6 Threatened species

6.1 Fauna habitat assessment

Concurrent with the vegetation mapping a habitat assessment was undertaken seeking to identify the following fauna habitat features within the Main Works survey area:

- habitat trees including large hollow-bearing trees;
- availability of flowering shrubs and feed tree species;
- waterway condition;
- quantity of ground litter and logs; and
- searches for indirect evidence.

The habitat assessment identified that in sections of the Main Works survey area where disturbance has been limited, fauna habitat features are abundant. In areas subject to disturbance, such as clearing and human activity, fauna habitat features are limited.

The upper section of Lobs Hole Ravine Road and the Marica area consists of tall wet sclerophyll forests to 40 m, dominated by Mountain Gum, Snow Gum and Alpine Ash, with a shrubby to grassy understorey. Hollow bearing trees are abundant within this area with large, old trees within undisturbed vegetation. Habitat complexity at ground level is high. Large logs, coarse woody debris and leaf litter are abundant on ground, providing shelter for a high number of fauna species. Watercourses are limited, and where they occur, are ephemeral and only found to flow for brief periods after heavy rains. Weed invasion is evident within creek lines, particularly with Blackberry.

Below approximately 1,200 m, vegetation transitions to drier sclerophyll forests with a shrubby understorey. Broad-leaved Peppermint, Robertson's Peppermint and Brittle Gum dominate the overstorey, with a sparse to moderately dense shrubby midstorey and sparse grassy groundcover. In these areas, hollows are limited to old, mature trees which tend to be rare. Large logs, coarse woody debris and leaf litter are also less common, providing more limited habitat for fauna species. Watercourses are more abundant on steep slopes but are even more highly ephemeral than other areas and only found to flow for brief periods after heavy rains. This vegetation extends down into Lobs Hole and includes areas outside the riparian zone and includes the northern end of Talbingo Reservoir.

Along intermittent and permanent watercourses in Lobs Hole a number of riparian communities occur. Where these communities are intact, large trees are moderately common and support large hollows. In many sections of the Main Works survey area, the midstorey and understorey are heavily disturbed, with significant weed invasion, particularly thickets of Blackberry. Where weeds are not present, a dense shrubby midstorey is present over a sparse groundcover. Coarse woody debris, logs and leaf litter varies from absent to moderately sparse, depending on past disturbance. There are limited areas considered to be of good quality for fauna species.

The plateau area supports a mix of grasslands and grassy woodlands. Grasslands on upper slopes provide an open to closed low grassland. Leaf litter is generally limited, but low cover is provided by moderate to dense cover of tussock grasses. Grasslands on lower slopes and drainage lines provide a dense cover of large tussock grasses, often over 100% cover. Grassy woodlands contain a mix of Snow Gum and Black Sallee, generally lacking hollows or with very limited small hollows. They support a moderate to sparse shrub layer and grassy groundcover. Fallen timber and coarse woody debris are generally moderate to sparse.

Vegetation directly adjacent to the edge of Tantangara Reservoir mainly consists of grasslands and adjacent grassy woodlands. Tree cover within these areas is limited including Black Sally. In some areas a moderate midstorey is present. Groundcover consists of tussock grasses, with limited large logs, coarse woody debris or leaf litter. These areas have been impacted by feral Horses, recreational use, and show moderate weed cover, and erosion due to use of the area by vehicles.

Areas east of Tantangara Reservoir consist of grassy woodlands with regeneration as a result of past fires. Groundcover consists of grass understorey with high amounts of fallen timber and large logs. These areas have been impacted by invasive weeds and pest species. West of Tantangara Reservoir a high number of riparian communities occur along intermittent and permanent watercourses. These areas include sub-alpine grasslands and grassy woodlands.

6.2 Ecosystem credit species assessment

Ecosystem credits species are threatened species that can be reliably predicted to use an area of land based on habitat surrogates. For the purposes of the BAM (OEH 2017a), ecosystem credit species are deemed to be offset through the habitat surrogates (PCTs) in which they occur. A list of ecosystem credit species predicted to occur within the Main Works survey area, based on the PCTs present and generated by the calculator associated within the BAM (OEH 2017a) is provided in Table 6.1. The potential for these species to occur within the Main Works disturbance footprint was assessed in accordance with Section 6.2 of the BAM (OEH 2017a).

Scientific name	Common name	Justification for exclusion
Anthochaera phrygia	Regent Honeyeater (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Callocephalon fimbriatum	Gang-gang Cockatoo (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Calyptorhynchus lathami	Glossy Black-Cockatoo (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Chthonicola sagittate	Speckled Warbler	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Circus assimilis	Spotted Harrier	Not excluded.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Daphoenositta chrysoptera	Varied Sittella	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Dasyurus maculatus	Spotted-tailed Quoll	Not excluded.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Haliaeetus leucogaster	White-bellied Sea- Eagle (Foraging)	The White-bellied Sea-eagle feeds on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion, using a perch near water. Species excluded from all PCTs not associated with the Yarrangobilly River, Talbingo Reservoir or Tantangara Reservoir (all PCTs except PCTs 296, 300, 302, 303, 1191 and 1224) and from cleared vegetation zones (condition class Low or Derived grassland).
Hieraaetus morphnoides	Little Eagle (Foraging)	Not excluded.

Table 6.1 Assessment of ecosystem credit species within the Main Works disturbance footprint

Table 6.1 Assessment of ecosystem credit species within the Main Works disturbance footprint

Scientific name	Common name	Justification for exclusion
Lophoictinia isura	Square-tailed Kite (Foraging)	Not excluded.
Melanodryas cucullata cucullate	Hooded Robin (south- eastern form)	Excluded from Low condition vegetation zones.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Neophema pulchella	Turquoise Parrot	Not excluded.
Ninox connivens	Barking Owl (Foraging)	Not excluded.
Ninox strenua	Powerful Owl (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Pachycephala olivacea	Olive Whistler	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Petaurus australis	Yellow-bellied Glider	Excluded from cleared vegetation zones (condition class Low or Derived grassland) due to lack of hollow bearing trees.
Petroica boodang	Scarlet Robin	Excluded from Low condition vegetation zones.
Petroica phoenicea	Flame Robin	Excluded from Low condition vegetation zones.
Phascolarctos cinereus	Koala (Foraging)	Excluded from all PCTs as the species is rare in KNP and no evidence was observed during targeted surveys.
Stagonopleura guttata	Diamond Firetail	Not excluded.
Suta flagellum	Little Whip Snake	Not excluded.
Tyto novaehollandiae	Masked Owl (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Tyto tenebricosa	Sooty Owl (Foraging)	Excluded from cleared vegetation zones (condition class Low or Derived grassland).
Varanus rosenbergi	Rosenberg's Goanna	Not excluded.

6.3 Species credit species assessment

6.3.1 Habitat constraints assessment (Step 2)

Species credit species are threatened species that cannot be reliably predicted to occur based on habitat surrogates. For the purposes of the BAM (OEH 2017a), species credit species require detailed assessment and, if present, additional offsets to ecosystem credits. An assessment of habitat constraints for threatened species credit species was undertaken in accordance with Step 2 of Section 6.4 of the BAM (OEH 2017a). For those threatened species credit species credit species predicted to occur, for which habitat constraints are listed, an assessment was undertaken of the presence of the habitat features within the Main Works survey area.

The species generated by the calculator with habitat constraints, as well as the results of the habitat constraints assessment, are shown in Table 6.2.

