suggesting groundwater level recovery and equilibrium is achieved approximately 10 years after the project is completed. The maximum drawdown in the centre of the pit remains between 10-20 metre at 100 years post quarrying, with modelled drawdown beyond the pit to the west contracting, as has the drawdown to the south-east, with these areas continuing to suffer drawdown of between 1-5 metre.



**Plate 4 Modelled groundwater drawdown at 100 years post-closure (EMM 2022)**

No groundwater drawdown is modelled as occurring within 130 metres of Temperate Highland Peat Swamp TEC vegetation, and as such the State and Commonwealth listed community, and known habitat for Broad-leaved Sally, is not expected to be effected by groundwater drawdown predicted to occur as a result of the project.

### Reductions to baseflow

EMM (2022) modelled the null (i.e. no quarrying) and project groundwater baseflow contributions to creeks and springs to ascertain the project’s potential impacts to baseflow. The null groundwater baseflow contribution was determined to be approximately 275 ML/year across all surface water sources within the modelled area. The maximum total reduction to groundwater baseflow contributions, for the six year period corresponding with the final quarrying stage (years 25-30) was modelled as 10.8 ML/year (or 0.3 L/second), which represents a minor reduction in groundwater contributions of 3.9% compared to the null case.

It should be noted that when compared to the volume of water present in Long Swamp Creek as surface flows, which were measured by EMM (2002) as between 1,606 and 4,380 ML/year (51-142 L/s), the reduction in baseflow of 0.3 L/second, equates to a negligible reduction of between 0.6 % and 0.2 % of water in the watercourse.

The modelled maximum reduction in total groundwater baseflow contributions is not expected to impact the viability of Long Swamp Creek, or substantially impact upon the Temperate Highland Peat Swamp TEC vegetation or known habitat for Broad-leaved Sally.

### Groundwater quality

EMM (2022) states that groundwater quality impacts are not expected or will be negligible due to:

- The relatively inert nature of the VENM/ENM fill material and the requirement of the fill material to be tested and meet contamination criteria prior to use as backfill within the pit

- The groundwater sink created by the quarry pit, whereby the lowering of the groundwater levels within the quarry pit will induce groundwater flow towards the pit during operation.
- The relatively small backfilled pit area compared to the extent of the ridgeline separating Long Swamp from Hanging Rock Swamp (and the whole recharge area).

Further assessment of the impacts to Temperate Highland Peat Swamp TEC vegetation and known habitat for Broad-leaved Sally will be undertaken once the Project's Surface Water Impact Assessment has been completed by EMM.

## 2 Threatened species

### 2.1 Ecosystem credit species

A list of predicted species (ecosystem credit species) expected to occur within the subject land was generated as per Section 5 of the BAM (DPIE 2020a). Impacts to these species require assessment, however targeted survey is not required as these species are assumed to occur, based on the occurrence of the PCTs in the relevant IBRA subregion, habitat constraints, native vegetation cover in the landscape and calculated patch sizes. These species are identified as ecosystem credit species in the Threatened Biodiversity Data Collection (TBDC). Table 5 lists the ecosystem credit species that could not be discounted, based on geographical restrictions or a lack of suitable habitat, from using the subject land on occasion.

These species were considered when prescribing management and mitigation measures for the project, and a number have been specifically considered as part of the assessment under the Commonwealth EPBC Act.

**Table 5 Ecosystem credit species (predicted species) with potential to occur**

Species name	Common name
<i>Anthochaera phrygia</i>	Regent Honeyeater
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo
<i>Daphoenositta chrysoptera</i>	Varied Sittella
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle
<i>Glossopsitta pusilla</i>	Little Lorikeet
<i>Hieraaetus morphnoides</i>	Little Eagle
<i>Hirundapus caudacutus</i>	White-throated Needletail
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat
<i>Miniopterus australis</i>	Little Bent-winged Bat
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat
<i>Neophema pulchella</i>	Turquoise Parrot
<i>Ninox connivens</i>	Barking Owl
<i>Ninox strenua</i>	Powerful Owl
<i>Petaurus australis</i>	Yellow-bellied Glider
<i>Petroica boodang</i>	Scarlet Robin
<i>Petroica phoenicea</i>	Flame Robin
<i>Phascolarctos cinereus</i>	Koala
<i>Pseudomys novaehollandiae</i>	New Holland Mouse

Species name	Common name
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat
<i>Tyto novaehollandiae</i>	Masked Owl
<i>Varanus rosenbergi</i>	Rosenberg's Goanna

Broad-headed Snake *Hoplocephalus bungaroides* was discounted from occurring within the subject land, and hence removed from the list of predicted species for the following reasons (with further detail provided in Appendix 1).

- The subject land is not within the known distribution of the species, which extends to Morton National Park, approximately 10 kms east of the subject land, but is separated by highly limited connectivity for the species. The species has never been recorded west of Morton National Park and snakes are unlikely to move into unoccupied habitat due to the short dispersal distances of juveniles and strong site fidelity of adults (Webb & Shine 1997b).
- The subject land supports rocky areas, but none were found to represent microhabitats suitable for the species (Webb & Shine 1998b, Pringle et al. 2003).
- Habitat assessment/mapping surveys combined with active searches for snakes was undertaken in summer/autumn 2021 (January to May) and did not record any evidence of the species.

## 2.2 Species credit species

Species credit species are threatened species for which vegetation surrogates and/or landscape features cannot reliably predict the likelihood of their occurrence, or components of their habitat. These species are identified as species credit species in the TBDC. A targeted survey or an expert report is required to confirm the presence of these species on the subject land, or alternatively the species can be assumed to be present (DPIE 2020a).

Appendix 1 provide the lists of species credit species predicted to occur within the subject land based on the IBRA subregion within which the project occurs, the native vegetation cover present within the assessment area, the PCTs present within subject land, and BAM patch sizes.

The potential for a species to occur within the subject land was assessed in accordance with Section 5.2 of the BAM (DPIE 2020a) and species with geographical restrictions, or habitat constraints not present, were not required to be assessed. Seven predicted species credit species, including one flora species and six fauna species have been excluded from occurring within the subject land based on a lack of suitable habitat / microhabitats (including 'species credit' breeding habitat for dual credit species), the subject land occurring outside the species' range, or the lack of mapped 'Important Areas' within the subject land.

A detailed assessment of potential for occurrence, and potential for impact, for all species credit species predicted to occur within the subject land is provided in Appendix 1. Species credit species considered to potentially occur within the subject land, and thus considered 'candidate species credit species' or simply 'candidate species' have been the subject of the target of threatened species surveys.

It should be noted that when deriving the list of candidate species, the final PCTs confirmed present within the development footprint (i.e. PCT 1150 and PCT 1152) were considered, along with species associated with potential likely alternative PCTs (i.e. 1082 and PCT 1086). Species associated with alternative PCTs, that were



considered to have some potential to occur within the subject land based on the occurrence of records in the locality, and broadly similar habitat requirements, were considered during targeted surveys. Further detail is provided in Appendix 1.

All candidate species considered as part of this assessment, and their associated method of assessment, are listed in Table 6 (flora species) and Table 7 (fauna species).

### Threatened flora

Habitats for threatened flora species within the subject land are considered to range from high to low quality based on the level of historical and ongoing influences/disturbances, such as historical clearing and subsequent levels of re-growth/regeneration, soil disturbance and grazing. Habitats within the core bushland are considered to be of a higher quality where intact vegetation occurs that has been left largely undisturbed. These areas support a range of rocky, sedge/grassy, steep, flatter, dry and wetter areas creating a range of potential habitats for threatened species. Areas subject to historical vegetation removal (c.1960) which have been allowed to naturally regenerate back to an intact condition state, support more moderate levels of habitat suitability for threatened species due to a lack of floristic structure and a more exhausted seedbank. Areas subject to historical clearing, followed by regrowth in combination with ongoing grazing (albeit at low levels) provide only low levels of habitat suitability for threatened species.

Table 6 provides a list of candidate flora species considered in this assessment, each species' required survey period and the relevant method of assessment. Further detail of the targeted surveys undertaken are provided below.

**Table 6 Candidate flora species**

Species name	Common name	BAM Candidate Species	Survey period (BioNet)	Method of assessment
<i>Acacia bynoeana</i>	Bynoe's Wattle	No	All year	Incidental survey spring/summer and autumn
<i>Eucalyptus macarthurii</i>	Paddys River Box	Yes	All year	Targeted survey spring/summer and autumn
<i>Grevillea raybrownii</i>	-	No	Oct – Dec	Incidental survey spring/summer
<i>Helichrysum calvertianum</i>	-	No	Aug – Feb	Incidental survey spring/summer
<i>Hibbertia puberula</i>	-	Yes	Oct – Dec	Targeted survey spring/summer
<i>Kunzea cambagei</i>		Yes	Oct – Nov	Targeted survey spring/summer
<i>Persoonia glaucescens</i>	Mittagong Geebung	No	Jan – March	Targeted survey spring/summer and autumn

Species name	Common name	BAM Candidate Species	Survey period (BioNet)	Method of assessment
<i>Persoonia mollis</i> subsp. <i>revoluta</i>		Yes	All year	Targeted survey spring/summer and autumn
<i>Phyllota humifusa</i>	Dwarf Phyllota	Yes	Nov – Jan	Targeted survey spring/summer
<i>Pomaderris cotoneaster</i>		Yes	Oct – Nov	Targeted survey spring/summer
<i>Pterostylis ventricosa</i>	-	Yes	Mar – May	Targeted survey autumn
<i>Zieria murphyi</i>	Velvet Zieria	Yes	Sept – Nov	Targeted survey spring/summer

Species listed in Table 6 above as 'No' under BAM Candidate Species, are those additional species considered, which are not associated with the final PCTs confirmed present in the development footprint, and are therefore not 'candidate species' in accordance with the BAM. These species have some small potential to occur within the development site, based on proximity of records and broadly similar habitat requirements, and were thus precautionarily considered during threatened flora surveys undertaken. These species are noted as being subject to 'incidental surveys', as they were not the main species targeted during the survey work, however their potential presence within the subject land was considered during all appropriately timed surveys, and were not recorded.

### Threatened fauna

Fauna habitat assessment was undertaken to determine whether the vegetation within the subject land contained microhabitats suitable to support the predicted species credit species, as in outlined in Appendix 1.

Habitat within the subject land comprises of relatively intact native vegetation containing a variety of microhabitats suitable for threatened fauna species. Vegetation including occasional grass tree (*Xanthorrhoea* species) skirts provide suitable shelter habitat for species such as Eastern Pygmy-possum *Cercartetus nanus* and possibly White-footed Dunnart *Sminthopsis leucopus*, while flowering shrubs and trees provide suitable nectar foraging resources. She-Oak (*Allocasuarina* spp. and *Casuarina* spp.) species provide suitable foraging resources for Glossy-black Cockatoo, and Gang-gang Cockatoo were observed on one occasion foraging on Eucalyptus in the subject land. A range of gum trees including species known Koala feed tree species; Sydney Peppermint, Grey Gum *Eucalyptus punctata*, Narrow-leaved Peppermint, Blue-leaved Stringybark and Silvertop Ash occur at high to low/moderate abundance across the subject land providing resources for the species.

Trees containing hollows provide shelter and nesting habitat for a number of species. Within the subject land and development footprint there are a variety of hollow sizes and types, providing suitable habitat for a number of threatened species including Southern Myotis *Myotis macropus*, Glossy-black Cockatoo, Gang-gang Cockatoo, Eastern Pygmy Possum, Squirrel Glider *Petaurus norfolcensis*, Greater Glider *Petauroides volans* and up to four species of large forest owls. The subject land provides suitable foraging and potential nesting habitat for predatory birds including Little Eagle *Hieraaetus morphnoides*, and habitat assessment and searches for signs of old or current nests were conducted to detect signs of breeding within the subject land.

Microhabitat supported by the subject land included rocky outcrops and cliffs which provide suitable shelter crevices for species such as Eastern Pygmy-possum, or possible habitat for Brush-tailed Rock-wallaby *Petrogale penicillata*. Where these rocky areas occur in conjunction with and sandy substrate waterways or swamps this also provide suitable potential habitat for Giant Burrowing Frog *Heleioporus australiacus*, Stuttering Frog *Mixophyes balbus*, Littlejohn's Tree Frog *Litoria littlejohni* and Red-crowned Toadlet *Pseudophryne australis*. Dams and streams containing emergent and fringing vegetation also provide potential habitat for some of these threatened frogs as well as a variety of common frog species. Rocky outcrops containing potential caves, large overhangs and crevices also provide habitat for cave-roosting microbat species such as Large Bent-winged Bat, Little Bent-winged Bat, Large-eared Pied Bat *Chalinolobus dwyeri*. Dams and open waterways also provide foraging habitat for Southern Myotis, while the majority of the subject land and adjacent vegetated areas in the wider locality provides suitable habitat for foraging by threatened and common microbat species.

Swampy wetland vegetation within and adjacent to Long Swamp Creek provides potential habitat for Giant Dragonfly *Petalura gigantea*, and whilst the species was not considered a candidate in accordance with the BAM, as the wetland habitat will not be directly impacted, targeted surveys were undertaken to determine presence.

Long-nosed Potoroo *Potorous tridactylus* was considered as a candidate species despite lack on dense understorey across the site. While small isolated patches of ferny ground cover occurred, these were generally very small patches (10 metres square) with large spaces between these areas (one patch within the development footprint). Habitat within the development footprint was comprised of mostly open vegetation and unlikely to be suitably dense for this species, outside of the development footprint more suitable habitat occurs along waterways.

A total of six threatened fauna species were removed as candidate species as the study area was found not to support suitable habitat / microhabitats (including 'species credit' breeding habitat for dual credit species), the subject land occurring outside the species' range, or the lack of mapped 'Important Areas' within the subject land. The full list of potential candidate species is provided in Appendix 1, along with assessment of their potential for occurrence.

No roosting camps for Grey-headed Flying fox were located within the study area. Important habitat area maps were searched for Regent Honeyeater and Swift Parrot *Lathamus discolor* did not occur within or adjacent to the assessment area. These species may still forage on occasion in the subject land but are unlikely to rely on resources within the subject land for survival.

White-footed Dunnart was not considered as a candidate species due to the species' requirement for a high level of native vegetation cover within the surrounding landscape (i.e. assessment area) providing high levels of connectivity to the subject land. Cover class for percentage native vegetation within the assessment area for the current assessment was found to be >30 – 70 % (variegated), whereas the minimum requirement for White-footed Dunnart is >70 % (intact). Despite this the species was considered during spotlighting surveys undertaken in November 2020.

Table 7 provides a list of candidate fauna species considered in this assessment, each species' required survey period and the relevant method of assessment. Further detail of the targeted surveys undertaken are provided below.

