



7.2 Fauna

7.2.1 Fauna Habitats

Habitat features and resources are described in terms of the native fauna they may support with specific reference to threatened species previously recorded in the survey corridor.

The habitat assessment identified eight habitat types across the survey corridor. These are described in detail below and their distribution mapped in Figure 5. The total mapped area of each habitat type within the survey corridor (as calculated in GIS) is presented in Table 18. Table 19 provides a breakdown of the area of each habitat type within the six sectors along the pipeline corridor.

Table 18 Total Extent of Each Habitat Type within the 400m Survey Corridor

Habitat Type	400m corridor (ha) (Treated Pipeline Option)	400m corridor (ha) (Raw Pipeline Option)
Forest	583.36	583.36
Forest (Planted)	22.86	22.86
Grassland	1638.13	1957.61
Mixed Dwelling/Patchy Vegetation	530.45	550.23
Riparian Scrub	5.88	11.05
Sedgeland	0.48	1.28
Shrubland	3.34	3.34
Woodland	145.53	106.62
Total	2930.03	3236.35



Table 19 **Extent of Mapped Habitat Type within each Sector of the Pipeline Route (ha)**

Habitat Type	Glenquarry	Werai - Moss Vale	Sutton Forest - Exeter	Paddy's River	Marulan	Towrang	Goulburn – Murray's Flat		Total	
							Treated Pipeline	Raw Pipeline	Treated Pipeline	Raw Pipeline
Forest	32.27	2.15	30.69	243.32	195.78	79.15	0.00	0.00	583.36	583.36
Forest (Planted)	2.63	0.46	1.31	8.35	8.08	2.04	0.00	0.00	22.86	22.86
Grassland	247.33	243.96	432.52	105.51	117.77	359.14	131.90	451.38	1638.13	1957.61
Mixed Dwelling/Patchy Vegetation	19.60	4.28	33.24	117.66	196.51	150.12	9.04	28.82	530.45	550.23
Riparian Scrub	0.00	1.52	0.00	1.58	0.00	2.79	0.00	5.17	5.88	11.05
Sedgeland	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.48	1.28
Shrubland	0.00	1.05	1.43	0.00	0.00	0.86	0.00	0.00	3.34	3.34
Woodland	0.00	1.80	0.00	55.09	1.83	34.14	52.68	13.76	145.53	106.62



Forest and Woodland

The forest and woodland habitats within the survey corridor are likely to have equivalent habitat value for native fauna and so are assessed together. Forests and woodlands within the survey corridor occur predominantly in the Towrang, Marulan and Paddy's River sectors. Other sections of the corridor contain small and modified patches of forest and woodland habitat.

Goulburn and Murray's Flat

Forests and woodlands along the proposed pipeline in the Goulburn and Murray's Flat sectors are generally intact and maintain relatively reasonable structural diversity. Tree cover in wooded areas on the western side of the Goulburn township is fragmented and of low to moderate density. Hollow-bearing trees are sparse along the majority of the survey corridor within this section. A higher abundance of hollow-bearing trees occur in forest north of Sydney Road. Mid-canopy and ground storey vegetation is of low to moderate density and comprise low grasses and some scattered low forbs and shrubs (to 2.5 m tall). This area supports disturbance-tolerant woodland birds such as the observed mistletoe bird (*Dicaeum hirundinaceum*), red wattlebird (*Anthochaera carunculata*) and grey fantail (*Rhipidura albiscapa*). Small piles (to 1.5 m high) of dirt, small rocks and logs near the water tank at the western end of Goulburn may provide shelter and foraging resources for reptiles and small mammals, though the paucity of significant leaf litter and ground cover in the immediate surrounding area lower this likelihood. Disturbances to these areas include numerous vehicle access tracks, adjacent residential and rural development, highway traffic noise, weeds and rubbish.

Towrang

The overstorey of forests within the Towrang section contains a range of different tree sizes and ages, though many areas predominantly consist of juvenile and/or sub-adult trees (approx. mean 10 – 15 m high and 15 – 30 cm DBH). Midstorey trees or shrubs are generally of low to moderate density. Ground vegetation cover is typically a mix of low to moderate density of exotic and native grasses, occasional shrubs and leaf litter.

The moderately dense forest canopy within the survey corridor provides foraging and breeding habitat for a wide range of woodland birds and arboreal mammals. Mature, fibrous barked trees such as *Eucalyptus cinerea* and *E. macrorhyncha* provide foraging resources for bark-foraging species such as the brown treecreeper (threatened under the TSC Act), white-throated treecreeper and varied sittella. All of these species were recorded during the field surveys. Several nests of the white-winged chough were observed.