Table 6.2Assessment of geographic and habitat constraint features within the Main Works survey
area

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat/geographic constraint present in development site	Justification
Calotis pubescens	Max Mueller's Burr-daisy	OtherTreeless vegetation above 1,000m in altitude.	High	Yes	The project area contains treeless vegetation above 1,000m.
Carex raleighii	Raleigh Sedge	OtherTreeless vegetation above 1,000m in altitude.	High	Yes	The project area contains treeless vegetation above 1,000m.
Discaria nitida	Leafy Anchor Plant	• Riparian areas above 1,000m in altitude.	High	Yes	The project area contains riparian areas above 1,000m.
Grevillea iaspicula	Wee Jasper Grevillea	 Confined to an area between 0 and 10 km west of the Goodradigbee River and extending 5 km to the south and 15 km to the north of Wee Jasper. 	High	No	The project area is not located in any of the areas identified in the calculator.
Litoria spenceri	Spotted Tree Frog	 Waterbodies. River environments with rocky habitat or with 500 m of rocky river. 	Very high	Yes	The project area contains waterbodies and river environments with rocky habitat.
Myotis macropus	Southern Myotis	 Hollow bearing trees. Within 200 m of riparian zone. Bridges, caves or artificial structures within 200 m of riparian zone. 	High	Yes	The project area contains hollow bearing trees and artificial structures (mine adits) within 200 m of a riparian zone.
Phascogale tapoatafa	Brush-tailed Phascogale	Hollow bearing trees.	High	Yes	The project area contains hollow bearing trees.
Pomaderris cotoneaster	Cotoneaster Pomaderris	 South of northern Kosciuszko National Park boundary. 	High	Yes	The project area is located to the south of the northern boundary of KNP.
Prasophyllum retroflexum	Kiandra Leek Orchid	OtherTreeless vegetation above 1,000m in altitude.	High	Yes	The project area contains treeless vegetation above 1,000m.
Pseudophryne pengilleyi	Northern Corroboree Frog	Above 700 m above sea level (ASL).	Very high	Yes	The majority of the project area is located above 700 m ASL.
Thesium australe	Austral Toadflax	Kosciuszko National Park.	Moderate	Yes	The project area is located within KNP.

Using the process outlined in Step 2 of Section 6.4 of the BAM (OEH 2017a) only one species, Wee Jasper Grevillea, was excluded from requiring further consideration. No further assessment is required as per Section 6.4.1.13 of the BAM (OEH 2017a).

All other species have not been excluded on the basis of the identified geographic or habitat constraints. Further consideration is given to these species in Section 6.3.2.

6.3.2 Identifying candidate species credit species for further assessment (Step 3)

To develop a list of species credit species for further assessment, an assessment was undertaken in accordance with Step 3 of Section 6.4 of the BAM (OEH 2017a), as shown in Table 6.3.

Scientific name	Common name	Candidate species	Justification
Flora			
Calotis glandulosa	Mauve Burr-daisy	Yes	Sprawling, branched herb confined to the Monaro and Kosciuszko regions. Colonizes bare patches and along roadsides at higher altitudes in Temperate Montane Grasslands, Subalpine Woodlands, Tableland Clay Grassy Woodlands and Southern Tableland Wet Sclerophyll Forests.
			The project area contains suitable habitat for this species, and the species was recorded within the survey area.
Calotis pubescens	Max Mueller's Burr-daisy	Yes	Perennial herb limited to three sites in the Snowy Mountains south-east of Mount Hotham. Grows on subalpine treeless plains in herb rich grasslands subject to periodic rainfall in Temperate Montane Grasslands.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Carex raleighii	Raleigh Sedge	Yes	Small perennial sedge confined to elevations over 1000 metres above sea level on the Southern Tablelands with most populations occuring in Mount Kosciuzsko National Park. Grows in scattered sphagnum bogs, swampy wetlands, damp grasslands and subalpine stream edges in Alpine Bogs and Fens and Temperate Montane Grasslands.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Discaria nitida	Leafy Anchor Plant	Yes	Leafy Anchor Plant generally occurs on or close to stream banks and on rocky areas near small waterfalls. The species occurs in both woodland with heathy riparian vegetation and on treeless grassy sub-alpine plains. The Leafy Anchor Plant is confined to the far south of the Southern Tablelands of NSW and north-east highlands of Victoria.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Euphrasia scabra	Rough Eyebright	No	Rough Eyebright occurs in or at the margins of swampy grassland or in sphagnum bogs, often in wet, peaty soil. The species appears to be self- fertilising but seed production is variable, perhaps depending on season. There are three known populations in NSW: Bondi State Forest, South East Forests National Park and near Nunnock Swamp.
			The project area does not contain suitable habitat for this species, therefore it is unlikely to occur.

Scientific name	Common name	Candidate species	Justification
Glycine latrobeana	Clover Glycine	Yes	Low growing herb endemic to south-eastern Australia with a wide distribution from Port Pirie in South Australia through Victoria to near Hobart in Tasmania. Recently discovered in Kosciuszko National Park. Grows up to elevations of ~1300 m in Subalpine Woodlands and Temperate Montane Grasslands. Grows in a variety of soils including alluvial, sandstone, mudstone, granite and basalt derived soils.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Irenepharsus magicus	Elusive Cress	No	The distribution of the Elusive Cress is not known, with information provided with a single collection within the vicinity of Geehi Dam. The record of the species in NSW includes the habitat note "growing on mineral soil of embankment". The species was also recorded in a rocky limestone area in eastern Victoria.
			The project area does not contain suitable habitat for this species, therefore it is unlikely to occur.
Pomaderris cotoneaster	Cotoneaster Pomaderris	Yes	Cotoneaster Pomaderris has a very disjunct distribution, being known from the Nungatta area, northern KNP (near Tumut). 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.
			Although unlikely to occur, based on the species geographic distribution, the survey area contains forest and rocky forested slopes that are considered suitable habitat to support this species based on the limited understanding of the species ecology.
Prasophyllum innubum	-	Yes	Terrestrial orchid restricted to a single population comprising of seven small colonies totalling 400 individuals in a small area 30 kilometres north-west of Cabramurra and 17 kilometres south of Talbingo including Bago State Forest. Found growing in streamside habitat amongst Sphagnum hummocks at elevations between 1150-1180 metres in Temperate Montane Grasslands. A cryptic species which is most visible when flowering from January to February. Grows in moist sandy soils over sandstone substrates.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Prasophyllum retroflexum	Kiandra Leek Orchid	Yes	Terrestrial orchid restricted to the Long Plain, Kiandra and Tantangara areas of Kosciuszko National Park. Found growing in subalpine meadows, subalpine grasslands and Snow Gum Eucalyptus pauciflora subsp. pauciflora woodlands in Temperate Montane Grasslands. This species is cryptic and most visible when flowering between October and December.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Pterostylis alpina	-	Yes	The Alpine greenhood grows in moist forests on foothills and ranges, extending to montane areas in New South Wales. Occurring in the Southern Tablelands south from Bondo State Forest. It is often found on sheltered southern slopes near streams in rich loam. The species flowers from August to October. The project area contains suitable habitat for this species, and was recorded within the survey area.