**Table 7 Candidate fauna species**

Species name	Common name	BAM Candidate Species	Survey period	Method of assessment
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Yes	Oct - Jan	Targeted tree hollow surveys and habitat assessment. Dawn/dusk and diurnal transect surveys during breeding season
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Yes	Jan - Sept	Targeted tree hollow surveys and habitat assessment. Dawn/dusk and diurnal transect surveys during breeding season
<i>Cercartetus nanus</i>	Eastern Pygmy Possum	Yes	Oct - Mar	Elliot trapping in January 2021, Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Yes	Nov - Jan	Threatened species habitat assessment, microbat acoustic detection surveys, stag watch, harp trapping in January 2021
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Yes	Sept - Apr	Threatened species habitat assessment, active searches, spotlighting, call play-back November 2020 and January 2021
<i>Hieraetus morphnoides</i>	Little Eagle	No	Aug - Oct	Targeted nest tree (stick nest) surveys and habitat assessment in October 2020
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	No	All year	Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	Yes	Jul - Nov	Aural-visual survey transects of suitable habitat in November 2020
<i>Miniopterus australis</i>	Little Bent-winged Bat	Yes	Dec - Jan	Threatened species habitat assessment, microbat acoustic detection surveys, stag watch, harp trapping in January 2021
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Yes	Dec - Jan	Threatened species habitat assessment, microbat acoustic detection surveys, stag watch, harp trapping in January 2021
<i>Mixophyes balbus</i>	Stuttering Frog	Yes	Sept - Mar	Threatened species habitat assessment, active searches, spotlighting, call play-back November 2020 and January 2021
<i>Myotis macropus</i>	Southern Myotis	No	Oct - Mar	Threatened species habitat assessment, microbat acoustic detection surveys, stag watch, harp trapping in January 2021

Species name	Common name	BAM Candidate Species	Survey period	Method of assessment
<i>Ninox connivens</i>	Barking Owl	Yes	May - Dec	Call Playback survey, targeted tree hollow surveys and habitat assessment
<i>Ninox strenua</i>	Powerful Owl	Yes	May - Aug	Call Playback survey, tree hollow surveys and habitat assessment
<i>Petalura gigantea</i>	Giant Dragonfly	No	Dec - Jan	Habitat mapping, targeted random meander and transect searches for adults and exuviae within suitable habitats in January 2021
<i>Petaurus norfolcensis</i>	Squirrel Glider	Yes	All year	Elliot trapping in January 2021, Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Yes	All year	Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021
<i>Phascolarctos cinereus</i>	Koala	Yes	All year	Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021, Spot Assessment Technique (SAT) survey in November 2021
<i>Potorous tridactylus</i>	Long-nosed Potoroo	Yes	All year	Remote camera trapping between January and March 2021, Spotlighting in November 2020 and January 2021
<i>Pseudophryne australis</i>	Red-crowned Toadlet	Yes	All year	Threatened species habitat assessment, active searches, spotlighting, call play-back November 2020 and January 2021
<i>Sminthopsis leucopus</i>	White-footed Dunnart	No	Oct - Nov	Spotlighting in November 2020
<i>Tyto novaehollandiae</i>	Masked Owl	Yes	May - Aug	Call Playback, tree hollow surveys and habitat assessment.
<i>Tyto tenebricosa</i>	Sooty Owl	Yes	Apr - Aug	Call Playback, tree hollow surveys and habitat assessment

### 2.2.1 Threatened species survey details

Targeted threatened species surveys of the subject land were undertaken within the relevant timeframes as provided in BioNet, and are detailed in Table 6 and Table 7. Weather observations for each survey date are shown in Table 8.

**Table 8 Survey dates and weather observations during targeted flora and fauna surveys (Moss Vale, NSW)**

Survey undertaken	Survey date	Temp. (°C)		Rain (mm)
		Min.	Max.	
Habitat assessment, hollow-bearing tree survey, raptor nest survey, Gang Gang Cockatoo survey	27/10/2020	7.6	13.8	4.8
Habitat assessment, hollow-bearing tree survey, raptor nest survey, Gang Gang Cockatoo survey	28/10/2020	9.1	17.3	1
Koala SAT, Frog survey, Spot Lighting	23/11/2020	15.5	21.5	8.4 (0.6mm in seven days prior)
Koala SAT, Frog survey, Spot Lighting	24/11/2020	11.7	20.3	2.6
Koala SAT, Frog Survey, Spot Lighting, Targeted Flora	25/11/2020	12.4	22.8	0
Koala SAT, Frog Survey, Spot Lighting	26/11/2020	11.9	29.6	0
Frog Survey, Spot Lighting, Targeted Flora	30/11/2020	11.1	18.9	0.6
Targeted Flora	7/12/2020	10.1	22.4	0
Targeted Flora	21/12/2020	14.2	20.7	0
Giant Dragonfly	14/01/2021	16.7	32.3	0
Giant Dragonfly	15/01/2021	14.7	28.0	0
Elliot trapping, Harp trapping, ANABATs, Remote camera deployment, Frog Survey, Dawn/dusk birds	18/01/2021	12.4	29.7	0 (0.4 mm in seven days prior)
Elliot trapping, Harp trapping, ANABATs, Remote camera deployment, Frog Survey, Dawn/dusk birds	19/01/2021	13.0	19.1	0
Elliot trapping, Harp trapping, ANABATs, Remote camera deployment, Frog Survey, Dawn/dusk birds	20/01/2021	11.3	19.1	0
Elliot trapping, Harp trapping, ANABATs, Remote camera deployment, Frog Survey, Dawn/dusk birds	21/01/2021	8.7	24.8	0
Elliot trap, Harp trap, ANABAT collection remote camera deployment, Dawn birds	22/01/2021	13.5	32.7	0
Broad-headed snake & Cockatoos	27/01/2021	15.2	17.2	5.8
Retrieval of cameras & Cockatoos	2/03/2021	11.3	20.7	0
Broad-headed snake & Cockatoos	16/04/2021	7.6	16.8	0
Targeted orchid surveys	23/04/2021	-	-	0
Targeted orchid surveys	14/05/2021	10.5	14.6	1.4

Survey undertaken	Survey date	Temp. (°C)		Rain (mm)
		Min.	Max.	
Targeted orchid surveys	21/05/2021	-0.7	12.1	0
Broad-headed Snake, Glossy Black Cockatoo & Owls	24/05/2021	5.5	16.1	5
Broad-headed Snake, Glossy Black Cockatoo & Owls	25/05/2021	8.9	17.1	1.4
Broad-headed Snake, Glossy Black Cockatoo & Owls	26/05/2021	7.6	13.4	0
Broad-headed Snake, Glossy Black Cockatoo & Owls	27/05/2021	2.2	12.6	0
Glossy Black Cockatoo & Owls	26/07/2021	8.5	12.9	0
Glossy Black Cockatoo & Owls	27/07/2021	10.1	15.4	0
Glossy Black Cockatoo & Owls	28/07/2021	8.6	18.7	0
Glossy Black Cockatoo & Owls	29/07/2021	4.8	10.6	0
Targeted orchid surveys	20/04/2022	3.3	17.8	8.0

Information from the Australia Government Bureau of Meteorology website.

Details of surveys undertaken as part of the current assessment are provided below.

### Threatened Flora

The subject land supports native vegetation ranging from higher intact condition to more degraded thinned condition. Areas of intact vegetation and some patches of thinned condition, less subject to ongoing disturbances, support habitat for threatened flora species and were assessed for the habitat values during initial habitat assessments undertaken throughout the subject land.

Targeted threatened flora surveys, undertaken on the dates listed in Table 8, were completed in accordance with the required BAM survey guideline, *Surveying threatened plants and their habitats* (DPIE 2020b). Targeted threatened flora survey were undertaken throughout all areas of the development footprint that supported potential threatened flora habitat. Areas excluded included those areas mapped as in thinned condition where the understorey was substantially depauperate, and subject to high levels of edge effects due to mature trees occurring as small isolated patches, and subject to ongoing intermittent grazing.

Surveys were undertaken implementing the two separate methods prescribed in *Surveying threatened plants and their habitats* (DPIE 2020b), those being parallel field traverses and the grid-based systematic approach.

Parallel field traverses were undertaken in April and May 2021, and May 2022, primarily targeting *Pterostylis venticosa*, with field traverses (transects) separated by 10 metres walked throughout all areas of potential habitat within the development footprint. Surveys were undertaken following confirmation of the species' flowering at a reference population by Shoalhaven Council staff.

The grid-based systematic method was employed for spring/summer surveys completed in November and December 2020 due to the large size of the areas of potential threatened flora habitat within and immediately surrounding the development footprint, and in particular the extraction area proposed at that time. *Surveying threatened plants and their habitats* prescribed this method as an alternative options when areas of potential habitat requiring survey are greater than 50 hectares in area (DPIE 2020b). An area of approximately 54 hectares of similar woodland / open forest potential habitat was surveyed using this method, which included areas proposed to be impacted as well as a buffer area to assess for potential indirect impacts.

Survey progress was captured using handheld GPS units, and ArcGIS Tracker enabled on field staff's mobile phones or tablet computers, to geospatially log transects walked throughout the targeted threatened species surveys. Spatial locations of all threatened species recorded were captured by either hand-held GPS units, mobile tablet computers running Collector for ArcGIS (both with accuracy of generally  $\pm 5$  metres, but potentially higher under denser canopy).

Targeted threatened flora surveys undertaken for the project are detailed in Table 9 below with a detailed assessment of candidate species provided in Appendix 1 **Error! Reference source not found..**

## Survey method and effort

### Grid-based systematic method

- A grid spaced at 100 square metres was placed over the development footprint using GIS to locate the survey locations at each grid intersect point, which were loaded onto field staff's tablet computers.
- A minimum of two experienced botanist staff members then undertook detailed surveys at each of the survey location by laying out two 40 m measuring tapes crossing-over at the grid intersect point.
- This 40 m square was then surveyed by walking parallel transect separate by between 2 – 5 m to ensure a high level of coverage with each survey location.
- It should be noted that surveying these 40 x 40 m squares resulted in surveys achieving a 25 – 30 % higher level of survey coverage than is prescribed by the guidelines which states each survey location should comprise a 40 m diameter circular area.
- A total of 80 grid intersect points were surveyed by over a period of seven person days in November and December 2020.

Surveying threatened plants and their habitats details that if a target species is located, finer scale grid surveys are used to "*locate population extent, which will help define the species polygon*" (DPIE 2020b). It should be noted that this follow-up finer-scale grid survey was not undertaken as part of the targeted flora survey effort for the current assessment, despite two target species being located during the initial grid-based searches, Dwarf Phyllota (three locations, 18 individuals) and *Hibertia puberula* (one location, one individual).

Follow-up finer scale grid surveys were not considered necessary to help define the species polygon for either species as all areas of suitable habitat, of similar or higher quality, in the areas surrounding where the plants were recorded was mapped and included in a conservative species polygon for each species.

### Parallel field traverses

- Parallel field traverses, separated by 10 m, were undertaken throughout the development footprint in November and December 2020 in all areas of potential threatened species habitat where the grid-based surveys were not appropriate. This generally included linear areas away from the main extraction area.
- To ensure a high level of coverage within areas of suitable habitat within the development footprint, parallel field traverses separated by 10 m, were selected as the survey method for surveys primarily targeting the presence of *Pterostylis ventricosa* in April and May 2021 and May 2022.
- During each survey parallel traverses were walked by a minimum of two experienced botanists working systematically across the development footprint following predetermined transect lines (start/end points) loaded onto tablet computers.
- Targeted surveys utilising the parallel field traverse method were conducted across all areas of suitable habitat within the development footprint over a total of nine person days.



## Justification of survey method and effort and timing

Targeted flora surveys followed the methods prescribed in the relevant BAM guidelines *Surveying threatened plants and their habitats* (DPIE 2020b), during the targeted species' survey periods as detailed in BioNet.

## Results

Table 9 provides a summary of the results of the targeted flora surveys completed.

**Table 9 Summary of targeted flora survey method and results**

Survey method	Target species	Survey results	Species Polygon
<b>Gird-based method</b> <b>November –</b> <b>December 2020</b>	<ul style="list-style-type: none"> <li>• Bynoe's Wattle</li> <li>• Dwarf Phyllota</li> <li>• <i>Grevillea raybrownii</i></li> <li>• <i>Helichrysum calvertianum</i></li> <li>• <i>Hibbertia puberula</i></li> <li>• <i>Kunzea cabbagei</i></li> <li>• Mittagong Geebung</li> <li>• <i>Persoonia mollis</i> subsp. <i>revoluta</i></li> <li>• Paddys River Box</li> <li>• <i>Pomaderris cotoneaster</i></li> <li>• Velvet Zieria</li> </ul>	<ul style="list-style-type: none"> <li>• Dwarf Phyllota – 3 locations, 18 individuals</li> <li>• <i>Hibbertia puberula</i> – 1 location, 1 individual</li> </ul>	<ul style="list-style-type: none"> <li>• Dwarf Phyllota – Required</li> <li>• <i>Hibbertia puberula</i> – Required</li> </ul>
<b>Parallel field traverses –</b> <b>December 2020,</b> <b>April-May 2021, May 2020</b>	<ul style="list-style-type: none"> <li>• Apr-May surveys (primary target species) <ul style="list-style-type: none"> <li>○ <i>Pterostylis ventricosa</i></li> </ul> </li> <li>• Apr-May surveys (incidental species) <ul style="list-style-type: none"> <li>○ Bynoe's Wattle</li> <li>○ Dwarf Phyllota</li> <li>○ Mittagong Geebung</li> <li>○ Paddys River Box</li> <li>○ <i>Persoonia mollis</i> subsp. <i>revoluta</i></li> </ul> </li> <li>• December surveys <ul style="list-style-type: none"> <li>○ Bynoe's Wattle</li> <li>○ Dwarf Phyllota</li> <li>○ <i>Grevillea raybrownii</i></li> <li>○ <i>Helichrysum calvertianum</i></li> <li>○ <i>Hibbertia puberula</i></li> <li>○ <i>Kunzea cabbagei</i></li> <li>○ Mittagong Geebung</li> <li>○ <i>Persoonia mollis</i> subsp. <i>revoluta</i></li> <li>○ Paddys River Box</li> <li>○ <i>Pomaderris cotoneaster</i></li> <li>○ Velvet Zieria</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• No target species recorded</li> </ul>	N/A

## Fauna habitat assessments

Fauna habitat assessment was undertaken to determine the presence microhabitats and other critical habitat components (habitat constraints) suitable for all fauna species outlined in Table 7 and Appendix 1. Habitat assessments focussed on the presence of the following features within the subject land:

- Habitat trees including large and/or hollow-bearing trees, stick nests, availability of flowering shrubs and canopy/understorey feed tree species.
- Soil type and presence of cliffs, overhangs and other rocky areas.
- Condition and type of native vegetation and the presence of exotic species.
- Presence and condition of pools and waterways.
- Quantity of ground litter and woody debris.
- Searches for indirect evidence of fauna (i.e. feathers, tracks and scats).
- General degradation of the site as a result of past and current disturbances such as grazing, vegetation clearing and rural land management practices.
- Topography and landscape morphology.
- Presence of Flying-fox camps.

Several habitat features with potential to support threatened species credit species were identified during these habitat assessments. These features have been summarised in Table 10.

**Table 10 Habitat features with potential to support threatened species credit species**

Habitat feature	Presence within the development footprint
<b>Hollow-bearing trees</b>	Habitat trees supporting hollows of a variety of size classes from small (<50 mm diameter) through to extra-large (> 400 mm diameter) were present across the subject land. These trees have the potential to provide breeding resources for a range of native fauna species including threatened cockatoos (Glossy Black-Cockatoo and Gang-gang Cockatoo), owls (Barking Owl, Masked Owl, Sooty Owl and Powerful Owl), arboreal mammals (Squirrel Glider and Greater Glider) and microbats.
<b>Feed tree species</b>	A variety of tree species identified as Koala use trees were detected during the assessment. These trees were identified in areas where there are known Koala records across the study area. Trees and shrubs providing food resources for smaller mammals such as Eastern Pygmy-possum and Squirrel Glider were also recorded, but in low abundance throughout the development footprint and impact assessment area.
<b>Caves and rocky overhangs</b>	Rocky overhangs and cliffines were identified within the subject land. These environments provide potential breeding habitat for threatened microbats including Large-eared Pied Bat, Little Bent-winged Bat, and Large Bent-winged Bat.
<b>Rocky outcrops and sandstone crevices</b>	The surface geology surrounding Long Swamp Creek along the northern boundary of the subject land and smaller tributaries to the south and originating within the subject land consists of Sandstone with the natural areas within the vicinity of both of these water courses supporting rocky outcrops, sandstone crevices, and caves. These features provide potential habitat for native frogs including the threatened

Habitat feature	Presence within the development footprint
	Giant Burrowing Frog, Red-crowned Toadlet and Littlejohn's Tree Frog.
<b>Major and minor watercourses and waterbodies (i.e. dams)</b>	Watercourses to the west and north of the development footprint include Long Swamp Creek, and its ephemeral streams originating within the subject land drain towards this creek. The sandy banks of the Creek and its tributaries with supporting vegetation along these systems provide potential habitat for amphibians including Red-crowned Toadlet and Giant Burrowing Frog. Artificial waterbodies (i.e. farm dams) at the western end of the development footprint and impact assessment area were also identified as potential habitat for threatened amphibians, and forage habitat for Southern Myotis.  Riparian areas also have the potential to support threatened fauna species in a fragmented landscape such as the one relevant to the current project. Large old trees, more likely to support tree hollows, are more common in riparian corridors.
<b>Woody debris and leaf litter</b>	Woody debris and leaf litter was prevalent in the vegetation patches across the subject land and development footprint. These features are required for species such as Red-crowned Toadlet and Stuttering Frog for shelter, in conjunction with drainage lines. Small mammals such as Eastern Pygmy-possum may forage within leaf litter and woody debris, and utilise these resources as part of their shelter habitat.