Marulan

On the slopes in the drier sclerophyll forests of the Marulan area, stringybark species, such as the prevalent red stringybark (*Eucalyptus macrorhyncha*), are nectar-bearing and are likely to provide a food resource for native fauna, including birds such as the red wattlebird and yellow-faced honeyeater observed in the survey corridor, other nectar feeding birds and arboreal mammals. These stringybark species are autumn and winter-flowering and may provide seasonal nectar resources for the swift parrot and regent honeyeater. Local populations of gang-gang cockatoo feed on stringybark flowers and fruits during their annual winter feeding migrations (URS, 2008).

The mid-storey layer is typically of low density consisting of a mix of young eucalypts and shrubs, including acacias and she-oaks (*Allocasuarinaceae*). This may limit the opportunity for bird species that



utilise this layer as a foraging or breeding resource. Acacia regrowth in some areas along the existing easement is important for a range of forest birds, the sugar glider and potentially the squirrel glider, providing shelter, nectar and sap. Noisy miners were observed to be nesting in the acacia regrowth along the edge of the existing easement.

The understorey is typically moderately to highly disturbed and provides limited habitat value for fauna. Low to moderate densities of exotic and native grasses and forbs limit feeding opportunities for many woodland species, and those requiring dense undergrowth for nesting and foraging, such as the superb fairy wren and diamond firetail, are less likely to occur.

Paddy's River

Coarse woody debris and leaf litter were generally of low to moderate density along the survey corridor, providing limited habitat for small mammals, reptiles and frogs. Several areas containing higher densities of leaf litter and fallen timber are likely to support a diverse invertebrate assemblage and in turn provide good quality foraging and sheltering habitat for a wide range of birds, reptiles, frogs and small mammals.

Some areas of forest contain better quality habitat. These typically consist of: (a) native grasses with a mixture of small shrubs and forbs dominating the ground layer; and/or (b) moderate to high density of leaf litter; (c) some coarse woody debris; (d) connectivity to other areas of habitat and larger forest or woodland patches. These areas are often larger in size and contain relatively low levels of disturbance providing high quality habitat for a wide range of reptiles, frogs and mammals. Fallen hollow logs provide shelter for a range of ground-dwelling mammals and reptiles.

However, forest or woodland habitats along the survey corridor are often modified, fragmented and poorly linked to other areas.

Numerous sections of the survey corridor contain a general paucity of large hollow-bearing trees (Figure 5). This may reflect a history of land-clearing and severe bushfires in the region (NSW RFS 2009). Habitats that contain hollow-bearing trees provide breeding and sheltering resources for hollow-dependent fauna such as arboreal mammals, microbats and birds, such as the observed gang-gang cockatoo.

The combination of several relatively large areas of intact vegetation, some moderately large hollow-bearing trees, a moderately diverse structure and some vegetated drainage lines in the Marulan and Paddy's River sectors suggest the survey corridor is likely to provide foraging habitat for large forest owls such as the powerful owl (*Ninox strenua*), historically recorded adjacent to the survey corridor (DECC 2009), and the masked owl (*Tyto novaehollandiae*).

Smaller, remnant patches of forest or woodland provide critical 'stepping stones' to the surrounding fragmented landscape. These are important for migrating or dispersing fauna, such as the satin and leaden flycatchers, or fauna that occupy large home ranges.

Sutton Forest-Exeter, Werai-Moss Vale, Glenquarry

Forests and woodlands within these sections of the pipeline corridor contained relatively unstructured communities, comprising a disjunct canopy of eucalypt species and a highly disturbed grass layer. Although the canopy stratum contains occasional features representative of good-quality habitat (e.g. hollows) for many fauna species; however, patch size, isolation and simple vegetation structures limit this. Several disturbance-tolerant bird species, such as magpies and noisy miners, were recorded in this habitat. Exotic ground mammals, particularly rabbits and foxes, were abundant.



Forest (Planted)

One patch of exotic plantation forest occurred in the Marulan section. Other exotic trees and shrubs occurred throughout the survey corridor. Some of these comprised small patches, while numerous scattered and isolated single trees exist. In general, this habitat type contains relatively little value for many fauna species; however they may be used to a limited extent by adaptable species for foraging and shelter.