Scientific name	Common name	Candidate species	Justification
Pterostylis foliata	Slender Greenhood	Yes	The Slender Greenhood grows in eucalypt forests amongst an understorey of shrubs, ferns and grasses. It's known to occur on loam or clay loam soils, found on sheltered slopes. The species is endemic to south-eastern Australia. This species was not predicted to occur but was added manually.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Rutidosis leiolepis	Monaro Golden Daisy	Yes	Low, tufted, perennial herb with a scattered distribution on the Monaro and subalpine plains of Kosciuszko National Park. Grows at high elevations in Temperate Montane Grasslands. Grows on basalt, granite and sedimentary substrates.
			The project area contains suitable habitat for this species, and was recorded within the survey area.
Thelymitra alpicola	-	Yes	Glabrous terrestrial herb. In Kosciuszko National Park and the Bago plateau the species occurs in wet heaths and adjacent to Sphagnum bogs between 1000-1500 metres. Associated species include <i>Hakea microcarpa</i> , <i>Leptospermum myrtifolium, Baeckea utilis, Baeckia gunniana, Epacris breviflora, Epacris paludosa, Baloskion austral</i> and <i>Empodisma minus</i> . Flowering occurs from late November to mid December.
			The project area contains suitable habitat for this species and was recorded within the survey area.
Thesium australe	Austral Toadflax	Yes	Austral Toadflax occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast, often in association with Kangaroo Grass and often in wet areas. This species is a root parasite that takes water and some nutrients from other plants, especially Kangaroo Grass. This species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands region.
			Suitable damp, grassy woodland habitat likely to be restricted to PCT 285, 1224 and damp areas of PCT 1196 within the project area.
Fauna			
Anthochaera phrygia	Regent Honeyeater (Breeding)	No	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. The species particularly favours Box-Ironbark woodland, and riparian forests of River Sheoak. Woodlands with significantly large numbers of mature trees with high canopy cover and abundance of mistletoe are favoured.
			The project area does not support suitable breeding habitat for this species and is not located within mapped important areas.
Callocephalon fimbriatum	Gang-gang Cockatoo (Breeding)	Yes	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.
			The project area contains suitable breeding habitat to support this species.

Scientific name	Common name	Candidate species	Justification
Calyptorhynchus lathami	Glossy Black- Cockatoo (Breeding)	No	The Glossy Black-cockatoo inhabits coastal woodlands and drier forest areas, open inland woodlands, or timbered watercourses where its main foot source, the casuarina (she-oak) is common. The species prefers to nest in hollows of large, old eucalypt trees, alive or dead, typically around 3 to 30 metres above the ground. The current known distribution within NSW covers areas from the coast to the tablelands, and as far west as the Riverina and Pilliga Scrub.
			The project area does not support suitable breeding habitat with dominant She-oak (<i>Allocasuarina</i> spp.) and is outside of the known range.
Cercartetus nanus	Eastern Pygmy- possum	Yes	The Eastern Pygmy-possum is found in a broad range of habitats from rainforest through sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collect from banksias, eucalypts and bottlebrushes. 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 (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation (eg grass- tree skirts). Nest-building appears to be restricted to breeding females. Tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.
			The project area supports suitable habitat for this species.
Cyclodomorphus praealtus	Alpine She- oak Skink	Yes	The Alpine She-oak Skink is found in treeless or very lightly treed areas that contain tussock grasses, low heath or a combination of both. The species preferences areas with litter, rocks, logs and other ground debris to use as shelter. Within NSW it has been observed in alpine to sub-alpine grasslands in flat to gently sloping areas. This species was not predicted to occur, but was added manually.
			The project area supports suitable habitat for this species.
Haliaeetus leucogaster	White- bellied Sea- Eagle (Breeding)	No	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass.
			No nests suitable for the species were observed during the habitat assessment. Breeding habitat unlikely to occur within the disturbance footprint.
Hieraaetus morphnoides	Little Eagle (Breeding)	No	The Little Eagle occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. The species nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.
			No nests suitable for the species were observed during the habitat assessment. Breeding habitat is unlikely to occur within the disturbance footprint.

Scientific name	Common name	Candidate species	Justification
Litoria booroolongensis	Booroolong Frog	Yes	The Booroolong Frog is associated with permanent streams in a variety of vegetation types. Primary habitat requirements are extensive rock bank structures along permanent rivers with the key feature of these rock structures being rock crevices in relatively shallow, slow to medium-flowing sections of stream.
			Suitable habitat for this species was identified along the Yarrangobilly River and Wallace's Creek within the project area during the habitat assessment.
Litoria spenceri	Spotted Tree Frog	No	The Spotted Tree Frog is extremely rare and occurs in scattered, geographically isolated populations. Historically it was known from two streams in southern NSW on the north-west side of the Great Dividing Range; however both populations appeared to have become locally extinct. One population has been re-established via a reintroduction program. It occurs among boulders or debris along naturally vegetated, rocky fast flowing upland streams and rivers.
			Due to extremely limited population distribution in NSW this species is considered unlikely to occur within the project area.
Litoria verreauxii alpina	Alpine Tree Frog	Yes	The Alpine Tree Frog occurs in the south-eastern NSW and Victorian high country (alpine and sub-alpine zones) generally above 1,100 m ASL. Most locations are within the KNP and some are close to alpine resorts. Found in a wide variety of habitats including woodland, heath, grassland and herb fields. Breed in natural and artificial wetlands including ponds, bogs, fens, streamside pools, stock dams and drainage channels that are still or slow flowing.
			The project area supports suitable sub-alpine grasslands and steam habitat.
Lophoictinia isura	Square- tailed Kite (Breeding)	No	The Square-tailed Kite is found in a variety of timbered habitats including dry woodlands and open forests. The species shows a particular preference for timbered watercourses, where nests are constructed in a fork or on large, horizontal limbs.
			No nests suitable for the species were observed during the habitat assessment. Breeding habitat is unlikely to occur within the disturbance footprint.
Mastacomys fuscus	Broad- toothed Rat	Yes	The Broad-toothed Rat occurs in two widely separated areas: the wet alpine and subalpine heaths and woodlands in KNP. The Broad-toothed Rat lives in a complex of runways through the dense vegetation of its wet grass, sedge or heath environment, and under the snow in winter. Food is mostly, gathered at night, in summer and autumn and during the afternoon and early evening in winter. The diet consists almost solely of greenery - grass and sedge stems, supplemented by seeds and moss spore cases. The habitat assessment recorded the scats of the species as abundant in dense tussock grasslands, including PCT 1225 and 637. The project area contains suitable wet alpine and subalpine heaths with dense
	F	N -	vegetation.
Miniopterus schreibersii oceanensis	Eastern Bentwing- bat (Breeding)	No	Caves are the primary roosting habitat, but also use derelict mines, storm- water tunnels, buildings and other man-made structures. Maternity caves have very specific temperature and humidity regimes, and are known from a limited number of sites across the species range.
			The project area does not contain suitable breeding habitat for this species. The project area does not support any maternity roosts.

Scientific name	Common name	Candidate species	Justification
Myotis macropus	Southern Myotis	Yes	This species roost in groups close to water in caves, mine shafts, hollow- bearing trees, storm water channels, building, under bridges and in dense foliage. The Southern Myotis relies on waterways with pools of 3 m wide or greater for foraging, breeding and roosting.
			The project area contains suitable habitat for the species, as defined in OEH (2018a).
Ninox connivens	Barking Owl (Breeding)	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. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. It typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. Nest-hollow entrances are 2-35 m above the ground with a diameter of 20-46 cm and depth of 20- 300 cm. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.
			The project area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees that are mainly located along the Yarrangobilly River, the upper reaches of Lobs Hole Ravine Road and the Marica area.
Ninox strenua	Powerful Owl (Breeding)	Yes	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest, requiring large tracts of forest or woodland habitat. The species nests in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. Nest in unburnt gullies and lower slopes within 100 m of streams.
			The project area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees that are mainly located along the Yarrangobilly River, the upper reaches of Lobs Hole Ravine Road and the Marica area.
Petaurus australis	Yellow- bellied Glider population on the Bago Plateau	No	Habitat on the Bago Plateau consists of tall wet sclerophyll forest dominated by Alpine Ash, Mountain Gum, Narrow-leaved Peppermint and Candlebark. The Yellow-bellied Glider feeds primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects. The species is very mobile and occupies large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.
			The project area is outside of the Bago Plateau.
Petaurus norfolcensis	Squirrel Glider	Yes	The Squirrel Glider 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. The species prefers mixed species stands with a shrub or Acacia mid-storey. The species relies on large old trees with hollows for breeding and nesting; however, trees need to be less than 50 m apart.
			Suitable feed and nesting trees are limited to the habitat west of Wallace's creek within the project area.
Petroica rodinogaster	Pink Robin	Yes	Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. Like most Robins, requires perching habitat from which it can predate insects and spiders, but does spend significant time on the ground.
			Potential for the species to occur within the project area.