Field capture of detailed fauna habitat information allowed for confirmation of presence/absence of habitat features and microhabitats for the range of candidate species across surveyed portions of the subject land. Fauna habitat assessments were captured using ArcGIS polygons attributed with specific habitat criteria that allowed for planning of further targeted survey for select species, or the exclusion of the potential for occurrence of various candidate species from the subject land.

## Nocturnal birds

### Survey method and effort

Targeted survey was undertaken for Powerful Owl, Masked Owl, Sooty Owl and Barking Owl within the subject land. Targeted survey included call playback for these species across three survey locations with the subject land, over a total of eight nights across two separate weeks. Two call playback points were undertaken each night and were separated by a minimum distance of 800 metres and a maximum distance of 1500 metres, creating a total of two survey sites to ensure the whole of the suitable habitat within the subject land was targeted.

### Justification of survey method and effort

Survey was undertaken in accordance with methodology outlined in the NSW Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004).

### Timing of survey

Nocturnal bird survey was undertaken in May and July 2021, and thus in accordance with the survey timing provided in BioNet for the four target owl species.

### Results

Table 11 provides a summary of the results of the nocturnal bird surveys completed. A single Powerful Owl was recorded within the subject land on one occasion in April 2021 during diurnal fauna surveys. However

none of the target species of owl were recorded during nocturnal surveys undertaken during the BioNet prescribed breeding season.

**Table 11 Summary of nocturnal bird survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon (ha)
<i>Ninox connivens</i>	Barking Owl	<ul style="list-style-type: none"> <li>8 nights call-playback and spotlighting</li> <li>24-27 May 2021 and 16-29 Jul 2021</li> </ul>	Not recorded during surveys.	N/A
<i>Ninox strenua</i>	Powerful Owl	<ul style="list-style-type: none"> <li>8 nights call-playback and spotlighting</li> <li>24-27 May 2021 and 16-29 Jul 2021</li> </ul>	Not recorded during surveys.	N/A
<i>Tyto novaehollandiae</i>	Masked Owl	<ul style="list-style-type: none"> <li>8 nights call-playback and spotlighting</li> <li>24-27 May 2021 and 16-29 Jul 2021</li> </ul>	Not recorded during surveys.	N/A
<i>Tyto tenebricosa</i>	Sooty Owl	<ul style="list-style-type: none"> <li>8 nights call-playback and spotlighting</li> <li>24-27 May 2021 and 16-29 Jul 2021</li> </ul>	Not recorded during surveys.	N/A

## Diurnal birds

### Survey method and effort

Diurnal bird survey consisted of thorough habitat assessment across the subject land to assess the locations of potential suitable nesting hollows, followed by bird survey transects, areas searches, and near-constant aural/visual surveys during all diurnal fauna surveys undertaken within the subject land.

Targeted diurnal area search surveys in May 2021 were undertaken in the two hours prior to sunset, during the core breeding season (April – August) for Glossy Black-Cockatoo. Area searches were conducted where potential suitable nesting hollows and foraging resources were located. In addition, where individual Glossy Black-Cockatoo were detected foraging, birds would be observed and followed at sunset when possible, to determine whether roosting or nesting was occurring within the subject land, assessment area, or outside of the area of interest. Additional surveys for Glossy Black-Cockatoo were also undertaken concurrently with multiple field survey events within the species' BioNet prescribed breeding season of April to August.

Gang-gang Cockatoo survey was undertaken during hollow-bearing tree surveys in October 2020, dawn survey during checking of mammal traps in January 2021, area searches and bird census undertaken in conjunction with Broad-headed Snake habitat mapping in January and April 2021, and collection of remote cameras in March 2021. All of these surveys were undertaken during the BioNet prescribed breeding season for the species.

The presence of large stick nests and Little Eagle breeding with the subject land was assessed during hollow-bearing tree surveys in October 2020, with potential foraging activity assessed during diurnal fauna surveys undertaken over the course of the field campaign.

## **Justification of survey method and effort**

Survey method and effort for both species were adapted from the Commonwealth Guidelines for the federally listed threatened Kangaroo Island population of Glossy Black-Cockatoo (DEWHA 2010).

Survey involved area searches for signs of breeding or foraging individuals throughout areas of suitable foraging habitat and areas with the highest densities of suitable breeding hollows. When individuals were located during area searches, opportunistic survey was undertaken which involved following or determine the direction in which individual birds were travelling immediately following sunset (where possible).

Surveys of potential tree hollows and nest trees throughout the subject land were undertaken in accordance with the methods prescribed in BioNet.

## **Timing of survey**

Diurnal bird survey was undertaken from January to October in accordance with the survey timings provided in BioNet.

## **Results**

Table 12 provides a summary of the results of the diurnal bird surveys completed. Two threatened species, Glossy Black-Cockatoo and Gang-gang Cockatoo were recorded within the subject land.

Glossy Black-Cockatoo were detected on numerous occasions foraging within the subject land. Targeted survey aimed to conduct transect searches through areas identified with suitable hollows and foraging resources to locate individuals or pairs, and listen for begging juveniles within hollows. Once located, the flight direction at sunset was determined by following the bird as far as possible, this method was included to locate pairs and follow them to roosts or nests (if onsite) during the breeding season.

No Glossy Black-Cockatoo were found to be breeding on site, evidenced by the flight direction and distance flown off-site at sunset during targeted surveys, undertaken over four nights in July during the species' core breed period. It was noted that individuals generally flew south-east of the subject land at the end of the day, with a number of birds heard calling from a similar direction on at least two afternoons at sunset. The distance from the site was estimated to be at least 500 metres away using observations and digital maps with aerial imagery. No juvenile begging birds were heard during survey in the breeding season and no adults were observed entering or near hollows.

Gang-gang Cockatoo was recorded on one occasion during diurnal bird / hollow-bearing tree surveys in October 2020. An individual and a pair were observed separately on the same day, the pair was able to be followed while moving across the subject land foraging, however, the end location was not resolved due to movements outside the subject land which could not be followed. No further Gang-gang Cockatoos were recorded within the subject land during minimum of 14 days (up to 28 person days) of diurnal fauna surveys undertaken within the BioNet prescribed breeding season for the species.

No evidence of Little Eagle breeding within the subject land was recorded during targeted nest tree surveys undertaken in October 2020, nor as a result of large stick nests being detected during diurnal fauna surveys undertaken over the course of the field campaign.

Based on the results of these diurnal bird surveys, it has been concluded that neither Little Eagle, Glossy Black-Cockatoo nor Gang-gang Cockatoo are breeding within the subject land.

**Table 12 Summary of diurnal bird survey method and results**

Species Name	Common name	Survey method	Survey results	Species Polygon (ha)
<i>Collocephalon fimbriatum</i>	Gang-gang Cockatoo	<ul style="list-style-type: none"> <li>Hollow-bearing tree surveys during BioNet prescribed breeding season</li> <li>Dawn/dusk and diurnal bird surveys during BioNet prescribed breeding season</li> </ul>	Gang-gang Cockatoo were not recorded breeding within the subject land during targeted surveys undertaken on multiple occasions during the species' breeding season	N/A
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	<ul style="list-style-type: none"> <li>Hollow-bearing tree surveys during BioNet prescribed breeding season</li> <li>Dawn/dusk and diurnal bird surveys during BioNet prescribed breeding season</li> </ul>	Sighted on multiple occasions foraging with the subject land during the species' breeding period. No breeding activity was detected during investigations	N/A
<i>Hieraaetus morphnoides</i>	Little Eagle	<ul style="list-style-type: none"> <li>Targeted nest tree (stick nest) surveys and habitat assessment.</li> </ul>	Species was not recorded during survey. No large stick nests were recorded within the subject land.	N/A

## Frogs

### Survey method and effort

A total of nine nights of targeted frog survey were undertaken, over two survey periods in spring/summer 2020/21 (November and January), along three 300-500 metre long transects by two experienced zoologists. Transects were located within permanent and ephemeral watercourses across the subject land, and the following methodology was implemented during each transect survey:

- An initial five minute period of passive listening at the start of the transect to detect and identify calling frogs present at the site.
- At each 50 metre interval along the transect a five minute passive listening period was completed followed by two minutes of call broadcast and an additional two minutes of listening for each of the species.
- Each interval was followed by a slow walking visual inspection for five minutes where suitable habitat was searched with torches combined with active searching.

One additional survey site was located within the dam (holding open water with little macrophyte vegetation) in the intact bushland in the centre of the subject land, where Littlejohn's Tree Frog had previously been

recorded. Habitat in this location was not suited to transect surveys, so aural/visual surveys and active searches were concentrated on the dam, its banks, and the surrounding vegetation.

All frog species heard or observed during the surveys were recorded.

### Justification of survey method and effort

Survey followed the *NSW survey guide for threatened frogs* (DPIE 2020c) guidelines developed for species credit frog species in accordance with the BAM.

### Timing of survey

Survey timing was conducted in accordance with the relevant guidelines (DPIE 2020c) and the survey timing provided in BioNet(DPIE 2020d).

### Results

One target species, Red-crowned Toadlet was recorded during frog survey. Table 13 provides a summary of the results of the frog surveys completed.

**Table 13 Summary of frog survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	<ul style="list-style-type: none"> <li>Threatened species habitat assessment, active searches, spotlighting, call play-back</li> <li>23-26 &amp; 30 November 2020 and 18-21 January 2021</li> </ul>	Species not recorded during surveys	N/A
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	<ul style="list-style-type: none"> <li>Threatened species habitat assessment, active searches, spotlighting, call play-back</li> <li>23-26 &amp; 30 November 2020</li> </ul>	Species not recorded during surveys	N/A
<i>Mixophyes balbus</i>	Stuttering Frog	<ul style="list-style-type: none"> <li>Threatened species habitat assessment, active searches, spotlighting, call play-back</li> <li>23-26 &amp; 30 November 2020 and 18-21 January 2021</li> </ul>	Species not recorded during surveys	N/A
<i>Pseudophryne australis</i>	Red-crowned Toadlet	<ul style="list-style-type: none"> <li>Threatened species habitat assessment, active searches, spotlighting, call play-back</li> <li>23-26 &amp; 30 November 2020 and 18-21 January 2021</li> </ul>	Species recorded on one occasion in November 2020 on a watercourse outside the development footprint	N/A The species was recorded outside the development footprint (>250 m east of the extraction area) on a branch of a watercourse that does not enter the development footprint. Therefore a species polygon is not considered

Species name	Common name	Survey method	Survey results	Species Polygon
				necessary, as prescribed by <i>NSW survey guide for threatened frogs</i> (DPIE 2020c)

## Reptiles

### Survey method and effort

Potential Broad-headed snake habitat mapping and active searches were conducted to locate areas of areas of sandstone outcropping within the subject land, which could potentially provide suitable habitat to the species. These areas were then further investigated for suitable microhabitat, including areas of crevices, cracks and boulders on top of rock outcropping. These features were then mapped accurately (within 2 metre GPS error) and visually inspected for the presence of the species (and other fauna).

### Justification of survey method and effort

Guidelines for survey of this species do not exist, however, habitat assessment and direct searching of rocky habitat during the cooler months when the species utilises rock shelter habitat to thermoregulate, is widely used for this species (Shine & Fitzgerald 1989, Webb, Brook, & Shine 2002).

### Timing of survey

Surveys were undertaken in cooler months (March-May) to target times when the species would be utilising rock shelter. Additional surveys were also completed in January when it would be expected that juveniles and gravid females would still be expected to be present in rocky habitat (Webb & Shine 1998). It should be noted that active searching was limited and undertaken carefully in these January surveys to limit potential disturbance to the species, if present.

### Results

Following the completion of habitat mapping and active searches it was concluded that Broad-headed Snake should be discounted from occurring within the subject land, and hence removed from the list of candidate species. The following reasons are provided, with further detail provided in Appendix 1.

- The subject land is not within the known distribution of the species, which extends to Morton National Park, approximately 10 kms east of the subject land, but is separated by highly limited connectivity for the species. The species has never been recorded west of Morton National Park and snakes are unlikely to move into unoccupied habitat due to the short dispersal distances of juveniles and strong site fidelity of adults (Webb & Shine 1997b).
- The subject land supports rocky areas, but none were found to represent microhabitats suitable for the species (Webb & Shine 1998b, Pringle et al. 2003).
- Habitat assessment/mapping surveys combined with active searches for snakes was undertaken in summer/autumn 2021 (January to May) and did not record any evidence of the species.

Table 14 provides a summary of the results of the reptile surveys completed.



**Table 14 Summary of reptile survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon
<i>Hoplocephalus bungaroides</i>	Broad-headed snake	<ul style="list-style-type: none"> <li>Threatened species habitat assessment, active searches, between January and May 2021</li> </ul>	Not recorded during surveys	N/A Species discounted as a candidate species

## Invertebrates

### Survey method and effort

The subject land was surveyed for suitable habitat for the Giant Dragonfly by a team of two ecologists familiar with the species and habitat requirements over a period of two days in January 2021. These surveys focussed upon the areas adjoining Long Swamp Creek, identify areas of swamp or bogs with low open vegetation, within and adjoining the subject land. Areas of suitable breeding habitat were mapped in the field using handheld tablet devices.

Areas of mapped suitable habitat were traversed using random meanders (Baird 2017) with the survey team actively observing adults perching or flying within the survey area, as well as any exuviae within the vegetation or substrates traversed. Any individuals observed were recorded and sex identified, if possible.

Transect surveys were also undertaken to detect exuviae, due to the difficulties associated with observing exuviae within often complex and covered habitats during random meanders. Multiple transects ranging between 20 and 30 metres in length (depending on the area of habitat) were established within areas of mapped breeding habitat targeting the most suitable habitats for breeding. Visual surveys were undertaken along 1.5 metre wide belted transects, searching all ground layer vegetation, inter-tussock hollows and low shrubs for perched, fallen or partially degraded exuviae.

### Justification of survey method and effort

No published survey guidelines for the Giant Dragonfly are available. As such the survey methods and timing detailed in the following section are based upon available scientific literature, in particular consideration of survey methods discussed in Baird (2012), and survey methods successfully employed in other locations (Sydney drinking water catchment) by Biosis for this species. Noting that the primary scope of these surveys are to identify the extent of suitable habitat within the study area and determine the presence or absence of the species. The transect surveys for exuviae are based upon those outlined in Baird and Burgin (2013).

### Timing of survey

The surveys were timed to coincide with the known breeding and emergence period of the species. Baird (2017) notes that surveys may commence in late November and continue until the middle of January, with the expectation that some late emerging individuals will continue past late January.

The warm and still conditions were considered highly suitable for species detection previous experience undertaking targeted survey for this species, with the lack of rain increasing the chance of detecting exuviae that are easily damaged and disintegrated by rainfall. This was further supported by observations of abundant flying invertebrates observed during the surveys.

## Results

Giant Dragonfly was detected during targeted survey, within areas of suitable habitat which are mapped outside of the development footprint, within the subject land. Table 15 provides a summary of the results of the invertebrate surveys completed.

**Table 15 Summary of invertebrate survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon
<i>Petalura gigantea</i>	Giant Dragonfly	<ul style="list-style-type: none"> <li>Habitat mapping.</li> <li>Random meander surveys through suitable habitat for adults and exuviae.</li> <li>Transect surveys in breeding habitat for exuviae.</li> <li>14-15 January 2021.</li> </ul>	<ul style="list-style-type: none"> <li>Three areas of breeding habitat were mapped, two within the subject land.</li> <li>Numerous adults of both life stages were observed, including in copulation.</li> <li>Adults were primarily observed perching or flying within the areas of breeding habitat but some observations of foraging or perching behaviour within the margins of these habitats or amongst emergent macrophytes in Long Swamp Creek were also observed.</li> <li>No exuviae were detected.</li> </ul>	TBC Based on final indirect groundwater / surface water impacts

## Mammals

### Survey method and effort

Mammal survey was undertaken using baited Elliot traps, remote cameras, spotlighting surveys and Koala Spot Assessment Technique (SAT) searches. Incidental sightings were also recorded during habitat assessment, and nocturnal surveys undertaken targeting frogs and owls.