Acacia Scrub (shrubland)

Acacia scrub is a regrowth community and does not contain mature habitat trees. It occurs in several patches along the edge of the existing easement that traverses forest habitat. Structural diversity within the community is limited; however, most patches occur in close proximity to eucalyptus woodland and forest. Collectively, this forms a structurally diverse vegetation association that is likely to support a diverse range of native birds and arboreal mammals. Acacia scrub would comprise an important food resource for the sugar glider, observed close to this habitat type, and potentially the squirrel glider. Acacia sap may also support the yellow-bellied glider (*Petaurus australis*) however the species is generally associated with taller, moister, more productive forests (DEC 2005).

Grassland

Exotic grassland is a secondary, or derived, vegetation community with the original shrub and grass species replaced with pasture grasses (DECC 2007). It may support a lower abundance and diversity of native fauna than in its natural state. Cleared grassland provides good quality foraging habitat for larger native mammals and many native bird species, but marginal shelter and foraging habitat for native reptiles and small terrestrial mammals. These areas are likely to be utilised by open country birds, such as the eastern rosella, red-rumped parrot, wedge-tailed eagle and Australian magpie, and mammals including the eastern grey kangaroo and common wombat. These species are generally widespread and common. Threatened fauna may occasionally forage in grazing land; however, this community is unlikely to contain important resources for these species. Grassland within the survey corridor is predominantly exotic pasture.

Native grassland present within the survey corridor has the potential to provide important foraging habitat for many native bird species, particularly finches and parrots. Native grasses provide a superior food resource to exotic pasture for many native birds including threatened species such as diamond firetail (*Stagonopleura guttata*) and turquoise parrot (*Neophema pulchella*). This community is in close proximity to intact woodland and may provide foraging habitat for threatened shelter-dependent bird species such as the speckled warbler and brown tree creeper.

Less intensely grazed portions of the survey corridor contain good growth of native tussock grasses. These areas also contain some limited quantities of fallen timber and rock fragments and may support striped legless lizard (*Delma impar*) or the pink-tailed worm-lizard (*Aprasia parapulchella*).

Aquatic and Riparian Habitat

The survey corridor contains aquatic habitat along several major creeks and rivers, ephemeral drainage lines and farm dams.

Farm Dams

Farm dams contain permanent or near-permanent water in areas of cleared grassland that would provide important refuges and breeding habitat for native frogs as well as fish, crustaceans and aquatic



invertebrates. Dams provide nocturnal refuge and foraging habitat for waterfowl including the recorded Pacific black duck and Australian grebe. They contain limited cover of aquatic and semi-aquatic vegetation and are surrounded by cleared grassland. Accordingly, they are unlikely to support shelter-dependant threatened wetland birds such as the Australian painted snipe (*Rostratula australis*) and Australasian bittern (*Botaurus poiciloptilus*). The survey corridor is also unlikely to support the open water species blue-billed duck (*Oxyura australis*) and freckled duck (*Stictonetta naevosa*) as suitable habitat (large, permanent wetlands with dense fringing vegetation (DEC, 2005)) is not present.

Dams within the survey corridor would provide foraging habitat for individuals of some microbat species, such as the large-footed myotis (*Myotis macropus*), which was recorded during the current surveys. Several other small waterbodies provide permanent foraging and shelter resources for a range of frogs and small mammals, including microbats.

One small (approximately 1 ha) wetland was observed north-east of the Goulburn township on Kenmore Creek. This wetland contains a mixture of native and exotic grasses and low forbs. Tree species include the exotic willow (*Salix* spp.) and White Poplar (*Populus alba*). Several frog species were observed calling and the wetland contains suitable habitat for a range of other frog and reptile species.

The Wollondilly and Paddy's Rivers traverse the survey corridor on six occasions. These rivers are expected to flow at most times of the year and would support a diverse aquatic ecological community (e.g. aquatic vegetation, submerged and emergent woody debris) and a range of waterbirds, frogs and reptiles. A number of waterbirds (e.g. Australian wood duck, dusky moorhen) were observed in the vicinity of these crossings. Others would be expected, including additional ducks and water hens, cormorants and kingfishers. Reptiles, such as turtles, and frogs would also be expected to occur in these rivers. The existing easement has altered the riparian vegetation at these crossings and decreased the amount and quality of riparian habitat present. The majority of vegetation at these crossings comprises exotic species.