Scientific name	Common name	Candidate species	Justification
Phascogale tapoatafa	Brush-tailed Phascogale	Yes	The Brush-tailed Phascogale prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. The species also inhabits heath, swamps, rainforest and wet sclerophyll forest. Nests and shelters in tree hollows with entrances 2.5 - 4 cm wide. Known to use many different hollows over a short time span.
			The species is scarce in the KNP, with a single record. Potential suitable habitat occurs within the project area and therefore the species will be retained as a candidate species.
Phascolarctos cinereus	Koala (Breeding)	Yes	Koalas live in eucalypt woodlands and forests. Home range size varies according to quality of habitat, ranging from less than two to several hundred hectares. The trees within the project area provide foraging or sheltering resources for Koala. Ribbon Gum, identified as a Koala feed tree, is present within the project area.
			Recent Koala records are scarce in KNP; however, as suitable habitat exists, the species is retained as a candidate species.
Pseudomys fumeus	Smoky Mouse	Yes	The precise habitat requirements of the Smoky Mouse are not clear. A wide range of vegetation communities are occupied, from damp coastal heath in East Gippsland, to sub-alpine heath. A characteristic of Smoky Mouse localities, except those in wet gullies, is a floristically diverse midstorey with members of the plant families <i>Epacridaceae</i> , <i>Fabaceae</i> and <i>Mimosaceae</i> well represented. Ground cover is also likely to be critical and can be in the form of dense low vegetation, such as occurs in heaths, or grass tussocks, rocks and logs in more open habitats. Soil conditions also need to be conducive to burrowing and growth of hypogeal fungi, a major component of the diet (Menkhorst and Broome 2006, 2008).
			Smoky Mouse has been recorded across the project area during targeted surveys.
Pseudophryne pengilleyi	Northern Corroboree Frog	Yes	The Northern Corroboree Frog occurs in forests, sub-alpine woodlands and tall heath in the Fiery Range from the Snowy Mountains Highway to Wee Jasper. Populations also occur in the pine plantations near Tumut. Summer breeding habitat includes pools and seepages in sphagnum bogs, wet heath, wet tussock grasslands and herbfields in low-lying depressions. Outside the breeding season adults move away from the bogs into the surrounding heath, woodland and forest to overwinter under litter, logs and dense groundcover.
Tyto novaehollandiae	Masked Owl (Breeding)	Yes	The Masked Owl lives in dry eucalypt forests and woodlands from sea level to 1,100 m. The species requires old hollow-bearing eucalypts greater than 90 cm diameter at breast height, with hollows greater than 40 cm wide, greater than 100 cm deep and at least 3 m above the ground, for breeding. Will breed in a variety of topographic positions.
			The project area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees that are mainly located along the Yarrangobilly River, the upper reaches of Lobs Hole Ravine Road and the Marica area.
Tyto tenebricosa	Sooty Owl (Breeding)	Yes	The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. It is mostly found on escarpments with a mean altitude <500 m. This species nests and roosts in hollows of emergent trees, mainly eucalypts often located in gullies.
			The project area contains suitable habitat. Suitable nesting habitat is limited to areas of mature trees that are mainly located along the Yarrangobilly River, the upper reaches of Lobs Hole Ravine Road and the Marica area.

Several threatened flora species have been recorded within and adjacent to the disturbance footprint that did not appear in the BAM calculator for consideration as candidate species. This is because the South East Highlands IBRA region and Bondo IBRA subregion was selected and the species are associated with the other IBRA regions and subregions (refer to Section 4.1.1). Species recorded during survey, but not included in the BAM calculator included:

- Clover Glycine;
- Kiandra Leek Orchid;
- Mauve Burr-daisy;
- Max Mueller's Burr-daisy;
- Monaro Golden Daisy;
- Prasophyllum innubum;
- Pterostylis alpina;
- Raleigh Sedge;
- Slender Greenhood; and
- Thelymitra alpicola;

Despite the above species not appearing, they have been added to the BAM calculator manually and have been considered during targeted flora surveys. *Pterostylis alpina* cannot be added to the calculator.

This assessment identified 14 threatened flora and 16 threatened fauna as candidate species requiring further assessment. An additional six EPBC listed species (including migratory species) were included as candidate species for the purposes of the EPBC Act assessment process (Section 9). Candidate species (including EPBC listed species) are outlined below (Table 6.4), in order of assessment within Sections 6.3.3 and 6.3.4.

Table 6.4Candidate species

Scientific name	Common name	BC Act	EPBC Act
Flora			
Calotis glandulosa	Mauve Burr-daisy	V	VU
Calotis pubescens	Max Mueller's Burr-daisy	E1	-
Carex raleighii	Raleigh Sedge	E1	-
Colobanthus curtisiae	Curtis' Colobanth	-	VU
Discaria nitida	Leafy Anchor Plant	V	-
Glycine latrobeana	Clover Glycine	E4A	VU
Pomaderris cotoneaster	Cotoneaster Pomaderris	E1	EN
Prasophyllum innubum	-	E4A	CE
Prasophyllum retroflexum	Kiandra Leek Orchid	V	VU
Pterostylis alpine	-	V	-
Pterostylis foliate	Slender Greenhood	V	-
Pterostylis oreophila	Blue-tongued Greenhood	E4A	CE

Table 6.4Candidate species

Scientific name	Common name	BC Act	EPBC Act
Rutidosis leiolepis	Monaro Golden Daisy	V	VU
Thelymitra alpicola	-	V	-
Thesium austral	Austral Toadflax	V	VU
Diurnal birds			
Callocephalon fimbriatum	Gang-gang Cockatoo (breeding habitat only)	V	-
Gallinago hardwickii	Latham's Snipe	-	Mi
Myiagra cyanoleuca	Satin Flycatcher	-	Mi
Petroica rodinogaster	Pink Robin	V	-
Rhipidura rufifrons	Rufous Fantail	-	Mi
Nocturnal birds			
Ninox connivens	Barking Owl (breeding habitat only)	V	-
Ninox strenua	Powerful Owl (breeding habitat only)	V	-
Tyto novaehollandiae	Masked Owl (breeding habitat only	V	-
Small terrestrial mammals			
Cercartetus nanus	Eastern Pygmy-possum	V	-
Mastacomys fuscus	Broad-toothed Rat	V	VU
Pseudomys fumeus	Smoky Mouse	E4A	CE
Large terrestrial mammals			
Dasyurus maculatus	Spotted-tailed Quoll	V	EN
Arboreal mammals			
Petauroides Volans	Greater Glider	-	V
Petaurus norfolcensis	Squirrel Glider	V	-
Phascogale tapoatafa	Brush-tailed Phascogale	V	-
Phascolarctos cinereus	Koala	V	VU
Microchiropteran bats			
Myotis Macropus	Southern Myotis	V	-
Amphibians			
Litoria booroolongensis	Booroolong Frog	E1	EN
Litoria verreauxii alpina	Alpine Tree Frog	E1	VU
Pseudophryne pengilleyi	Northern Corroboree Frog	E4A	CE
Reptiles			
Cyclodomorphus praealtus	Alpine She-oak Skink	E1	EN

Notes: 1. BC Act status: E4A – critically endangered, E1 – endangered, E2 – endangered population, V – vulnerable 2. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable

Targeted surveys were undertaken, and the presence or absence of these species in the Main Works survey area determined, in accordance with Section 6.4 of the BAM (OEH 2017a). Survey methods and outcomes are discussed further below.