Two lines of 25 'size A' Elliot traps were placed across two stratification units for a total of four nights, totalling 200 trap nights.

Four arboreal remote cameras were placed on trees at least 1.5 metres from the ground, facing bait canisters on an opposite tree. Six terrestrial cameras were placed on trees between 20 centimetres and 50 centimetres from the ground, facing bait canisters fixed to the ground with large metal pegs. Cameras used were reconyx hyperfire models which are triggered by motion. The cameras were set to record three images after a motion trigger, with a three second pause between each image and a 15 second quiet period between triggers. Cameras were placed across the subject land and development footprint within locations containing suitable microhabitat or immediately adjacent to suitable microhabitat (hollow-bearing trees, dense shrubs, cliff faces/rock outcrops).

Diurnal Koala SAT searches were also undertaken at four locations in suitable vegetation within the subject land in November 2020, with the following methodology implemented during the survey:

- Searches were undertaken for Koala scats beneath 30 trees at each site in accordance with the method described in Phillips & Callaghan (2011). This involves searching the ground surface for scats within a distance of 100 cm of the base of each tree for two minutes per tree.

- Each tree was also inspected for scratch marks.

### Justification of survey method and effort

Elliot traps were deployed as a mixture of arboreal and terrestrial traps within locations containing suitable microhabitat or immediately adjacent to suitable microhabitat (hollow-bearing trees, hollow-logs, in/under feed trees, in/under shelter habitat) targeting Eastern Pygmy-possum, with some potential for recording Squirrel Gliders.

Arboreal cameras were deployed for a total of 167 trap nights comprised of three cameras over 42 nights and one camera over 41 nights. Arboreal cameras aimed to detect Squirrel Glider and Eastern Pygmy-possum.

Terrestrial cameras were deployed for a total of 221 trap nights comprised of one camera which malfunctioned after only 15 nights, one camera deployed for 42 nights and the remaining four cameras deployed for 41 nights. Terrestrial cameras aimed to detect Brush-tailed Rock Wallaby, Long-nosed Potoroo, and incidentally Southern Brown Bandicoot and White-footed Dunnart.

Camera trapping is a contemporary method widely regarded as suitable for survey of the mammal species targeted, and when combined with Elliot trapping and spotlighting is considered a comprehensive survey approach for mammals for the current assessment.

Koala SAT surveys combined with spotlighting, potential for camera trapping, and ongoing incidental observations of activity is considered sufficient to determine the presence of Koala within the subject land.

### Timing of survey

Survey timing was conducted in accordance with the relevant guidelines and the survey timing provided in BioNet.

### Results

No threatened mammal species were detected during Elliot or camera trapping surveys. Spotlighting survey detected Greater Glider within the subject land, and evidence of Koala was recorded during SAT surveys.

Table 16 provides a summary of the results of the mammal surveys completed.

**Table 16 Summary of mammal survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon (ha)
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	<ul style="list-style-type: none"> <li>• Elliot trapping</li> <li>• Remote camera survey</li> <li>• Spotlighting</li> </ul>	Not recorded during survey.	N/A
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	<ul style="list-style-type: none"> <li>• Remote camera survey</li> <li>• Spotlighting</li> </ul>	Not a candidate species. Not recorded during survey.	N/A
<i>Petauroides volans</i>	Greater Glider	<ul style="list-style-type: none"> <li>• Remote camera survey</li> <li>• Spotlighting</li> </ul>	Not a candidate species as not BC Act listed. Recorded on multiple occasions.	N/A
<i>Petaurus</i>	Squirrel Glider	<ul style="list-style-type: none"> <li>• Remote camera survey</li> </ul>	Not recorded during	N/A

Species name	Common name	Survey method	Survey results	Species Polygon (ha)
<i>norfolcensis</i>		<ul style="list-style-type: none"> <li>Spotlighting</li> <li>Elliot trapping</li> </ul>	survey.	
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	<ul style="list-style-type: none"> <li>Remote camera survey</li> <li>Spotlighting</li> </ul>	Not recorded during survey.	N/A
<i>Phascolarctos cinereus</i>	Koala	<ul style="list-style-type: none"> <li>SAT surveys</li> <li>Remote camera survey</li> <li>Spotlighting</li> <li>Incidental searches for evidence</li> </ul>	Recorded during SAT surveys and incidentally throughout the subject land	Required
<i>Potorous tridactylus</i>	Long-nosed Potoroo	<ul style="list-style-type: none"> <li>Remote camera survey</li> <li>Spotlighting</li> </ul>	Not recorded during survey.	N/A
<i>Sminthopsis leucopus</i>	White-footed Dunnart	<ul style="list-style-type: none"> <li>Elliot trapping</li> </ul>	Not a candidate species. Not recorded during survey.	N/A

## Microchiropteran bats

### Survey method and effort

A total of six full spectrum songmeters were deployed to record calls produced by Microchiropteran bats (microbats) within the subject land from 19-20 January 2021 to 9 March 2021. Songmeter units were deployed in/around areas of suitable flyways to detect foraging bats, and near rocky habitat features considered to be potential habitat for cave dwelling species.

Ultrasonic call analysis was undertaken by Kirsty Bloomfield of Lesryk Environmental, who provided the following information in relation to the analysis.

It should be noted that some insectivorous bat species have distinctive echolocation calls that are unlikely to be confused with those of other species. Other bat species overlap in both call frequency and structure making identification problematic in some cases. For the *Nyctophilus* sp. determination through call analysis is difficult and therefore no attempt to identify this genus to species level was made.

The degree of confidence attached to call identifications will depend on the quality of the recordings as well as the activity of the bat at the time of recording and its direction of flight. In some instances a particular species may be identified with confidence, while at other times its identification will be less certain. For this report, echolocation call identifications have been assigned to three categories with regard to certainty of identification. These are:

- C - Confident Identification. Small possibility of confusion of calls with those of other bat species.
- P - Probable Identification. Some possibility of confusion of calls with those of other bat species.
- Po - Possible Identification. Likely to be confused with calls with those of other bat species.

In analysing the calls recorded, only search phases that are longer than three pulses were analysed.

A total of 12 nights' data selected on the basis of nights with higher volumes of call data, and nights with warm, relatively dry and still weather conditions, when microbats and likely to be most active, was analysed

from each songmeter unit. This equates to a total of 70 trap nights of microbat ultrasonic call data analysed as part of the current assessment.

Ultrasonic call recording surveys were combined with active trapping of microbats using harp traps deployed within the subject land, in habitats similar to those chosen to deploy songmeter units (including near a dam targeting Southern Myotis). Four harp traps were set for a total of four nights each, and checked each morning for trapped individuals. The primary objective of trapping was to determine the breeding status of the bats within the subject land. All trapped bats were assessed for species, sex and breeding status before dawn, prior to being collected and re-released that evening.

### Justification of survey method and effort

Bat survey was undertaken in accordance with BAM survey guidelines *Species credit threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method* (OEH 2018).

### Timing of survey

Survey timing was conducted in accordance with the relevant guidelines and the survey timing provided in BioNet.

### Results

Table 17 provides a summary of the results of the microbat surveys completed.

**Table 17 Summary of microbat survey method and results**

Species name	Common name	Survey method	Survey results	Species Polygon (ha)
<b><i>Chalinolobus dwyeri</i></b>	Large-eared Pied Bat	<ul style="list-style-type: none"> <li>Microbat acoustic detection surveys Jan – Mar 2021</li> <li>Harp trapping Jan 2021</li> </ul>	<ul style="list-style-type: none"> <li>Recorded on acoustic data (foraging)</li> <li>Not recorded in harp traps (breeding)</li> </ul>	Required
<b><i>Miniopterus australis</i></b>	Little Bent-winged Bat	<ul style="list-style-type: none"> <li>Microbat acoustic detection surveys Jan – Mar 2021</li> <li>Harp trapping Jan 2021</li> </ul>	<ul style="list-style-type: none"> <li>Recorded on acoustic data (foraging)</li> <li>Not recorded in harp traps (breeding)</li> </ul>	N/A Species polygon required for breeding habitat only
<b><i>Miniopterus orianae</i></b>	Large Bent-winged Bat	<ul style="list-style-type: none"> <li>Microbat acoustic detection surveys Jan – Mar 2021</li> <li>Harp trapping Jan 2021</li> </ul>	<ul style="list-style-type: none"> <li>Recorded on acoustic data (foraging)</li> <li>Not recorded in harp traps (breeding)</li> </ul>	N/A Species polygon required for breeding habitat only
<b><i>Myotis macropus</i></b>	Southern Myotis	<ul style="list-style-type: none"> <li>Microbat acoustic detection surveys Jan – Mar 2021</li> <li>Harp trapping Jan 2021</li> </ul>	<ul style="list-style-type: none"> <li>Recorded on acoustic data (foraging)</li> <li>Not recorded in harp traps (breeding)</li> </ul>	Required

### 2.2.2 Incidental flora and fauna surveys

The following threatened species were recorded during the field campaign. They comprise either BAM ecosystem credit species (not subject to targeted survey requirements), or species recorded during incidental surveys undertaken as part of the current assessment:

- Dwarf Phyllota – 14 individuals were recorded during flora surveys undertaken outside the targeted survey efforts. These plants occurred both within the development footprint, and within the project's proposed offset areas near Long Swamp Creek.
- Broad-leaved Sally *Eucalyptus aquatica* - An estimated 250+ individuals were recorded within and adjacent to Long Swamp Creek in the north-western portion of the subject land.
- *Helichrysum calvertianum* – 10 individuals were located during incidental flora surveys within the eastern portion of the subject land, approximately 125 m north-west of the development footprint.
- Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Yellow-bellied Sheath-tail-bat *Saccolaimus flaviventris* were recorded using ultrasonic call recorders deployed within the subject land.
- Flame Robin *Petroica phoenicea* and Scarlet Robin *Petroica boodang* recorded during incidental bird surveys.

## 2.3 Potential impacts to habitat connectivity

### 2.3.1 Nature

The removal of vegetation associated with the project will impact upon movement corridors at both the site scale and the landscape scale, with impacts to habitat connectivity along Long Swamp Creek and its tributaries as well as to the Regional Wildlife Habitat Corridor, mapped in the *Wingecarribee Local Environment Plan 2010*.

Impacts to habitat connectivity will occur to all entities known or predicted to occur within the vegetation and habitats comprising the connectivity corridors, with more mobile threatened species that rely on habitat connectivity to maintain life-cycle stages likely to be most impacted.

Species considered most at risk from impacts to habitat connectivity, as a result of the project, include; Koala, Gang-gang Cockatoo, Glossy Black-Cockatoo and Greater Glider.

### 2.3.2 Extent

Connectivity within the subject land occurs in the northern and western portions of the site within the intact vegetation and along Long Swamp Creek and its tributaries. Habitats within the subject land are connected to an area to the west of approximately 2,000 hectares, of more-or-less contiguous native vegetation, between Canyonleigh Road (to the north) and the Hume Highway (to the south). There is little to no connectivity to the east and south-east of the subject land, which comprises areas of cleared land and the occasional paddock trees, and the Hume Highway. Habitat connectivity to the north-east of the subject land is limited to an area of approximately 65 hectares of vegetation along Long Swamp Creek (approximately 1.3 kilometres upstream), before all native vegetation is replaced by cleared paddocks. Habitat connectivity to the south of the subject land exists for approximately 1.3 kilometres to the Hume Highway, when areas of native vegetation become more linear shaped and run parallel with the highway. Native vegetation is replaced on the southern side of the highway by the large areas of Pine plantations comprising Penrose State Forest. Native vegetation occurs in these areas along Baronga Creek, Stingray Swamp and Hanging Rock Swamp, and is again present in a mosaic of remnant native bushland and cleared rural areas.

Vegetation removal associated with the site-scale habitat connectivity corridors equates to an area of approximately 42 hectares of mainly higher condition intact native vegetation. This comprises the areas of the proposed extraction area, and western portions of the noise bind and haul road, and equates to an area approximately 700 metres wide (north/south) by approximately 850 metres long (east/west).

Vegetation providing connectivity in a north-east to south-west direction through the subject land is currently between 700 metres and 1600 meters wide. In considering the worst case scenario during the operational phase of the project (the entire 42 hectares of vegetation are removed), the width of this connected vegetation could be reduced to approximately 300 metres, and confined to the steeper areas adjacent to Long Swamp Creek.

It should be noted that this worst case scenario is unlikely to be realised as the entire northern extent of the extraction area is unlikely to be cleared of vegetation at any one time with staged extraction and rehabilitation planned for the life of the project. Furthermore it should be noted that connectivity through the site in the north-east to south-west direction is the most limited in terms of length and total area of connected vegetation. Habitats supported by native vegetation only occurs for approximately 1.3 kilometres to the north-east of the subject land, to the upper reaches of Long Swamp Creek, and as such fauna movement through the site in this direction is likely to be limited to species moving between forage resources, rather than as part of any breeding migrations.

Connectivity through the site from the north and north-west to the south and south-east will also be impacted by the project, however the potential proportional changes in corridor widths will not be as pronounced. Vegetation providing connectivity in a north and north-west to the south and south-east direction through the subject land is currently between 1.5 kilometres and 3 kilometres wide, which in again assuming worst case scenario impacts, could be reduced to between 700 metres to 2.5 kilometres. This north and north-west to the south and south-east, and further to the south-west, is the most likely pattern of fauna movement through the site and in the locality, however the native vegetation corridors are interrupted by the Pine plantations of Penrose State Forest to the south of the site, which creates a pinch-point and funnels fauna utilising the corridor in the south-westerly direction.

The key landscape-scale habitat connectivity feature relevant to the subject land is the Regional Wildlife Habitat Corridor, mapped in the *Wingecarribee Local Environment Plan 2010*, which provides connectivity between the southern Blue Mountains and Morton National Park. The Regional Wildlife Habitat Corridor spans an area of approximately 40,000 – 50,000 hectares, and comprises a mix of large tracts of remnants bushland, as well as more fragmented areas subject to historical clearing. A number of conservation reserves such as Bangadilly National Park, Joadja Nature Reserve and Wollondilly River Nature Reserve form part of the corridor, and the corridor extends over a lineal area of approximately 40 kilometres. The subject land occurs within the southern quarter of the corridor closet to Morton National Park.

This southern portion of the corridor, from north of Canyonleigh to south of Penrose occurs as the more fragmented portion of the corridor, with large areas of intact bushland interspersed with large areas of cleared land subject to historical on ongoing rural land management activities.

The subject land occurs on the eastern edge of the corridor with connectivity mainly present to the west and north-west along Long Swamp Creek, and south-west towards Paddys River, however connectivity is impacted to the south by the presence of the Hume Highway and the Pine plantations of Penrose State Forest.

When considered at this landscape scale the current width of the Regional Wildlife Habitat Corridor in relation to the subject land is approximately 6.8 kilometres wide, which will not be substantially altered due to the location of the project's development footprint on the edge of the corridor, and being adjacent to the upper reaches of Long Swamp Creek and the associated native vegetation. Assuming a worst case scenario impact the width of the landscape scale corridor in relation to the subject land could be assessed as being reduced to approximately 6 kilometres wide. It should be noted that at this landscape scale the total extant/width of the habitat corridor is not comprised of intact native vegetation. Cleared areas occur within the widths quoted above, where some species less able to traverse these cleared areas, would avoid and move through the intact vegetation around the edges.

### 2.3.3 Duration

Impacts are considered long-term as they will occur over the 30 year life of the project, but progressive rehabilitation will ensure they are temporary in successfully rehabilitated areas.