6.3.3 Targeted survey methods

i Targeted flora surveys

Targeted flora surveys have been undertaken in accordance with OEH (2016c) and DoE (2013a) guidelines, and included transects spaced at intervals of 10 m. Targeted surveys along roads were undertaken with an observer walking either side of the road 5 to 7 m from the road edge.

In the western section of the survey area, areas with basalt derived soils along Lobs Hole Ravine Road, and areas dominated by Kangaroo Grass, were targeted based on suitability of habitat for candidate species. As the likelihood of threatened flora species occurring in many montane PCTs is low due to a lack of suitable habitat, surveys focused on sub-alpine areas and suitable habitat, with targeted flora surveys in montane areas limited to key microhabitats, such as along riparian areas for Cotoneaster Pomaderris. In the eastern section of the study area all PCTs were considered to provide suitable habitat for threatened flora species and were subject to targeted surveys.

Targeted flora surveys were undertaken within the survey area between December 2017 and January 2018 and December 2018 and January 2019. These targeted surveys were undertaken prior to the final disturbance footprint being provided. Surveys were completed within a broader study area and are relevant to our assessment in providing results for candidate species. Where surveys have not been undertaken within the disturbance footprint, due to the provision of the final footprint outside of the seasonal survey requirements for some species, either presence has been assumed if the species has been recorded in similar habitats, or surveys will be undertaken prior to the response to submissions and an updated assessment and offset requirements provided. Targeted flora survey transect locations are illustrated in Figure 6.1.





- Main Works disturbance footprint
- Waterbody
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.1











- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.2









Main Works disturbance footprint — Watercourse / drainage line Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.3









KEY Main Works disturbance footprint — Watercourse / drainage line Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.4









- Main Works disturbance footprint
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.5













GDA 1994 MGA Zone 55 💦 snowy2.0







Snowy 2.0

. Main Works Figure 6.1.8





- Main Works disturbance footprint
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.9









- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.10











- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.11









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.12









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.13









Main Works disturbance footprint

- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.14









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.15









GDA 1994 MGA Zone 55 N



GDA 1994 MGA Zone 55 💦











GDA 1994 MGA Zone 55 🕥







- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.20







GDA 1994 MGA Zone 55 N







- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.22






GDA 1994 MGA Zone 55 N

snowy 2.0





- Main Works disturbance footprint
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.24









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.25









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.26









- Main Works disturbance footprint
- Waterbody
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.27









KEY Main Works disturbance footprint

- Watercourse / drainage line Flora survey transect

Flora survey locations









- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.29









- Main Works disturbance footprint
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.30









- KEY
- C Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.31









- Main Works disturbance footprint
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.32









KEY
Main Works disturbance footprint
Watercourse / drainage line

Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.33









- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.34









- KEY Main Works disturbance footprint — Watercourse / drainage line
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.35









- Main Works disturbance footprint
- Waterbody
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report Main Works Figure 6.1.36









- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Flora survey locations

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.37









- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect

Flora survey locations









- Main Works disturbance footprint
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.39









- Main Works disturbance footprint
- Waterbody
- Watercourse / drainage line
- Flora survey transect

Snowy 2.0 Biodiversity Assessment Report . Main Works Figure 6.1.40









snowy2.0

Snowy 2.0

. Main Works







snowy2.0





- Main Works disturbance footprint
- Watercourse / drainage line
- Flora survey transect









Main Works disturbance footprint

Flora survey transect

Flora survey locations









- Main Works disturbance footprint
- Flora survey transect

Flora survey locations





ii Targeted fauna surveys

Targeted fauna surveys were conducted within the Main Works survey area between August 2017 and June 2019 in accordance with various NSW (DEC 2004, DECC 2009, OEH 2018a) and Commonwealth (DSEWPaC 2010a, 2010b, 2010c, 2011a, 2011b) guidelines.

Stratification units, as well as survey methods and effort are outlined for each fauna group below. Fauna survey locations are illustrated in Figure 6.2. A summary of fauna surveys, including sites and survey effort is provided in Annexure C, while weather data for the survey period is provided in Annexure D.

a Diurnal birds

Diurnal bird surveys were undertaken for five species listed under the BC Act and three additional migratory species listed under the EPBC Act. Targeted bird species include:

- Gang-gang Cockatoo (breeding habitat);
- Pink Robin;
- Breeding habitat for birds of prey, including:
 - Little Eagle;
 - Square-tailed Kite;
 - White-bellied Sea-Eagle;
- Latham's Snipe;
- Rufous Fantail; and
- Satin Flycatcher.

Stratification units and area of each survey unit in the survey area is shown in Table 6.5.

Table 6.5 Stratification units and survey area – diurnal birds

Vegetation class/survey area	Area (ha)
Montane Wet Sclerophyll Forests	22.12
Southern Tablelands Dry Sclerophyll Forests	165.03
Southern Tablelands Grassy Woodlands	61.38
Southern Tablelands Wet Sclerophyll Forests	68.13
Subalpine Woodlands	415.48
Upper Riverina Dry Sclerophyll Forests	48.26
TOTAL	780.40

Bird survey methods and survey effort have been developed in accordance with DEC (2004) and DSEWPaC (2010a) guidelines. Methods include a mix of transect and areas searches, to record bird activity, and targeted nest searches for the Gang-gang Cockatoo, Pink Robin and birds of prey. Methods and survey effort are outlined in Table 6.6.

Method	Survey description	Survey effort
Transect and area searches (Pink Robin)	 Land based areas searches and transects. Surveyors walked transect (access tracks) or area searches within a 1-3 ha area (other areas). All calls and habitat features were investigated. Birds observed or heard were recorded. 	DEC (2004) has not resolved bird survey requirements and does not provide guidance on survey effort. DSEWaPaC (2010a) was reviewed and sympatric species survey efforts indicated a requirement for 10 hours over 5 days (2 hours per day) for sites less than 50 ha. No survey effort for larger sites is provided.
		Based on the stratification units listed above, this requires a total of 190 hours over 95 days (2 hours per day).
		A total of 70 bird surveys have been completed within the disturbance footprint, with a total of 190 people hours between December 2017 and April 2019. An additional 41 surveys, with a total of 70 people hours, have been completed in adjacent areas during the same survey period.
		The minimum survey effort was exceeded.
Targeted nest searches (Gang- gang Cockatoo, White-bellied Sea- Eagle, Little Eagle)	Observers travelled across available habitat, seeking out habitat features including nest trees and hollows. Suitable nest or breeding hollows were marked and watched to determine if they are being used by the target species.	DEC (2004) has not resolved nest search requirements, and does not provide guidance on survey effort. DSEWPaC (2010a) was reviewed and sympatric species survey efforts indicated 8 hours over 4 days (2 hours per day) for sites less than 50 ha.
White-bellied Sea- Eagle, Little Eagle)	watched to determine if they are being used by the target species.	reviewed and sympatric species survey of indicated 8 hours over 4 days (2 hours p for sites less than 50 ha. Survey effort is outlined above.

Table 6.6 Methods and survey effort – diurnal birds

b Nocturnal birds

Nocturnal bird surveys were undertaken to identify breeding habitat for three forest owl species listed under the BC Act. Targeted nocturnal bird species include:

- Barking Owl;
- Powerful Owl; and
- Masked Owl.

Table 6.7 Stratification units and survey area – nocturnal birds

Vegetation class/survey area	Area (ha)
Montane Wet Sclerophyll Forests	22.12
Southern Tablelands Dry Sclerophyll Forests	165.03
Southern Tablelands Wet Sclerophyll Forests	68.13
Subalpine Woodlands	415.48
Upper Riverina Dry Sclerophyll Forests	48.26
TOTAL	719.02

Bird survey methods and survey effort were developed in accordance with DEC (2004). Methods included call playback and spotlighting, with listening periods to listen for the call between roosting males and nesting females where appropriate. Methods and survey effort are outlined in Table 6.8.

Table 6.8Methods and survey effort – nocturnal birds

Method	Survey description	Survey effort
Call playback and spotlighting	 DEC (2004) recommends call playback and spotlighting are undertaken to target these owl species. Commence surveys with a 10-15 minute listening period. This will target the male and female calling 	DEC (2004) recommends at least 5 visits for the Powerful Owl and Barking Owl, 6 visits for the Sooty Owl and 8 visits for the Masked Owl. Sites should be separated by 1 km.
	back and forth to one another and is useful in identifying nesting trees.	Based on the above, and availability of suitable habitat, up to 24 survey sites were required to
	• This will be followed by spotlighting for 10 minutes in the immediate vicinity.	be completed for the Barking Owl, Powerful Owl and Masked Owl.
	 Call playback is then undertaken with the call of each target species played intermittently for a 5 minutes period followed by a 10 minute listening period. 	Surveys have been completed at 28 sites within the disturbance footprint, with eight night visits at 26 of these sites, and four nights for the other two sites. An additional four sites, with a minimum of four visits were completed within adjacent areas.
	 Following call payback a further 10 minutes of spotlighting is undertaken. 	
	If forest owls were found to be present within the survey area, surveys would try to identify nesting sites by listening to roosting males calling to nesting females on dusk. Female calls would be triangulated and nest searches undertaken in identified areas over several nights.	The minimum survey effort was exceeded.

c Small terrestrial mammals

Small terrestrial mammal surveys were undertaken to target three small mammal species, including:

- Eastern Pygmy-possum;
- Broad-toothed Rat; and
- Smoky Mouse.

Stratification units and area of each survey unit in the survey area are shown in Table 6.9.

Table 6.9 Stratification units and survey area – small terrestrial mammals

Vegetation class/survey area	Area (ha)
Alpine Bogs and Fens	4.09
Montane Bogs and Fens	0.12
Montane Wet Sclerophyll Forests	22.57
Southern Tablelands Dry Sclerophyll Forests	171.39
Southern Tablelands Wet Sclerophyll Forests	69.62
Subalpine Woodlands	509.60
Temperate Montane Grasslands	142.72
Upper Riverina Dry Sclerophyll Forests	49.77
TOTAL	969.88

Methods and survey effort have been developed in accordance with DEC (2004) and DSEWPaC (2011a), modified as per Nelson et al. (2009), and included a mix of terrestrial trapping and remote camera surveys. Methods and survey effort are outlined in Table 6.10.

Method	Survey description	Survey effort
Trapping	 20 Elliot A traps placed 10 m apart in two parallel lines separated by 25 m (access roads) or 25 Elliot A traps placed 10 m apart in a 5 x 5 grid (other areas): Traps were baited with a mixture of peanut butter, rolled oats and honey. Traps were checked early in the morning and closed for the day. Traps were opened and rebaited in the late afternoon. Animals were temporarily marked to allow mark-recapture data to be collected. 	DSEWPaC (2011) specifies two sites per 5 ha stratification unit with replication across habitat types in areas of greater than 5 ha. No level of replication is specified. Consultation was undertaken with Linda Broome (OEH) to determine a suitable survey effort per stratification unit. This consultation determined that a suitable effort would be 20-25 Elliot A traps placed out for 4 nights = 100 trap nights, per 50 ha site, with additional replicates for every additional 100 ha. Based on the areas above this required 17 survey sites equating to 1,700 trap nights. Trapping within the disturbance footprint was conducted between December 2017 to April 2019 at 29 sites, equating to 2,900 trap nights. An additional 50 sites were completed adjacent to the disturbance footprint, equating to 5,000 trap nights.
		The minimum survey effort was exceeded.
Remote cameras	 Remote camera surveys were undertaken in accordance with the following guidelines: Cameras placed at least 100 m apart. Cameras were attached to tree or stake and positioned approximately 25cm above ground with bait stations placed 1.5m away. Bait stations were baited with a mixture of peanut butter, rolled oats and honey. DSEWPaC (2011a) recommends cameras are placed out for at least one week. However, Nelson et al. (2009) detected the Smoky Mouse on cameras on or before the tenth night of survey. As such, it was determined one week may not be sufficient to reliably detect the species, and surveys were extended to a minimum of 14. 	DSEWPaC (2011a) recommends that for the Smoky Mouse two cameras are placed out for one week, in areas up to 5 ha. Based on the areas above this required 198 survey sites. If surveys are undertaken for one week, as outlined in DSEWPaC (2011a), this equates to 2,772 camera nights. No guidelines are available for the Broad-toothed Rat or Eastern Pygmy- possum. Remote camera surveys were undertaken between December 2017 and April 2019 at 52 sites (104 cameras) within a minimum of 14 nights per site and up to 31 nights for some sites. A total of 1,771 camera nights has been completed within the disturbance footprint. An additional 41 sites (82 cameras) with a total of 965 camera nights were completed within areas.
Regional surveys	Regional surveys for the Smoky Mouse were undertaken to put findings of the Smoky Mouse on Lobs Hole Ravine Road and at Marica in context. Surveys were undertaken as per above, with two cameras placed out for a minimum of 14 nights, separated by 100m. Cameras baited as per above. Sites were selected based on a 1km grid of all areas above 1000m AHD.	A total of 66 sites were surveyed within and adjacent to the survey area. Two cameras were placed out per site for 14 nights. Sites where Smoky Mouse was not recorded during the first round of survey had an additional round of survey. This equates to a total of 5,808 nights (220 cameras placed out). Three sites (seven cameras) were within the disturbance boundary, with a total of 198 nights

Table 6.10 Methods and survey effort – small terrestrial mammals

d Large terrestrial mammals

Large terrestrial mammal surveys were undertaken to target the Spotted-tail Quoll. Stratification units and area of each survey unit in the Main Works survey area are shown in Table 6.11.

Table 6.11 Stratification units and survey area – large terrestrial mammals

Vegetation class/survey area	Area (ha)
Montane Wet Sclerophyll Forests	22.57
Southern Tableland Dry Sclerophyll Forests	172.65
Southern Tableland Wet Sclerophyll Forests	69.62
Subalpine Woodlands	509.60
Upper Riverina Dry Sclerophyll Forests	52.49
TOTAL	826.93

Methods and survey effort have been developed in accordance with DSEWPaC (2011a), specifically the species profile for the Spotted-tailed Quoll, and the Victorian Survey Standard for the Spot-tail Quoll (DSE 2011a). Methods and survey effort are outlined in Table 6.12.