### 2.3.4 Consequences

Recent advice was sought by the NSW Minister for Planning and Public Spaces and the Minister for Energy and Environment from the Office of the NSW Chief Scientist & Engineer (OCSE) regarding the adequacy of Koala specific measures in the Wilton Growth Area and Greater Macarthur Growth Area proposed as part of the Cumberland Plain Conservation Plan. The OCSE advice (OCSE 2021) identifies 31 principles relevant to the protection of Koalas in the Wilton Growth Area and Greater Macarthur Growth Area and surrounds. Principle 5 relates to determining adequate Koala corridor widths and states:

*Corridors should be widened where feasible through revegetation to an average minimum width of 390 - 425 m, include a buffer on either side (30 m wide where fenced and wider to ~ 60 m where fencing is infeasible), and trees should 3 m from the fence (to prevent tree branch damage to fence).*

Of relevance to the current assessment is the required average minimum width for Koala corridors of between 390 meters and 425 meters, and also the consideration of whether the habitat is 'functional' (or preferred) for Koala movement. In particular, the advice states that 'corridor measurements should reflect their functionality for koalas' (OCSE 2021) with functionality measured based areas that are likely to be more or less accessible to Koala moving through the landscape, generally in relation to steep slopes alongside major watercourses, being less accessible and therefore less functional (Biosis 2021).

Site scale impacts to potential Koala movement corridors are associated with movements through the subject land in both a north-east to south-west (and vice versa) direction, and north and north-west to the south and south-east (and vice versa) direction. As outlined above, assuming worst case scenario impacts to habitat connectivity, the habitat corridor providing north-east to south-west connectivity would be reduced to a minimum pinch-point width of approximately 300 metres, below the minimum 390 metre width required to represent a functional Koala corridor. It should also be noted that this pinch-point would occur in an area where moderately steep slopes down to Long Swamp Creek occur, however these slopes are well vegetated with tall trees and are not considered so steep as to render them less accessible to Koala movements.

The current functionality of this north-east to south-west corridor to facilitate Koala movements is considered limited due to it being a 'dead-end' at the upper reaches of Long Swamp Creek, approximately 1.3 kilometres to the north-east of the subject land, and due to the already limited width of the corridor along this 1.3 kilometre length. Portions of the habitat corridor that still occur within the subject land, between approximately 350 metres and 800 metres to the north-east of the proposed extraction area, exist with a width of approximately 300 metres, and as such below the width required to be considered a functional Koala corridor. The habitat then continues to reduce in width further upstream along Long Swamp Creek. As such the project is not considered likely to reduce the functionality of this north-east to south-west corridor with regards to the movement of Koalas through the landscape.

Furthermore when the potential worst case scenario impacts are considered, the project will not result in the loss of, or substantial impacts to, a the functional Koala corridors comprising the north and north-west to the south and south-east site-scale corridor (minimum width of approximately 700 metres), or the landscape-scale Regional Wildlife Habitat Corridor (minimum width of approximately 6 kilometres).

Gang-gang Cockatoo are a highly mobile species known to be seasonal migrants with altitudinal movements between tall mountain forest and woodlands in summer, and drier more open eucalypt forests and woodland assemblages at lower altitudes in winter (Commonwealth of Australia 2022b). As such it is expected that the species would utilise the landscape-scale Regional Wildlife Habitat Corridor as part of these migratory movements. It is not expected however that localised impacts, when considered at the landscape-scale, which



remove a small fraction of the intact native vegetation that comprises the movement corridor, would result in a substantial or significant effect on Gang-gang Cockatoo movement throughout the landscape. When worst case scenario impacts are considered at the site scale, the potential reduction in habitat corridor width to between 300 metres and 700 metres, is also not considered likely to result in a substantial or significant effect to a highly mobile species, easily capable of avoiding pinch-points and utilising large adjacent areas of habitat. Furthermore it is stated in BioNet that the species can occur in patches of vegetation less than 5 hectares in area. As such the residual areas of habitat that comprise the site-scale movement corridors, even after worst case scenario impacts of the project are considered, would be substantially greater than the minimum patch size required to support the species' use of the habitats.

Glossy Black-Cockatoo is another highly mobile bird species known to disperse over large distances of between 44 kilometres to 78 kilometres (Mooney & Pedler 2005) and can forage up to 12 kilometres from their nest site without breeding success being compromised, but prefer to forage closer when food is available (Cameron 2007). Glossy Black-Cockatoo are known to forage within the subject land and are likely to move between areas of suitable forage and breeding habitat that exist within the Regional Wildlife Habitat Corridor, and could conceivably use the entire 40 kilometre corridor to move through the landscape. Like Gang-gang Cockatoos the impacts of the project to the edge of the Regional Wildlife Habitat Corridor, are not considered likely to substantially or significantly impact upon potential movement patterns for the species which is capable of moving over large areas of unsuitable habitat. There is evidence that Glossy Black-Cockatoos have crossed 300 kilometres of mostly unsuitable habitat in northern Queensland (Cameron 2007). Again, like Gang-gang Cockatoos, BioNet indicates that the species can occur in patches of vegetation less than 5 hectares in area. As such, the residual areas of habitat that comprise the site-scale movement corridors, even after worst case scenario impacts of the project are considered, would be substantially greater than the minimum patch size required to support the species' use of the habitats.

It is noted that Glossy Black-Cockatoos are known to travel up to 12 kilometres from their nest site to forage, which may be occurring within the area surrounding the subject land, and be the reasons for the species' recorded presence on site. Very large areas of intact bushland, including Morton National Park, and the 8-10 kilometre wide expanses of the Regional Wildlife Habitat Corridor, west of Belanglo State Forest occur with a 12 kilometre buffer of the subject land, and the project's impacts are considered highly unlikely to disrupt the species' movement patterns at this scale.

Greater Glider is a species with relatively small home ranges of between 1 and 3 hectares (Lindenmayer & Nix 1993), and can occur at quite high densities of between 0 to 1.13 (+/- 0.34) individuals per hectare (with an average of 0.41 Greater Gliders per hectare) (Vinson et al 2020), with individuals' home ranges potentially overlapping, although less so in males (Threatened Species Scientific Committee 2016). The species is also one known to survive well in wildlife corridors (Lindenmayer & Nix 1993).

The EPBC Act Conservation Advice for Greater Glider states that the species is considered to be particularly sensitive to forest clearance and to intensive logging, although responses vary according to landscape context and the extent of tree removal and retention. Also of relevance is that, in part due to the species low dispersal ability, Greater Gliders may be sensitive to fragmentation, have relatively low persistence in small forest fragments, and disperse poorly across vegetation that is not native forest. Modelling suggests that the species requires native forest patches of at least 160 km<sup>2</sup> to maintain viable populations (Threatened Species Scientific Committee 2016).

Based on the above advice it can be expected that the population of Greater Glider utilising the subject land comprises a small portion of the larger viable population supported by the native vegetation and habitats that comprise the Regional Wildlife Habitat Corridor. This is supported by the density of BioNet records for the species that occur within the corridor, both to the north and south of the subject land.

Despite the species' potential sensitivity to vegetation clearing, the project's impacts are unlikely to render the retained habitats with the subject land, or the un-impacted habitats surrounding the subject land unsuitable for the species. Furthermore the project's impacts are not considered likely to result in substantial habitat fragmentation. The species will continue to be able to utilise the habitats present within both the site-scale and landscape-scale habitat corridors, and movement patterns and population viability are not expected to be substantially or significantly impacted by the project.

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## Appendix 1 BAM Candidate species and MNES assessment

**Table A. 1 Threatened flora species assessment**

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<i>Acacia bynoeana</i> Bynoe's Wattle	V	E	No	<p>Bynoe's Wattle is a semi-prostrate shrub growing up to 1 m tall with shiny stiff narrow phyllodes (1.5-5 cm long, 1-3 mm wide) and single flower heads.</p> <p>This species occurs in central; eastern NSW from the Hunter District to the Southern Highlands and west to the Blue Mountains. It occurs in heath or dry sclerophyll forest on sandy soils and prefers open or disturbed sites. Bynoe's Wattle is associated with Red Bloodwood <i>Corymbia gummifera</i>, Scribbly Gum, Parramatta Red Gum, Saw Banksia <i>Banksia serrata</i> and Narrow-leaved Apple. The survey period is year round.</p>	Low	No	Yes – targeted survey undertaken Nov-Dec 2020, Apr-May 2021, Apr 2022	No	<p>This species has been previously recorded on 28 occasions within a 10 km radius of the subject land.</p> <p>Species is not associated with PCT 1150 or 1152.</p> <p>Incidental surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period (and summer flowering period) for the species.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>
<i>Acacia flocktoniae</i> Flockton Wattle	VU	VU	Yes	<p><i>Flockton Wattle</i> can be an erect or somewhat pendulous shrub 2 - 4 m tall, with somewhat winged branchlets. The wattle 'leaves' (phyllodes) are straight, between 5 - 10 cm long and 2 - 5 mm wide. Sprays of 5 - 10 golden-yellow globular flower-heads appear between June and August.</p>	Low	No	No	No	<p>This species has not been previously recorded within a 10 km buffer of the subject land.</p> <p>BioNet states "<i>The Flockton Wattle is found only in the Southern Blue Mountains (at Mt Victoria, Megalong Valley and Yerranderie).</i>"</p> <p>Potential habitat for this species is associated with PCT 1150, however the</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				The survey period for this species is July – September.					subject land occurs outside the species state area of occurrence (BioNet).
<b><i>Baloskion longipes</i></b> <b>Dense Cord-rush</b>	VU	VU	No	Dense Cord-rush is a perennial, rush-like herb with separate male and female plants. Its flowering stems are up to 1.5 m tall, and are narrow and circular in cross section. Flowering spikelets are produced on slender stalks towards the tops of these stems in summer. Commonly found in swamps or depressions in sandy alluvium, sometimes growing with sphagnum moss. Also occurs in swails within tall forest, and in Black Gum ( <i>Eucalyptus aggregata</i> ) Woodland. Produces new shoots from underground stems (rhizomes), but little is known about its biology.  Survey period is all year.	Low	No	No	Low potential for indirect impact based on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	This species has been previously recorded on 8 occasions within a 10 km radius of the subject land.  Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species.  Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.
<b><i>Caladenia tessellata</i></b> <b>Thick Lip Spider Orchid</b>	VU	EN	No	Small orchid found in a wide variety of communities including Central Gorge Dry Sclerophyll Forests, Cumberland Dry Sclerophyll Forests, Coastal Floodplain Woodlands and Subalpine Woodlands. Grows on clay loam or sandy soils.	Low	No	No	No	The species has only been recorded in one location within 50 kilometres of the study area, and is considered highly unlikely to occur.  Species was not recorded during targeted flora surveys.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Carex klaphakei</i></b> <b>Klaphake's Sedge</b>	-	EN	No	Perennial sedge that grows in swamp communities at altitudes of between 600-1200 metres above sea level in Coastal Heath Swamps, Montane Bogs and Fens and Montane Lakes.	Low	No	No	Low potential for indirect impact based on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	This species has been previously recorded on 9 occasions within a 10 km radius of the subject land.  Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species.  Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.
<b><i>Commersonia prostrata</i></b> <b>Dwarf Kerrawang</b>	EN	EN	No	Dwarf Kerrawang is a ground-hugging shrub that forms mats to more than 1 m across. Its leaves are up to 4 cm long and 2.5 cm wide, on 5 to 20 mm long leaf-stalks. Occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum ( <i>Eucalyptus pauciflora</i> ) Woodland and Ephemeral Wetland floor at Rowes Lagoon; Blue leaved Stringybark ( <i>E. agglomerata</i> ) Open Forest at Tallong; and in Brittle Gum ( <i>E. mannifera</i> ) Low Open Woodland at Penrose; Scribbly Gum ( <i>E. haemastoma</i> ) Swamp Mahogany ( <i>E. robusta</i> ) Ecotonal Forest at Tomago.  Associated native species may include <i>Imperata cylindrica</i> , <i>Empodisma minus</i> and	Low	No	No	No	This species has been previously recorded on 10 occasions within a 10 km radius of the subject land.  Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species.  Incidental surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period and did not record this species.



Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>Leptospermum continentale.</p> <p>Appears to respond positively to some forms of disturbance. However, there are conflicting reports about the response of the species to fire. The population at the Thirlmere lakes is most abundant in the areas of prior lake bed exposed by the dropping water levels. It is uncertain how long this may remain the case, as many of the individuals are very large, growing among the decomposing bases of bulrushes. It is also found among wattle thickets in the drainage line between the lakes.</p> <p>Survey period all year.</p>					
<b><i>Cryptostylis hunteriana</i></b> <b>Leafless Tongue Orchid</b>	VU	Vu	No	Orchid that grows in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Heath Swamps, New England Dry Sclerophyll Forests and Sydney Coastal Heaths. Grows in sandy soils.	Low	No	No	No	Only one record of the species occurs within 35 kilometres of the study area and the species is not associated with any impacted PCTs. As such the species likelihood of occurrence within the study area is considered low. Species was not recorded during targeted flora surveys.
<b><i>Diuris ochroma</i></b> <b>Pale Golden Moths</b>	VU	EN	No	Terrestrial orchid recorded in the Kosciuszko National Park and Kybean area. Grows in Temperate Montane Grasslands, Subalpine Woodlands and Tableland Clay Grassy	Low	No	No	No	The closest record of the species occurs near Braidwood along 100 kilometres to the south of the study area. As such the species likelihood of occurrence within the study area is considered low.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				Woodlands.					Species was not recorded during targeted flora surveys.
<b><i>Eucalyptus aggregata</i></b> <b>Black Gum</b>	VU	VU	No	Small to medium sized woodland tree that grows in the wetter, cooler areas of the Southern Highlands on the lowest parts of the landscape in poorly drained flats and hollows adjacent to creeks and small rivers. Associated with a variety of communities including Eastern Riverine Forests, Montane Bogs and Fens, Temperate Montane Grasslands, Subalpine Woodlands and Southern Tableland Wet Sclerophyll Forest. Grows in alluvial soils.	No	No	No	No	The species has not been recorded in the locality, is not associate with any impacted PCTs, and was not recorded during targeted flora surveys.
<b><i>Eucalyptus aquatica</i></b> <b>Broad-leaved Sally</b>	VU	VU	No	The Broad-leaved Sally is a tree to 7 m tall. It can have a single trunk or take a many-stemmed, mallee form. Found primarily in the Penrose area near Goulburn where all records are either from State Forest or private property. There is also one record from within Morton National Park. Occurs as scattered plants on open, swampy flats.  Survey time all year.	High – Recorded outside development footprint within the project's proposed offset area	No	No	Potential for indirect impact based on presence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	The species has been recorded as an estimated 250+ individuals along the northern boundary of the subject land.  Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species.  Species has been assessed in terms of potential for indirect impacts only.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<i>Eucalyptus macarthurii</i> <b>Paddys River Box, Camden Woollybutt</b>	EN	EN	Yes	<p>Paddy's River Box is a tall tree reaching up to 40 metres high. The grey-brown, shortly fibrous, thick bark is persistent on the trunk and larger branches. Above this the bark is smooth, grey and sheds in short ribbons. Occurs on grassy woodland on relatively fertile soils on broad cold flats.</p> <p>Survey time all year.</p>	Moderate	Yes	Yes – targeted survey undertaken Nov-Dec 2020, Apr-May 2021, Apr 2022	No	<p>This species has been previously recorded on 189 occasions (based on BioNet records) within 10 km of the subject land. Furthermore Biosis is aware of a large (250+ individuals) within close proximity to the subject land, yet to be uploaded to BioNet.</p> <p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>
<i>Genoplesium baueri</i> <b>Bauer's Midge Orchid</b>	EN	EN	No	<p>Terrestrial orchid that grows on moss gardens in a variety of communities including Sydney Coastal Dry sclerophyll Forests, Sydney Coastal Heaths, Sydney Montane Heaths, Southern Lowland Wet Sclerophyll Forests and Sydney Hinterland Dry Sclerophyll Forests. Grows on sandstone substrates</p>	Low	No	No	No	<p>The nearest record of the species is over 40 kilometres to the south-east, and the species is not associated with any impacted PCTs.</p> <p>The species was not recorded during targeted flora surveys.</p>
<i>Gentiana wingecarribiensis</i> <b>Wingecarribee</b>	EN	CE	No	<p>Wingecarribee Gentian is an erect annual herb, to 9 cm tall, with a reddish, unbranched or sparsely-</p>	Low	No	No	Low potential for indirect impact based	<p>This species has been previously recorded on 6 occasions within a 10 km radius of the subject land.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b>Gentian</b>				<p>branched stem. It grows in bogs, in Sphagnum Moss humps and in sedge communities. It is an annual herb.</p> <p>Survey period October – December.</p>				<p>on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek</p>	<p>Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species.</p> <p>Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.</p>
<b><i>Grevillea raybrownii</i></b>	-	VU	No	<p>Generally occurs on ridgetops and, less often, slopes and benches of Hawkesbury Sandstone and Mittagong Formation;<sup>2</sup> It occurs in Eucalyptus open forest and woodland with a shrubby understorey on sandy, gravelly loam soils derived from sandstone that are low in nutrients.</p> <p>Survey period October - December</p>	Low	No	Yes – incidental survey undertaken Nov-Dec 2020, Apr-May 2021, Apr 2022	No	<p>This species has been previously recorded on 1 occasion within a 10 km radius of the subject land.</p> <p>The species is not associated with PCT 1150 or 1152, however incidental surveys were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration</p>
<b><i>Helichrysum calvertianum</i></b> -	-	VU	No	<p>It occurs in dry sclerophyll forest and heathland with rock outcrops, predominantly on Hawkesbury sandstone soils. At altitudes between approximately 650 and 855 m. Rainfall ranges from 850 mm per annum at the western-most sites, to over 1500 mm at the eastern-most</p>	High – Recorded outside development footprint within the project's proposed offset area	No	Yes – targeted survey undertaken Nov-Dec 2020, with incidental surveys undertaken in Apr-May 2021,	No	<p>This species has been previously recorded on 8 occasions within a 10 km radius of the subject land.</p> <p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>site. It is likely the seeds are wind dispersed. The fire response of <i>H. calvertianum</i> is unknown.</p> <p>Survey period is August – February.</p>			Apr 2022		<p>A total of 10 individuals were recorded in one location to the north of the project's development footprint, within the proposed offset area.</p> <p>Based on the location of the species outside the project's development footprint the species does not require further consideration, other than for potential indirect impacts.</p>
<b><i>Hibbertia puberula</i></b> -	-	EN	Yes	<p>Flowering time is October to December, sometimes into January. Occurs on sandy soil often associated with sandstone, or on clay. Habitats are typically dry sclerophyll woodland communities, although heaths are also occupied. One of the recently (2012) described subspecies also favours upland swamps.</p> <p>Survey period is October – December.</p>	High – Recorded within the subject land	Yes	Yes – targeted survey undertaken Nov-Dec 2020, with incidental surveys undertaken in Apr-May 2021, Apr 2022	Yes	<p>This species has been previously recorded on 1 occasion within a 10 km radius of the subject land.</p> <p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period (and summer flowering period) for the species.</p> <p>A total of 3 individuals were recorded in one location in the centre of the project's development footprint.</p> <p>Further assessment and an associated offset requirement is provided above.</p>
<b><i>Kunzea cabbagei</i></b> <b>Cabbage Kunzea</b>	VU	VU	Yes	<p>Cabbage Kunzea is restricted to damp, sandy soils in wet heath or mallee open scrub at higher altitudes on sandstone outcrops or Silurian group sediments. Flowering occurs</p>	Low	Yes	Yes – targeted survey undertaken Nov-Dec 2020, with incidental	No	<p>Records of the species closest to the subject land include a population approx. 15 kms to the north-east near Medway and a population approx. 25 kms to the west in the Tarlo River National Park.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>between September and November.</p> <p>Survey period is October to November.</p>			<p>surveys undertaken in Apr-May 2021, Apr 2022</p>		<p>Species habitat of damp, sandy soils in wet heath or mallee open scrub at higher altitudes does not occur within the project's impact area.</p> <p>Species is associated with PCT 1150 and as such targeted surveys were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>
<p><i>Leucochrysum albicans</i> var. <i>tricolor</i></p> <p><b>Hoary Sunray</b></p>	EN	-	No	<p>Small perennial herb that occur throughout the Southern Tablelands and the South Eastern Highlands, Australian Alps and Sydney Basin Bioregions. Grows in disturbed areas and intertussock spaces in grasslands, woodlands and forests. Grows in a variety of soils including clays, clay loams, stony and gravelly.</p>	Low	No	No	No	<p>Only two species' records occur within 12 kilometres of the study area, with one record being from 1947 and the other being highly inaccurate (10,000m accuracy). Potential habitat within the subject and may occur in areas where PCT 1155 and PCT 1152 occur with an abundance of surface rock, however these areas have been subject to targeted flora field surveys and the species was not recorded.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Persicaria elatior</i></b> Tall Knotweed	Vu	VU	No	Erect herb found in damp places usually on the margins of waterbodies and in swamp forests in a variety of communities including Coastal Floodplain Wetlands, Coastal Swamp Forests, Eastern Riverine Forests, Coastal Freshwater Lagoons and Coastal Heath Swamps.	Low	No	No	No	The species has not been recorded within 50 kilometres of the study area since 1969 and as such its likelihood of occurrence is considered low.
<b><i>Persoonia glaucescens</i></b> Mittagong Geebung	VU	EN	No	The Mittagong Geebung grows in woodland to dry sclerophyll forest on clayey and gravely laterite. The preferred topography is ridge-tops, plateaux and upper slopes. Aspect does not appear to be a significant factor. Within its habitat, <i>P. glaucescens</i> is generally rare and the populations are linear and fragmented. Under ideal circumstances, the species can be locally common, though such conditions are very rare. Plants are killed by fire and recruitment is solely from seed. Like most <i>Persoonia</i> species this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides.  Survey period January to March.	Low	No	Yes – incidental survey undertaken Nov-Dec 2020, Apr-May 2021, Apr 2022	No	Records of the species closest to the subject land occur between 15 and 50 kms to the north-east centred around Bargo and Mittagong.  The species is not associated with PCT 1150 or 1152, however incidental surveys were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022.  It is acknowledged that surveys were not undertaken within the BioNet prescribed survey however, the NPWS Impact Assessment Guidelines for the species state <i>Persoonia glaucescens</i> is identifiable throughout the year, although more readily detected during the flowering period in summer and early autumn (NPWS 2000). Surveys undertaken between November and April area considered sufficient to have recorded the species.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
									<p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration</p>
<p><b><i>Persoonia mollis</i></b>  <b>subsp. <i>revoluta</i></b>            -</p>	-	VU	Yes	<p>Mainly on relatively deep sandy soils on broad ridgetops and upper slope. Frequently on Hawkesbury Sandstone on Soapy Flat or Sandy Flat soil landscapes</p> <p>Survey time all year</p>	Moderate	Yes	<p>Yes – targeted survey undertaken Nov-Dec 2020, Apr-May 2021, Apr 2022</p>	No	<p>This species has been previously recorded on 19 occasions within a 10 km radius of the subject land.</p> <p>Species is associated with PCT 1150 or 1152.</p> <p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period (and summer flowering period) for the species.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>
<p><b><i>Phyllota humifusa</i></b>  <b>Dwarf Phyllota</b></p>	VU	VU	Yes	<p>The species occurs in dry sclerophyll forest, sometimes near swamps, in deep sandy soils or gravely loams over a sandstone substrate. Accompanying trees are often Brittle Gum Eucalyptus mannifera, Narrow-leaved Peppermint <i>E. radiata</i> or</p>	High – Recorded within the development footprint and project’s proposed offset	Yes	<p>Yes – targeted survey undertaken Nov-Dec 2020, with incidental surveys undertaken in</p>	Yes	<p>This species has been previously recorded on 45 occasions (based on BioNet records) within 10 km of the subject land. Furthermore, Biosis is aware of a large (1,000+ individuals) within close proximity to the subject land, yet to be uploaded to BioNet.</p>



Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>Sydney Peppermint <i>E. piperita</i>. Plants apparently resprout following fire.</p> <p>Survey period November – January.</p>	area		Apr-May 2021, Apr 2022		<p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period (and summer flowering period) for the species.</p> <p>A total of 35 individuals were recorded in multiple locations across of the project's development footprint and proposed offset area.</p> <p>Furthermore field assessments by Kevin Mills and Associates undertaken in 2015 located 105 individuals in the north-western corner of the subject land within the project's now proposed offset area.</p> <p>Further assessment and an associated offset requirement is provided above.</p>
<b><i>Pomaderris cotoneaster</i></b> -	EN	EN	Yes	<p>Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs. Little is known about the ecology of the species. It is probably killed by fire but plants have been observed to re-sprout from the stem following death of the crown from</p>	Low	Yes	Yes – targeted survey undertaken Nov-Dec 2020, with incidental surveys undertaken in Apr-May 2021, Apr 2022	No	<p>This species has been previously recorded on 2 occasions within a 10 km radius of the subject land.</p> <p>Species is associated with PCT 1150 or 1152.</p> <p>Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period for the species.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>apparent drought. Populations tend to be isolated and range in size from a few individuals to many hundreds. Populations are not apparently influenced by local variations in habitat - it is not obvious why they are only growing where they are.</p> <p>Survey period October to November.</p>					<p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>
<b><i>Pterostylis ventricosa</i></b> -	-	CE	Yes	<p>Predominantly in more open areas of tall coastal eucalypt forest often dominated by one or more of the following tree species:- Turpentine, Spotted Gum, Grey Ironbark, Blackbutt, White Stringybark, Scribbly Gum and Sydney Peppermint. Often favours more open areas such as along power line easements and on road verges where the tree overstorey has been removed or thinned. Grows in a range of groundcover types, including moderately dense low heath, open sedges and grasses, leaf litter, and mosses on outcropping rock. Small moss gardens are a commonly associated micro-habitat feature in most habitats. Soil type ranges from moisture-retentive grey silty loams to grey sandy loams. Sometimes found</p>	Moderate	Yes	Yes - targeted survey undertaken Apr-May 2021, Apr 2022	No	<p>This species has not previously been recorded within a 10 km radius of the subject land, with the closest record approx. 13 kms to the south-west.</p> <p>Species is associated with PCT 1150 or 1152.</p> <p>Targeted surveys for this species were undertaken within the impact area between April and May 2021, and April 2022 during the approved survey period (and autumn flowering period) for the species.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>in skeletal soils on sandstone rock shelves.</p> <p>Survey period Match to May.</p>					
<b><i>Pultenaea elusa</i> Elusive Bush-pea</b>	EN	CE	No	The Elusive Bush-pea has only been recorded twice, in 1938 at Penrose and Wingello on the Southern Tablelands. Both collections of the Elusive Bush-pea record the habitat only as swamp.	Low	No	No	Very low potential for indirect impact based on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	Whilst the species has been recorded in the locality, it has not been recorded for over 80 years. As such the likelihood of the species' occurrence in the subject land it considered low. Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.
<b><i>Thelymitra kangaloonica</i> Kangaloon Sun Orchid</b>	CR	CR	No	Terrestrial orchid found growing in swamps and sedgeland at elevations between 550 and 700 metres in Temperate Highland Peat Swamps on Sandstone, Coastal Heath Swamps and Montane Bogs and Fens. A cryptic species which is most visible when flowering between late October and early November. Grows in grey silty or grey loam soils.	Low	No	No	No	A single record of the species occurs within 100 kilometres of the study area and is 40 years old. As such the species' likelihood of occurrence is considered low. Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.
<b><i>Thesium australe</i> Austral Toadflax</b>	Vu	VU	No	Small, straggling herb and root parasite found growing on damp sites in grassland, grassy woodlands and coastal headlands often in	Low	No	No	No	The species has not been recorded within 80 kilometres of the study area in over 100 years, nor is it associated with any impacted PCTs. As such the species'

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				association with Kangaroo Grass <i>Themeda triandra</i> in a variety of communities including New England Dry Sclerophyll Forests, Western Slopes Grasslands, Northern Tableland Wet Sclerophyll Forests, Brigalow Clay Plain Woodlands, Subalpine Woodlands and Maritime Grasslands.					likelihood of occurrence is considered low.
<b><i>Xerochrysum palustre</i></b> <b>Swamp Everlasting</b>	VU	-	No	Grows in swamps and bogs which are often dominated by heaths. Also grows at the edges of bog margins on peaty soils with a cover of shrubs or grasses. Re-sprouts after fires. Sometimes grows in bogs with Sphagnum.  Survey period September to May.	Low	No	No	Low potential for indirect impact based on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	The species has only been recorded in two locations north of Bredbo in the Southern Alps, one of which is approximately 35 kilometres to the east of the subject land in Wingecarribee Swamp.  Species is not associated with PCT 1150 or 1152 and is not considered a BAM candidate species. Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.
<b><i>Zieria murphyi</i></b> <b>Velvet Zieria</b>	VU	VU	Yes	The Velvet Zieria is found in sheltered positions in moist gullies in moist eucalypt forest with sandy soil. Flowering of southern populations, between Bundanoon and Penrose, has only been recorded in spring whereas flowering in northern populations has been recorded throughout the year.	Moderate	Yes	Yes – targeted survey undertaken Nov-Dec 2020, with incidental surveys undertaken in Apr-May 2021, Apr 2022	No	This species has been previously recorded on 17 occasions within a 10 km radius of the subject land.  Species is associated with 1152.  Targeted surveys for this species were undertaken within the impact area between November and December 2020, April and May 2021, and April 2022 during the approved survey period for the

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				Survey period September to November.					<p>species.</p> <p>No individuals of this species was detected.</p> <p>Based on the absence of this species within the impact area the species does not require any further consideration.</p>

## Fauna

**Table A. 2 Threatened fauna species assessment**

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Anthochaera phrygia</i> Regent Honeyeater (Breeding and Foraging)</b>	CE	CE	Yes	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall	Low	No	No	Breeding – No Foraging – Low level potential impacts	The subject land is not located within an area mapped by DPE as important (breeding) habitat for this species.  No BioNet records for the species exist within 10 km of the subject land with the closest records being 17-25 kms from the subject land.  Foraging habitat for this species is supported by PCTs 1150 and 1152 within the development footprint.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				mature eucalypts and Sheoaks. Also nest in mistletoe haustoria (DPIE 2020d). This species is relevant to the Cumberland and Wollemi IBRA subregions.					
<b><i>Aprasia parapulchella</i></b> <b>Pink-tailed Legless Lizard</b>	VU	VU	No	Fossorial species, which lives beneath surface rocks and occupies ant burrows. It feed on ants, particularly their eggs and larvae. Thought to lay eggs within the ant nests under rocks that it uses as a source of food and shelter. Key habitat features are a cover of native grasses, particularly Kangaroo Grass ( <i>Themeda australis</i> ), sparse or no tree cover, little or no leaf litter, and scattered small rock with shallow embedment in the soil surface.	No	No	No	No	Species is not associated with impacted PCTs and potential habitat does not occur within the subject land.
<b><i>Botaurus poiciloptilus</i></b> <b>Australasian Bittern</b>	EN	EN	No	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes ( <i>Typha</i> spp.) and spikerushes ( <i>Eleocharis</i> spp.) Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with	Low	No	No	Low potential for indirect impact based on low likelihood of occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	No BioNet records for the species exist within 10 km of the subject land with the closest records being 17-20 kms from the subject land.  Foraging habitat for this species is supported by PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek.  Species has been assessed in terms of potential for indirect impacts only, which are considered unlikely.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch.					
<b><i>Calidris ferruginea</i> Curlew Sandpiper</b>	CR	EN	No	Inhabits sheltered intertidal mudflats. Also non-tidal swamps, lagoons and lakes near the coast. Infrequently recorded inland.	No	No	No	No	Species habitat is not present within the subject land.
<b><i>Collocephalon fimbriatum</i> Gang-gang Cockatoo</b>	EN	V	Yes	Gang-gang Cockatoo is a medium sized cockatoo coloured slate grey with males sporting a scarlet head and crest and females have a grey head and crest with salmon pink edged feathers on their undersides. Gang-gang Cockatoo is distributed from southern Victoria to central eastern NSW. In Spring and Summer, this species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests, in winter often move to lower altitudes in drier more open eucalypt forests. In Autumn and Winter, the species moves to lower altitudes, inhabiting dry sclerophyll forests and woodlands. Gang-gang Cockatoo favours old growth forest and	High – Recorded foraging within the subject land	Yes (Breeding only)	Yes – Habitat assessment, hollow-bearing tree survey and dawn/dusk and diurnal surveys for breeding birds undertaken between Oct 2020 and Jan 2021 over the subject land.	Breeding habitat – No Foraging habitat – Yes	This species has been previously recorded on 69 occasions within a 10 km radius of the subject land, including multiple times within the subject land during the current and previous biodiversity assessments.  Potential breeding habitat in the form of hollow-bearing trees containing suitably sized hollows (>10 cm diameter and at least 9 m above the ground) occur within the development footprint, however surveys over a total of 14 days within the species breeding season survey period did not record the species breeding on the subject land.  Foraging habitat for this species was detected throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152.



Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>woodland for breeding where it nests in hollows over 10 cm in diameter and above 9 m from the ground (DPIE 2020d).</p> <p>This species is relevant to the Cumberland and Wollemi IBRA subregions.</p>					
<p><b><i>Calyptrorhynchus lathamii</i></b> <b>Glossy Black-Cockatoo</b></p>	VU	VU	Yes	<p>Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of Sheoak occur. Black Sheoak and Forest Sheoak are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak and Allocasuarina gymnathera. Belah is also utilised and may be a critical food source for some populations. Dependent on large hollow-bearing eucalypts for nest sites.</p>	High - Recorded foraging within the subject land	Yes (Breeding only)	Yes – Habitat assessment, hollow-bearing tree survey and dawn/dusk and diurnal surveys for breeding birds undertaken between Jan and Jul 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been previously recorded on 58 occasions (BioNet) within a 10 km radius of the subject land, including multiple times within the subject land during the current and previous biodiversity assessments.</p> <p>Potential breeding habitat in the form of hollow-bearing trees containing suitably sized hollows (&gt;15 cm diameter and at least 8 m above the ground) occur within the development footprint, however surveys over a total of 17 days within the species breeding season survey period did not record the species breeding on the subject land.</p> <p>Foraging habitat for this species was detected throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152.</p>
<p><b><i>Cercartetus nanus</i></b> <b>Eastern Pygmy-possum</b></p>	-	VU	Yes	<p>Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and</p>	Moderate	Yes	Yes – Elliot trapping in Jan 2021, Remote	No	<p>This species has been previously recorded on one occasion within a 10 km radius of the subject land.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. They may occupy small patches of vegetation in fragmented landscapes and although the species prefers habitat with a rich shrub understory, they are known to occur in grassy woodlands and the presence of Eucalypts alone is sufficient to support populations in low densities. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation (e.g. grass-tree skirts), tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.</p>			<p>camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021</p>		<p>Potential foraging habitat and breeding habitat occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential habitat also occurs throughout the remained of the subject land, which is proposed as the project's offset area and to be managed as a Biodiversity Stewardship Site. Targeted surveys were undertaken between November 2020 and March 2021 and the species was not recorded.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Chalinolobus dwyeri</i></b> <b>Large-eared Pied Bat</b>	VU	VU	No	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin ( <i>Petrochelidon ariel</i> ), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring.	High – Recorded foraging within the subject land	Yes (Breeding only)	Yes – Ultrasonic call recording and Harp trapping undertaken in Jan 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been previously recorded on 5 occasions within a 10 km radius of the subject land.</p> <p>Species was recorded on ultrasonic call detectors, but not in harp traps, in January 2021.</p> <p>Foraging habitat for this species occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152.</p> <p>Potential breeding habitat occurs in the form of rocky outcrops within and surrounding the subject land. However no evidence was found of the species breeding within the subject land during targeted surveys.</p>
<b><i>Dasyurus maculatus maculatus</i></b> <b>Spotted-tailed Quoll</b>	EN	VU	No	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Quolls use hollow-bearing trees, fallen logs,	Moderate	No	Yes – Remote camera traps deployed between Jan and Mar 2021	No	<p>This species has been previously recorded on 2 occasions within a 10 km radius of the subject land. Furthermore additional records of the species occur within 10-20kms of the subject land.</p> <p>Species was not recorded on remote</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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				<p>other animal burrows, small caves and rock outcrops as den sites. Mostly nocturnal, although will hunt during the day; spend most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds. Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals. A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl. Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creeklines. Average litter size is five; both sexes mature at</p>					<p>sensing camera traps deployed between January and March 2021.</p> <p>Foraging habitat for this species occurs throughout the development footprint in the form of intact PCTs 1150 and 1152.</p> <p>Potential den or latrine sites were not recorded within the subject land.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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				about one year of age. Life expectancy in the wild is about 3-4 years.					
<b><i>Grantiella picta</i> Painted Honeyeater</b>	VU	VU	No	Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe. Often found on plains with scattered eucalypts and remnant trees on farmlands.	Low	No	No	No	The species has not been recorded within 40km of the study area, and the species' characteristic habitat is not present.
<b><i>Heleioporus australiacus</i> Giant Burrowing Frog</b>	VU	VU	Yes	Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter. Individual frogs occupy a series of burrow sites, some of which are used repeatedly. The home ranges of both sexes appear to be non-overlapping suggesting exclusivity of non-breeding habitat. Home ranges are approximately 0.04 ha in size. Individuals move into the breeding site either immediately before or following heavy rain and occupy these sites for up to 10 days. Most individuals will not attempt to breed every year. When breeding,	Low	Yes	Yes – Targeted frog surveys undertaken in Nov 2020 and Jan 2021	No	No BioNet records for the species exist within 10 km of the subject land with the closest records being >30 kms from the subject land.  Potential habitat for the species occurs within and surrounding the sandy watercourses present on the subject land.  Targeted surveys undertaken over 8 nights did not record the species.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>frogs will call from open spaces, under vegetation or rocks or from within burrows in the creek bank. Males show strong territoriality at breeding sites. This species breeds mainly in autumn, but has been recorded calling throughout the year. Egg masses are foamy with an average of approximately 500-800 eggs and are laid in burrows or under vegetation in small pools. After rains, tadpoles are washed into larger pools where they complete their development in ponds or ponded areas of the creekline. Tadpole development ranges from around 12 weeks duration to up to 12 months with late developing tadpoles overwintering and completing development when warmer temperatures return. Breeding habitat of this species is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water. This frog is a slow growing and long-lived species, living up to 10 years of age, possibly longer.</p>					

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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<b><i>Hieraaetus morphnoides</i> Little Eagle</b>	-	VU	Yes	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Lays two or three eggs during spring, and young fledge in early summer. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.	Moderate	No	Yes – Habitat assessment and searches for suitable stick nests were undertaken in Oct 2020 during the species breeding season, Dawn/dusk and diurnal bird surveys were also undertaken Jan, Apr, May, Jul 2021	Breeding habitat – No Foraging habitat – Yes	This species has been previously recorded on 10 occasions (BioNet) within a 10 km radius of the subject land.  Foraging habitat for this species occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152, and over adjacent areas of open exotic grasslands.  Whilst potential nest trees occur within the subject land, no evidence of breeding was recorded during October 2020 surveys, and the species was not observed during any fauna survey work undertaken for the project.
<b><i>Hirundapus caudacutus</i> White-throated Needletail</b>	VU	-	No	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia.	Low	No	No	No	Species may forage over the study area, but impact to habitat will not occur.
<b><i>Hoplocephalus bungaroides</i> Broad-headed Snake</b>	VU	EN	Yes	Nocturnal. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in crevices or hollows in large trees within 500m of escarpments in summer. Feeds mostly on geckos and small skinks; will also eat frogs	Low	No	Yes – Habitat mapping and active searches of rocky areas were undertaken in Jan, Apr and May 2021	No	The subject land is not within the known distribution of the species, which extends to Morton NP (approx. 10 kms east of the subject land), however there is highly limited connectivity between the NP and the subject land. The species has never been recorded west of Morton NP and snakes are unlikely to move into unoccupied habitat due to the short

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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				and small mammals occasionally. Females produce four to 12 live young from January to March, which is a relatively low level of fecundity.					<p>dispersal distances of juveniles and strong site fidelity of adults (Webb &amp; Shine 1997b).</p> <p>The subject land supports rocky areas, but none were found to represent microhabitats suitable for the species. The species is not known to occur in the Scribbly Gum dominated PCT 1152, which supports the majority of the more open (sunnier) rocky areas within the subject land. Rocky areas were recorded in PCT 1150 (associated with the species in BioNet), however these rocky habitats were found to occur in shadier areas such as gullies, down cliff faces, flatter areas with a dense tree layer, and on slopes with a southerly aspect. Larger rocky areas with a westerly aspect and plenty of sun exposure occur in PCT 1150, in the west of the subject land, approximately 200 m from the development footprint.</p> <p>Broad-headed Snakes are known to occupy crevices that have a sunny aspect (Webb &amp; Shine 1998b) and rocks used by snakes are those that receive the most warmth from the sun (Pringle et al. 2003). Thermally suitable microhabitat are a limiting resource for the species (Pringle et al. 2003).</p> <p>Habitat assessment/mapping surveys combined with active searches for snakes</p>



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									<p>was undertaken in summer/autumn 2021 (Jan-May) and did not record any evidence of the species.</p> <p>Adults use rocks and crevices as shelter sites in rocky outcrops in autumn, winter and early spring (Webb &amp; Shine 1994), whilst juvenile snakes remain in rocky habitat year round (Downes 1999). In late spring and summer adult males and non-breeding adult females move into adjacent woodland (Webb &amp; Shine 1997a). However gravid females and juveniles remain in rocky habitat, using cooler, shaded rocks and crevices (Webb &amp; Shine 1998a). It is acknowledged that surveys were undertaken outside the BioNet prescribed survey window for the species (Aug-Sept), however if the effectively sessile species was present on the subject land, its presence would have been recorded during these targeted surveys.</p>
<p><i>Isoodon obesulus</i> <b>Southern Brown Bandicoot (eastern)</b></p>	EN	EN	Yes	<p>Southern Brown Bandicoots are generally only found in heath or open forest with a heathy understorey on sandy or friable soils. Males have a home range of approximately 5-20 hectares whilst females forage over smaller areas of about 2-3 hectares. Nest during the day in a shallow depression in the ground covered by</p>	Low	No	<p>Yes – Remote camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021</p>	No	<p>This species has not previously been recorded within a 10 km radius of the subject land, with the closest recent record of the species approx. 40 kms to the south-east. Records are confined to more coastal areas, generally within 25 kms of the coast. The subject land supports only marginally suitable habitat for the species, with understorey vegetation present more</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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				leaf litter, grass or other plant material. Nests may be located under Grass trees, blackberry bushes and other shrubs, or in rabbit burrows.					open than the heathy understorey required to support the species.  Surveys were however undertaken between November 2020 and March 2021 and the species was not recorded.
<b><i>Lathamus discolor</i> Swift Parrot</b>	CE	EN	No	Migrates to the Australian south-east mainland between February and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i> , Spotted Gum <i>Corymbia maculata</i> , Red Bloodwood <i>C. gummifera</i> , Forest Red Gum <i>E. tereticornis</i> , Mugga Ironbark <i>E. sideroxylon</i> , and White Box <i>E. albens</i> . Commonly used lerp infested trees include Inland Grey Box <i>E. microcarpa</i> , Grey Box <i>E. moluccana</i> , Blackbutt <i>E. pilularis</i> , and Yellow Box <i>E. melliodora</i> . Return to some foraging sites on a cyclic basis depending on food availability.	Low	No	No	Breeding – No Foraging – Low level potential impacts	The subject land is not located within an area mapped by DPE as important (breeding) habitat for this species.  No BioNet records for the species exist within 10 km of the subject land with the closest records being approx. 20 kms to the south-west and 40 kms to the east of the subject land.  Foraging habitat for this species is supported by PCTs 1150 and 1152 within the development footprint.
<b><i>Litoria booroolongensis</i> Booroolong Frog</b>	EN	EN	Yes	Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults	Low	No	Yes – Frog surveys undertaken in	No	This species has not previously been recorded within a 10 km radius of the subject land, with the closest recent record

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				occur on or near cobble banks and other rock structures within stream margins. Shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks near flowing water during summer.			Nov 2020 and Jan 2021		of the species approx. 60 kms to the north-east. The subject land does not support the species' rocky stream habitat. Targeted surveys did not recorded the species.
<b><i>Litoria littlejohni</i> Littlejohn's Tree Frog</b>	VU	VU	No	This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground. Breeding is triggered by heavy rain and can potentially occur all year, but is usually from late summer to early spring when conditions are favourable. Males call from low vegetation close to slow flowing pools. Eggs are laid in loose gelatinous masses attached to small submerged twigs. Eggs and tadpoles are mostly found in still or slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools.	High – Species previously within the subject land	Yes	Yes – Targeted frog surveys undertaken in Nov 2020	Direct impact – No Indirect impacts – Potential	The species has been recorded on four occasions within the subject land between August and October 2018. Three of these four records occur outside the project's development footprint in areas proposed to be included in the project's offset area and managed as a Biodiversity Stewardship Site. One record occurs towards the western extent of the development footprint associated with a small dam at the head of an ephemeral creekline. Targeted surveys for the species were undertaken over five nights in November 2020, by Biosis zoologists familiar with the species from monitoring works undertaken within the Sydney drinking water catchment (Woronora Plateau), and the species was not recorded. As such it is considered that due to a lack of detection, when undertaking targeted surveys in accordance with the relevant guidelines, direct impacts to the species

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									will not occur as a result of the project.
<b><i>Macquaria australasica</i></b> <b>Macquarie Perch</b>	EN	-	No	Macquarie Perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. Macquarie perch are found in both river and lake habitats, especially the upper reaches of rivers and their tributaries	No	No	No	No	Habitat for this species does not occur within the study area.
<b><i>Miniopterus australis</i></b> <b>Little Bent-winged Bat</b>	-	VU	Yes	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. In NSW the largest maternity colony is in close association with a large maternity colony of Eastern	High – Recorded foraging within the subject land	Yes (Breeding only)	Yes – Ultrasonic call recording and Harp trapping undertaken in January 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been previously recorded on 1 occasion within a 10 km radius of the subject land, which was during previous biodiversity studies undertaken for the project.</p> <p>Species was recorded on ultrasonic call detectors during the current assessment, but not in harp traps, in January 2021.</p> <p>Foraging habitat for this species was detected throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152.</p> <p>Potential breeding habitat occurs in the form of rocky outcrops within and surrounding the subject land. However no evidence was found of the species breeding within the subject land during targeted surveys.</p>

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				Bentwing-bats ( <i>Miniopterus orianae oceanensis</i> ) and appears to depend on the large colony to provide the high temperatures needed to rear its young. Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer. Only five nursery sites /maternity colonies are known in Australia.					
<b><i>Miniopterus orianae oceanensis</i> Large Bent-winged Bat</b>	-	VU	Yes	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops.	High – Recorded foraging within the subject land	Yes (Breeding only)	Yes – Ultrasonic call recording and Harp trapping undertaken in January 2021	Breeding habitat – No Foraging habitat – Yes	This species has been previously recorded on 12 occasions within a 10 km radius of the subject land including during previous biodiversity studies undertaken for the project.  Species was recorded on ultrasonic call detectors during the current assessment, but not in harp traps, in January 2021.  Foraging habitat for this species was detected throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152.  Potential breeding habitat occurs in the form of rocky outcrops within and surrounding the subject land. However no evidence was found of the species breeding within the subject land during targeted surveys.