Table 6.12 Methods and survey effort – large terrestrial mammals

Method	Survey description	Survey effort
Remote Cameras	 Remote camera surveys were undertaken in accordance with the following guidelines for each 100 ha site: Two cameras placed out for one month. Cameras placed at least 500 m apart. Cameras were set for 24 hour operation. Cameras placed out in associated with bait stations filled with chuditch bait (meat meal, sardines, fish oil, chicken oil and rolled oats). Cameras were attached to either a tree or stake and placed approximately 1 m above the ground and 2-3 m from the bait station. 	DSE (2011a) recommends two cameras per 100 ha sampling unit (or part thereof) placed out for 30 days. Based on the areas above, this equates to 11 survey sites (22 cameras) and 660 camera nights. Surveys were undertaken between February and April 2018 across six survey sites (12 cameras) within the disturbance footprint, equating to 409 camera nights. An additional two sites (four cameras) were completed within adjacent areas. A total of 525 camera nights was completed within the survey area.
		The minimum survey effort was exceeded.

e Arboreal mammals

Arboreal mammal surveys were undertaken within the Main Works survey area to target four arboreal species listed under the EPBC Act and/or BC Act. Targeted arboreal mammal species include:

- Koala;
- Squirrel Glider;
- Brush-tailed Phascogale; and
- Greater Glider.

Stratification units and area of each survey unit in the survey area is shown in Table 6.13.

Table 6.13 Stratification units and survey area – arboreal mammals

Vegetation class/survey area	Area (ha)
Montane Wet Sclerophyll Forests	22.12
Southern Tablelands Dry Sclerophyll Forests	165.03
Southern Tablelands Wet Sclerophyll Forests	68.13
Subalpine Woodlands	415.48
Upper Riverina Dry Sclerophyll Forests	48.26
TOTAL	719.02

The Koala was deemed to have potential to occur in suitable Eucalypt forest and woodland below 800 m elevation (DSEWPaC 2012, DoE 2014a, TSSC 2012).

Methods and survey effort have been developed in accordance with DEC (2004), DSEWPaC (2011a), the Victorian Survey Standard for the Greater Glider (DSE 2011b) and Biolink (2008) for the Koala. Methods and survey effort is outlined in Table 6.14.

Table 6.14 Methods and survey effort – arboreal mammals

Method	Survey description	Survey effort
Trapping (Phascogale and Gliders)	 Ten Elliot B or cage traps were placed at 2-4 m above the ground, 50 m apart in two parallel lines separated by 50 m: Traps were baited with a mixture of peanut butter, 	DEC (2004) requires 24 trap nights over 3-4 consecutive days per 50 ha of stratification unit. Based on the above stratification units, this would equate to 17 surveys and 408 trap nights.
	rolled oats and honey.	Surveys were undertaken between December
	 A mixture of water and honey was sprayed on each tree trunk. 	2017 and April 2019 at 24 trapping sites within the disturbance footprint, equating to 960 trap
	 Traps were checked early in the morning and closed for the day. 	adjacent to the disturbance footprint, equating
	 Traps were re-opened and rebaited in the late afternoon. 	The minimum survey effort was exceeded.
	 Animals were temporarily marked to allow mark- recapture data to be collected. 	
	 Trapping was undertaken in conjunction with terrestrial mammal trapping where suitable habitat occurs. 	

Method	Survey description	Survey effort
SpotlightingDSEWPaC (2011a) recommends two parallel 200 m transects per 5 ha site. No survey effort for larger sites is specified.In line with DSE (2011b) and DEC (2004), a survey effort of two parallel 2,000 m transects per 100 ha site (half the survey effort, but over a larger area) was deemed suitable in consultation with OEH. Surveys included:•2,000 m transects were undertaken by 2 observers (4,000 m total transect), with 25 m between transects.	DSEWPaC (2011a) recommends two parallel 200 m transects per 5 ha site. No survey effort for larger sites is specified. In line with DSE (2011b) and DEC (2004), a survey effort of two parallel 2,000 m transects per 100 ha site (half	DSEWPaC (2011a) recommends two parallel transects per 5 ha site, while DEC (2004) recommends 2 transects per 200 ha of stratification unit. Given the size of the survey area and the fact
	that no species-specific guidelines are available for the Greater Glider, a survey effort of two 2,000 m transects per 100 ha stratification unit, repeated on two separate occasions, was deemed appropriate based on DSE (2011b) and	
	 Observers moved at a speed of 10 m per minute (ie 200 minutes for a 2,000 m transect). All animals observed were recorded, including the distance of the animals from the observer. 	Based on the above stratification units, this
		would equate to 20 x 2000m spotlighting surveys, repeated on two occasions (40 transects).
		Surveys were undertaken between December 2017 and June 2019, with 77 transects (2,000 m minimum distance) completed within the disturbance footprint, totalling 342, 514 m in length. Some transects were less than 2,000 m as they were sited in infrastructure areas where a 2,000m transect was not appropriate. An additional 26 transects were completed adjacent to the disturbance footprint, totalling 159, 762 m in length.
		The minimum survey effort was exceeded.
Regularised Grid Based (RGB) Spot Assessment	The RGB SAT method requires application of a uniform assessment method across a broad area. A 350 m x 350 m grid was applied to the survey area to identify survey	Grid points located below 800 m and in proximity to and surrounding the survey area were included for survey.
Technique (SAT) (Koala)	locations. At each grid point, the SAT (Phillips and Callaghan 2011) was undertaken, as follows:	A total of 71 grid locations have been surveyed, with 17 grid locations within the disturbance
	 Centre tree was located and marked with flagging tape. 	footprint.
	 The 29 nearest trees to the centre tree were also identified and marked. 	
	 Koala faecal pellets were searched for beneath each of the 30 trees within a distance of 100 cm. Initial inspections were checked in undisturbed ground surface, followed by a more thorough inspection involving disturbance of leaf litter and ground cover (if no faecal pellets were initially detected). 	
	 An average of approximately two person minutes per tree were dedicated to the faecal pellet search. 	
	 Activity levels can be interpreted using Table 2 from Phillips and Callaghan (2011). 	

Table 6.14 Methods and survey effort – arboreal mammals

Table 6.14 Methods and survey effort – arboreal mammals

Method	Survey description	Survey effort
Songmeters (Koala)	 Following recent use of acoustic recorders to document calling by male Koalas (eg Law and Brasil 2018, Law et al.2018) Songmeters were deployed during the breeding season to record males bellowing: Songmeters set to record between dusk and dawn. Songmeters were deployed at sites separated by at least 3km, over a mix of landscape positions (ridge, walley, gully, and flat). 	No survey effort has been determined for the use of Songmeters. Songmeters were placed out at five sites within the survey area for a minimum of 61 nights per site. This equates to 308 nights of survey.
	 Songmeters were deployed at each site for a minimum of seven nights. 	

f Microchiropteran bats

Microbat surveys were undertaken within the Main Works survey area to target the Southern Myotis. Stratification units and area of each survey unit in the survey area is shown in Table 6.15.

Table 6.15 Stratification units and survey area – microchiropteran bats

PCT	Area (ha)
PCT 299 – Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands	3.74
PCT 1191 – Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	19.89
TOTAL	23.63

Methods and survey effort have been developed in accordance with DEC (2004) and OEH (2018). Methods and survey effort are outlined in Table 6.16.

Table 6.16 Methods and survey effort – Microchiropteran bats

Method	Survey description	Survey effort
Acoustic detection	OEH (2018) permits the use of acoustic devices to record presence of the Southern Myotis.	OEH (2018) specifies a total effort of 16 nights for each 2.5 km of suitable habitat. An initial habitat assessment indicated there are 10
	• Detectors were set out over waterways.	
 Detectors were placed out for a minimum of four nights. Calls were analysed by a person experienced in bat call analysis. 	waterways that may provide foraging habitat for the Southern Myotis, with twenty 2.5 km, or shorter, lengths. Based on this, 10 sites were	
	call analysis.	Acoustic detection was completed at 10 sites within the survey area, with a total of 43 nights survey effort. Three sites were within the disturbance footprint.
		Minimum survey effort was met.

g Amphibians

Amphibian surveys were undertaken within the Main Works to target three amphibian species listed under the EPBC Act and BC Act. Targeted amphibian species include:

- Booroolong Frog;
- Alpine Tree Frog; and
- Northern Corroboree Frog.

Stratification units and area of each survey unit in the survey area is shown in Table 6.17.

Table 6.17 Stream lengths – amphibians (Booroolong Frog and Alpine Tree Frog)

Target species	Waterway	Length (m)
Booroolong Frog	Yarrangobilly 1	3363
	Yarrangobilly 2 and Wallace's	2125
	Yarrangobilly Trib 1	1128
	Yarrangobilly Trib 2	823
	Yarrangobilly Trib 3	656
TOTAL		8,095
Alpine Tree Frog	Bullock Creek	5145
	Eucumbene River 3	1099
	Black Waters Creek	762
	Nungar Creek 4	705
	Nungar Creek 5	1068
	Gulf Plain Creek	931
	Gulf Plain Creek Trib	908
	Little Gulf Creek	1107
	Tantangara Creek Trib 1	449
	Tantangara Creek Trib 2	512
	Tantangara Creek Trib 3	812
	Nungar Creek Trib	443
TOTAL		13,941

Table 6.18 Stratification units and survey area – Northern Corroboree Frog

Plant community type	Area (ha)
1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	1.00
1224 - Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	14.00
1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	20.00
637 - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion	5.00
644 - Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion	2.00
TOTAL	42.00

Methods and survey effort have been developed in accordance with DECC (2009) and Commonwealth of Australia (2010b) and are outlined in Table 6.19.

Table 6.19 Methods and survey effort – amphibians

Method	Survey description	Survey effort
Habitat assessment	A habitat assessment was undertaken to identify suitable habitat along all watercourses within the survey area.	All streams were assessed for suitable habitat.

Table 6.19 Methods and survey effort – amphibians

Method	Survey description	Survey effort
Nocturnal searches (visual encounter surveys (VES))	VES were undertaken in accordance with the following:	DECC (2009) and DSEWPaC (2010b) specify a minimum survey effort of one 200 m transect per stream, repeated on four nights (two nights in DECC 2000)
	 Surveys were undertaken in temperatures of greater than 10°C, and not during rain. 	Booroolong Frog:
	 Two observers walked a 200 m transect along a stream. Using a spotlight and head torch searches were completed for surrounding vegetation, rocks and other microhabitats. All frogs observed or heard were recorded. Hygiene protocols were followed to prevent the spread of chytrid fungus, with full wash down between streams. 	Based on the five streams within the survey area this would equate to five x 200 m transects repeated on four nights, equating to 4.000 m of transect survey.
		Surveys were undertaken in December 2017 to January 2019. All four watercourses have been surveyed for their entire length (rather than 200 m transects) to gain an understanding of the distribution of the species across these watercourses, with surveys repeated on four nights.
		Overall, 19 transects within the disturbance footprint were completed, equating to 118, 080 m of transect survey. An additional three transects with 35, 692 m of transect survey were completed adjacent to the disturbance footprint.
		The minimum survey effort was exceeded.
		Alpine Tree Frog:
		Based on the 12 streams adjacent to the survey area this would equate to 12 x 200m transects repeated on four nights, equating to 9,600 m transect surveys.
		Surveys were undertaken in January 2018 and between January to April 2019. Overall, a total of 19 transects were completed within the disturbance footprint, equating to 78,858 m of transect survey. An additional 20 transects with 107,359 m of transect survey were completed adjacent to the disturbance footprint.
		The minimum survey effort was exceeded.
Egg mass and tadpole sampling surveys	Egg mass and tadpole sampling was undertaken in accordance with the following:	DECC (2009) and Commonwealth of Australia do not specify minimum survey requirements for tadpoles. One transect per stream was undertaken during VES surveys.
	• Egg mass were detected during VES listed above.	
	 Tadpole sampling was undertaken using a dip net, with the net dragged along a transect for 1-2 minutes. 	
	 Any samples detected were keyed out using Anstis (2013). 	

Table 6.19Methods and survey effort – amphibians

Method	Survey description	Survey effort
Diurnal call surveys (Northern Corroboree Frog)	Call surveys were undertaken in accordance with the following:	DECC (2009) and DSEWPaC (2010b) specify a minimum survey effort of one 200 m transect per stream, repeated on a minimum of two
	• Surveys were undertaken during the daytime.	separate days. A number of sites were identified during habitat assessments
	 Observers walked a minimum of a 200 m transect along a waterbody shouting "Hey frog!". 	undertaken as part of the biodiversity assessment for Snowy 2.0. Targeted surveys of all sites were undertaken, in consultation with Dave Hunter (DPIE, pers. comm.), with over 200 km of transects
	• All frogs observed or heard were recorded.	walked through suitable habitat.
	 Hygiene protocols were followed to prevent the spread of chytrid fungus, with full wash down between streams. 	

h Reptiles

Reptile surveys were undertaken to target the Alpine She-oak Skink. Stratification units and area of each survey unit in the Main Works survey area are shown in Table 6.20.

Table 6.20 Stratification units and survey area – reptiles

Plant community type	Area (ha)
PCT 637 - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion	4.09
PCT 644 - Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion	116.22
PCT 679 - Black Sallee - Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps Bioregion	0.26
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	348.14
PCT 1224 - Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	134.84
PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	9.00
ΤΟΤΑΙ	612 55

No specific survey guidelines for the Alpine She-oak Skink exist, and they are not included in Commonwealth of Australia (2011). A review of relevant literature indicates that shelter surveys are a productive survey technique. Survey methods have been adapted from the recommended survey effort for the Striped Legless Lizard (*Delma impar*) outlined in Commonwealth of Australia (2011) and following consultation with OEH in 2017. In 2018 tile grids were adapted to tile transects, following consultation with OEH. Methods and survey effort are outlined in Table 6.21.

Method	Survey description	Survey effort
Tile grids	 Each tile grid was set out as follows: Tile grid, consisting of 25 tiles spaced at 5 m spacing between tiles in a 5 x 5 grid (N.Clemmens pers. comm.). The corner of each grid was marked with a star picket, and each tile labelled A1 to E5. Tile grids were checked at least twice a month, 	Minimum survey requirements for the Striped Legless Lizard recommends that 10 tile grids are deployed for sites greater than 30 ha in size using a 5 x 10 grid. In consultation with species experts we proposed to use smaller 5 x 5 grids to increase survey coverage, with a minimum of 20 tile grids to be deployed (D.Hunter person comm., N.Clemmens pers. comm.).
 when temperatures were below 28°C. If the species was detected at a tile gricollected and moved to an alternate logincrease survey coverage. 	 when temperatures were below 28°C. If the species was detected at a tile grid, the grid was collected and moved to an alternate location to increase survey coverage. 	A total of 32 tile grids were deployed between December 2017 and October 2018. Three of these grids were within the disturbance footprint.
Tile transects	Each tile transect was set out as follows:Tile transect, consisting of 10 tiles spaced at 5 m spacing between tiles in a transect.	The tile transect survey effort extends the previous tile grid survey effort, which exceeded survey requirements specified.
	 Tile transects were checked at least twice a month, when temperatures are below 28°C. If the species was detected at a tile transect, the transect was collected and moved to an alternate location to inscrease survey coverage. 	Fourteen tile grids, surveyed over 2017/18, have been converted to tile transects. Tile transects have been deployed at an additional 44 locations within the survey area. Twelve sites are within the disturbance footprint.

Table 6.21 Methods and survey effort – reptiles