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<b><i>Mixophyes balbus</i></b> <b>Stuttering Frog</b>	VU	EN	Yes	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Feed on insects and smaller frogs. Breed in streams during summer after heavy rain. Eggs are laid on rock shelves or shallow riffles in small, flowing streams. As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose.	Yes	Yes	Yes – Targeted frog surveys undertaken in Nov 2020 and Jan 2021	No	<p>The species has been recorded on four occasions within 10kms of the subject land surrounding the township of Bundanoon. Three of these records are historic, however one is from 2011.</p> <p>The species' habitat noted in BioNet and the DPIE Frog Survey Guidelines is "rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range", which does not occur within the development footprint. However potential breeding habitat (although noted as on the Southern Highlands plateau, rather than the foothills / escarpment of the Great Dividing Range) is supported by PCT 1107 which occurs to the north of the development footprint along Long Swamp Creek, within the prospect's proposed offset area. Furthermore it is acknowledged that the species' non-breeding habitat is native vegetation located within 500 metres of a breeding site, and the species is known to move long distances from breeding sites (DPIE 2020), and as such the species was retained as a candidate and targeted surveys undertaken.</p> <p>The species was not recorded during surveys in November 2020 or January 2021.</p>

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<b><i>Myotis macropus</i></b> <b>Southern Myotis</b>	-	VU	No	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.	Yes	No	Yes – Ultrasonic call recording and Harp trapping undertaken in January 2021`	Yes	<p>This species has been previously recorded on one occasion (BioNet) within a 10 km radius of the subject land, with a number of additional records &lt;15 kms from the subject land.</p> <p>Species was recorded on ultrasonic call detectors during the current assessment, but not in harp traps, in January 2021.</p> <p>Foraging habitat occurs within the subject land supported by a number of dams within the eastern portion of the site, as well as one dam within the more intact vegetation in the centre of the core bushland. Furthermore the eastern portions of Long Swamp Creek support 3 m wide pools that provide forage opportunities for the species. Tree hollows within the subject land, that occur near these forage resources, may also support breeding habitat for the species.</p>
<b><i>Ninox connivens</i></b> <b>Barking Owl</b>	-	VU	Yes	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on	Yes	Yes (breeding only)	Yes – Targeted surveys undertaken in May and Jul 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been previously recorded on one occasion (BioNet) within a 10 km radius of the subject land.</p> <p>Foraging habitat and potential nest trees occur throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential breeding habitat is considered more likely to occur in the gullies surrounding the project's</p>

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	EPBC	BC							
				these fertile riparian soils. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.					<p>extraction area, and includes other PCTs recorded within the subject land.</p> <p>Targeted surveys were undertaken across four nights in May, and four nights in July 2021, with additional incidental spotlighting surveys undertaken in November 2020 and January 2021.</p> <p>The species was not recorded breeding within the subject land.</p>
<b><i>Ninox strenua</i></b> <b>Powerful Owl</b>	-	VU	Yes	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can	Yes	Yes (breeding only)	Yes – Targeted surveys undertaken in May and Jul 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been previously recorded on twelve occasions (BioNet) within a 10 km radius of the subject land. This includes on two occasions within the subject land.</p> <p>Foraging habitat and potential nest trees occur throughout the development</p>



Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
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				occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. There may be marked regional differences in the prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls.					<p>footprint in the form of intact and thinned PCTs 1150 and 1152. Potential breeding habitat is considered more likely to occur in the gullies surrounding the project's extraction area, and includes other PCTs recorded within the subject land.</p> <p>Targeted surveys were undertaken across four nights in May, and four nights in July 2021, with additional incidental spotlighting surveys undertaken in November 2020 and January 2021.</p> <p>The species was not recorded breeding within the subject land.</p>
<b><i>Numenius madagascariensis</i></b> <b>Eastern Curlew</b>	CR	-	No	Occurs in sheltered coasts, especially estuaries, embayments, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats often with beds of seagrass.	No	No	No	No	Species habitat does not occur within the subject land.
<b><i>Pseudomys novaehollandiae</i></b> <b>New Holland Mouse</b>	VU	-	No	Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 ha to 1.4 ha. The New Holland Mouse is a social animal, living predominantly in burrows shared with other individuals. The species is nocturnal	Low	No	No	Low	The species likelihood of occurrence within the subject land is considered low based on a lack of records in the locality and the limited amount of marginal habitat present within the site.

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				and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal. It is likely that the species spends considerable time foraging above-ground for food. Breeding typically occurs between August and January, but can extend into autumn.					
<b><i>Petalura gigantea</i> Giant Dragonfly</b>	-	EN	No	Lives in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins. Adults fly over the swamp and along its margins hunting for flying insects. Males sometimes congregate waiting for females to mate with. Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of	High – Recorded within the subject land	No	Yes – Targeted survey undertaken Jan 2021	Potential for indirect impact based on occurrence in PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek	This species has been previously recorded on 3 occasions within a 10 km radius of the subject land.  Habitat for this species is supported by PCT 1078 and PCT 1256 within and adjacent to Long Swamp Creek. Indirect impacts to this species are considered further above.  Targeted surveys recorded the species in January 2021 within the project's proposed offset area.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands. Larvae dig long branching burrows under the swamp. Larvae are slow growing and the larval stage may last 10 years or more. It is thought that larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.					
<b><i>Petauroides volans</i> Greater Glider</b>	VU	-	No	Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. Shelter during the day in tree hollows and will use up to 18 hollows in their home range. Occupy a relatively small home range with an average size of 1 to 3 ha. Give birth to a single young in late autumn or early winter which remains in the pouch for approximately 4 months and is independent at 9 months of age. Usually solitary, though mated pairs and offspring will share a den during the breeding season and until the young are independent. Can glide up to a horizontal distance of 100m including changes of direction of as much as 90 degrees.	High – Recorded within the subject land	No	Yes – Spotlighting surveys undertaken in Nov 2020 and Jan 2021	Yes	This species has been previously recorded on 78 occasions within a 10 km radius of the subject land, including multiple time within the subject land during the current and previous biodiversity assessments. Foraging habitat and potential breeding habitat occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential habitat also occurs throughout the remained of the subject land, which is proposed as the project's offset area and to be managed as a Biodiversity Stewardship Site. Targeted surveys were undertaken in November 2020 and January 2021 and the species was recorded on a number of occasions.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Petaurus norfolcensis</i> Squirrel Glider</b>	-	VU	Yes	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	Moderate	Yes	Yes – Elliot trapping in Jan 2021, Remote camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021	No	This species has been previously recorded on 3 occasions within a 10 km radius of the subject land.  Foraging habitat and potential breeding habitat occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential habitat also occurs throughout the remained of the subject land, which is proposed as the project's offset area and to be managed as a Biodiversity Stewardship Site.  Targeted surveys were undertaken between November 2020 and March 2021 and the species was not recorded.
<b><i>Petrogale penicillata</i> Brush-tailed Rock-wallaby</b>	VU	EN	Yes	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Highly territorial and have strong site fidelity with an average home range	Low	Yes	Yes – Remote camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021	No	This species has been previously recorded on one occasion within a 10 km radius of the subject land. It should be noted that this is a historical Australian Museum Specimen Register record. More recent records occur between 15-25 kms from the subject land.  Potential habitat occurs in the rockier areas of the subject land which mainly occurs outside of the development footprint.  Targeted surveys were undertaken between November 2020 and March 2021

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				size of about 15 ha. Males tend to have larger home ranges than females. The home range consists of a refuge area and a foraging range linked by habitually used commuting routes. Females settle in or near their mother's range, while males mainly disperse between female groups within colonies, and less commonly between colonies. Dominant males associate and breed with multiple females. Breeding occurs throughout the year with a peak in births between February and May, especially in the southern parts of the range and at higher altitudes.					and the species was not recorded.
<b><i>Phascolarctos cinereus</i></b> <b>Koala</b>	VU	VU	Yes	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night. Spend most of their time in trees, but will descend and traverse open ground to move between trees. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex	High – Evidence of the species (scats) recorded in the subject land	Yes	Yes – SAT surveys in Nov 2021, Remote camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021	Yes	This species has been previously recorded on 378 occasions within a 10 km radius of the subject land, including multiple times within the subject land during the current and previous biodiversity assessments.  Foraging habitat and potential breeding habitat occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential habitat also occurs throughout the remained of the subject land, which is proposed as the project's offset are and to be managed as a Biodiversity Stewardship Site.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				social hierarchies based on a dominant male with a territory overlapping several females and subordinate males on the periphery.					Evidence of the species presence (scats) was recorded during SAT surveys undertaken in November 2020, as well as additional incidental evidence of scats and scratches on trees.
<b><i>Potorous tridactylus</i> Long-nosed Potoroo</b>	VU	VU	Yes	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogenous (underground-fruited) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil. Often digs small holes in the ground in a similar way to bandicoots. Mainly nocturnal, hiding by day in dense vegetation - however, during the winter months animals may forage during daylight hours. Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2-5 ha. Breeding peaks typically occur in late winter to early summer and a single	Low	Yes	Yes – Remote camera trapping between Jan and Mar 2021, Spotlighting in Nov 2020 and Jan 2021	No	This species has been previously recorded on one occasion within a 10 km radius of the subject land.  Potential habitat occurs throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential habitat also occurs throughout the remained of the subject land, which is proposed as the project's offset area and to be managed as a Biodiversity Stewardship Site.  Targeted surveys were undertaken between November 2020 and March 2021 and the species was not recorded.

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				young is born per litter. Adults are capable of two reproductive bouts per annum					
<b><i>Pseudophryne australis</i></b> <b>Red-crowned Toadlet</b>	-	VU	Yes	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Red-crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5. 4 Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of the tadpoles takes place in the egg. Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable	High – Recorded within the subject land	Yes	Yes – Targeted frog surveys undertaken in Nov 2020 and Jan 2021	No	<p>This species has been previously recorded on one occasion within a 10 km radius of the subject land.</p> <p>Potential habitat for the species occurs within and surrounding the sandy watercourses present on the subject land.</p> <p>Targeted surveys recorded the species within the project's proposed offset area, approximately 250m to the west of the development footprint.</p> <p>As the species was recorded outside the development footprint (&gt;250 m east of the extraction area) on a branch of a watercourse that does not enter the development footprint, a species polygon is not considered necessary, as prescribed by <i>NSW survey guide for threatened frogs</i> (DPIE 2020c)</p> <p>Furthermore the species was not recorded during surveys within the development footprint.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				breeding habitat. Red-crowned Toadlets are usually found as small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites. Due to this tendency for discrete populations to concentrate at particular sites, a relatively small localised disturbance may have a significant impact on a local population if it occurs on a favoured breeding or refuge site.					
<b><i>Pteropus poliocephalus</i></b> <b>Grey-headed Flying-fox</b>	VU	VU	Yes	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. Annual mating commences in January and conception occurs in April or May; a single young is born in October or November. Site fidelity to camps is high; some camps have been used	High – Foraging only	No	Yes – Surveys for breeding camps undertaken throughout field campaign	No	Grey-headed Flying-fox camps containing up to 500 individuals have been recorded at Moss Vale, approximately 16 kms north-east of the subject land and approximately 30 kms to the north-east of the subject land at Mittagong, based on the National Flying-fox Viewer.  No camps occur within the subject land.



Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				for over a century. Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.					
<b><i>Rostratula australis</i></b> <b>Australian Painted Snipe</b>	EN	EN	No	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, but have been recorded in brackish waters. Forages on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.	Low	No	No	Low	The species has been recorded only once within 20km of the study area, with the next closest records being >50kms away along the coast. Potential habitat for the species occurs in the form of the wetland vegetation present, but the low likelihood of occurrence and the low potential for impact mean a significant impact to the species is considered highly unlikely.
<b><i>Sminthopsis leucopus</i></b> <b>White-footed Dunnart</b>	-	VU	No	The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest. In NSW, the species seems to favour vegetation communities with an open understorey structure (contrasting with populations in Victoria which apparently prefer dense shrub and ground layers). It is	Low	No	Yes – Spotlighting undertaken in Nov 2020	No	No BioNet records for the species exist within 10 km of the subject land. All records of the species (within 100kms of the subject land) are confined to within 25 kms of the coast, with the western-most occurrence of the species being noted in BioNet as the Budjong area ~10kms west of Nowra.  The species is not considered a potential candidate in accordance with the BAM as the species requires 'intact' (>70%) native vegetation cover in the assessment area,

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				<p>patchily distributed across these habitats and, where present, typically occurs at low densities.</p> <p>Breeding populations have been recorded in logged forest shortly after disturbance, but these usually do not persist as regeneration proceeds and a dense ground cover of vegetation establishes.</p> <p>Home range and movement patterns of this species vary according to sex. Adult females usually have small, discrete home ranges, approximately 80 metres in length. Adult males have overlapping home ranges, approximately 100 metres in length, but are capable of making regular exploratory movements of up to 1 km. The White-footed Dunnart is an opportunistic carnivore that feeds on a variety of ground-dwelling invertebrates and, occasionally, small lizards.</p>					<p>illustrating the species' requirement for high levels of habitat connectivity, not present surrounding the subject land.</p> <p>The species presence was targeted nonetheless during spotlighting surveys undertaken in November 2020, and was not recorded.</p>
<b><i>Synemon plana</i> Golden Sun Moth</b>	CR	EN	No	<p>The Golden Sun Moth's is found in the area between Queanbeyan, Gunning, Young and Tumut. Occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands, with groundlayer dominated by wallaby grasses of the genus <i>Austrodanthonia</i></p>	No	No	No	No	<p>The study area occurs over 100km to the east of the edge of the species known distribution. The species is not associated with any impacted PCTs.</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
<b><i>Tyto novaehollandiae</i></b> <b>Masked Owl</b>	-	VU	Yes	Lives in dry eucalypt forests and woodlands from sea level to 1100m. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Yes	Yes (Breeding only)	Yes – Targeted surveys undertaken in May and Jul 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has been recorded on two occasions (BioNet) within a 10 km radius of the subject land.</p> <p>Foraging habitat and potential nest trees occur throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential breeding habitat is considered more likely to occur in the gullies surrounding the project's extraction area, and includes other PCTs recorded within the subject land.</p> <p>Targeted surveys were undertaken across four nights in May, and four nights in July 2021, with additional incidental spotlighting surveys undertaken in November 2020 and January 2021.</p> <p>The species was not recorded breeding within the subject land.</p>
<b><i>Tyto tenebricosa</i></b> <b>Sooty Owl</b>	-	VU	No	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) or Sugar Glider ( <i>Petaurus</i>	Yes	Yes (Breeding only)	Yes – Targeted surveys undertaken in May and Jul 2021	Breeding habitat – No Foraging habitat – Yes	<p>This species has not been previously recorded (BioNet) within a 10 km radius of the subject land. Records occur further east within Morton NP.</p> <p>Foraging habitat and potential nest trees occur throughout the development footprint in the form of intact and thinned PCTs 1150 and 1152. Potential breeding habitat is considered more likely to occur in the gullies surrounding the project's</p>

Species	Status		BAM predicted SCS	Habitat description	Potential occurrence in subject land	BAM Candidate species	Survey required/undertaken	Potential for impact	Candidate species rationale
	EPBC	BC							
				breviceps). Nests in very large tree-hollows.					<p>extraction area, and includes other PCTs recorded within the subject land.</p> <p>Targeted surveys were undertaken across four nights in May, and four nights in July 2021, with additional incidental spotlighting surveys undertaken in November 2020 and January 2021.</p> <p>The species was not recorded breeding within the subject land.</p>

## Migratory species (EPBC Act listed)

The following table includes a list of migratory species that have potential to occur within the study area.

**Table A.3 Migratory fauna species recorded or predicted to occur within 5 kilometres of the study area**

Scientific name	Common name	Most recent record
<i>Actitis hypoleucos</i>	Common Sandpiper	#
<i>Apus pacificus</i>	Fork-tailed Swift	#
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	#
<i>Calidris ferruginea</i>	Curlew Sandpiper	#
<i>Calidris melanotos</i>	Pectoral Sandpiper	#
<i>Gallinago hardwickii</i>	Latham's Snipe	#
<i>Hirundapus caudacutus</i>	White-throated Needletail	2000#
<i>Motacilla flava</i>	Yellow Wagtail	#
<i>Numenius madagascariensis</i>	Eastern Curlew	#
<i>Pandion cristatus</i>	Osprey	#

# - Species predicted to occur within the 5 kilometres search area buffer on the study area by the DCCEE Protected Matters Search Tool.

Substantial or significant impacts to the above EPBC Act listed Migratory species are not expected to occur as a result of the project. Only one species has ever been recorded (BioNet) within the locality of the subject land.