Creek Crossings

The proposed pipeline route crosses numerous creeks, streams and rivers. At the time of the ecological surveys conducted as part of the current investigation, the majority of these waterways did not contain water. A general habitat assessment of major creek or rivers within the survey corridor was undertaken as part of the fauna survey, although no specific aquatic surveys (fish and macroinvertebrate sampling) were conducted. The majority of drainage lines within the survey corridor are in poor condition and provide little habitat for fauna. Many are eroded and contain little riparian vegetation and a variety of exotic grasses and forbs. They are ephemeral, channel confined streams which would form a chain of shallow ponds after heavy rain.

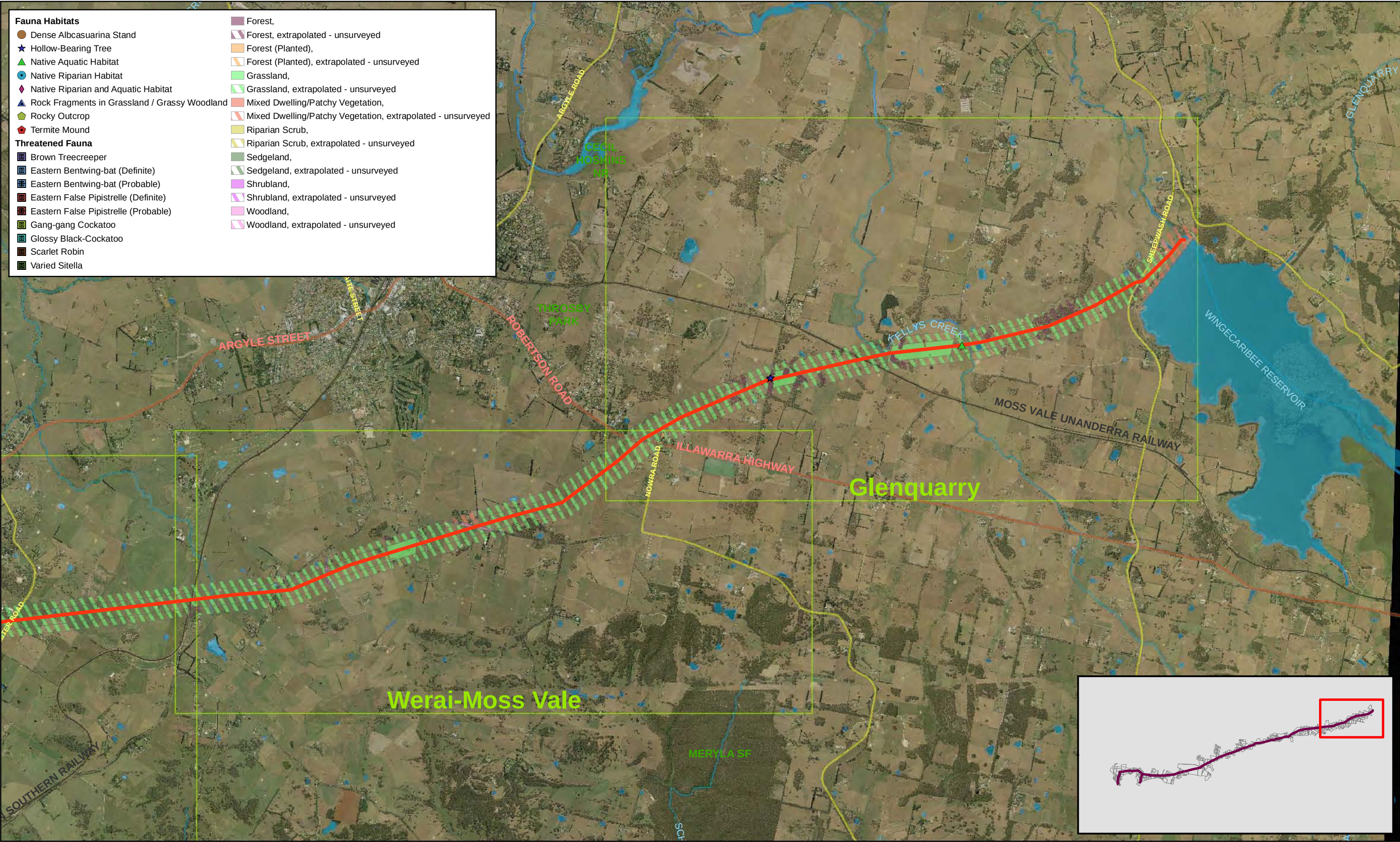
A detailed classification of all waterway crossings traversed by the proposed pipeline corridor has been conducted as part of the *Geomorphology Report* (GHD 2010), which is attached to the EA as a specialist study. The study identifies 138 waterway crossings along the pipeline route, which have been classified as follows:

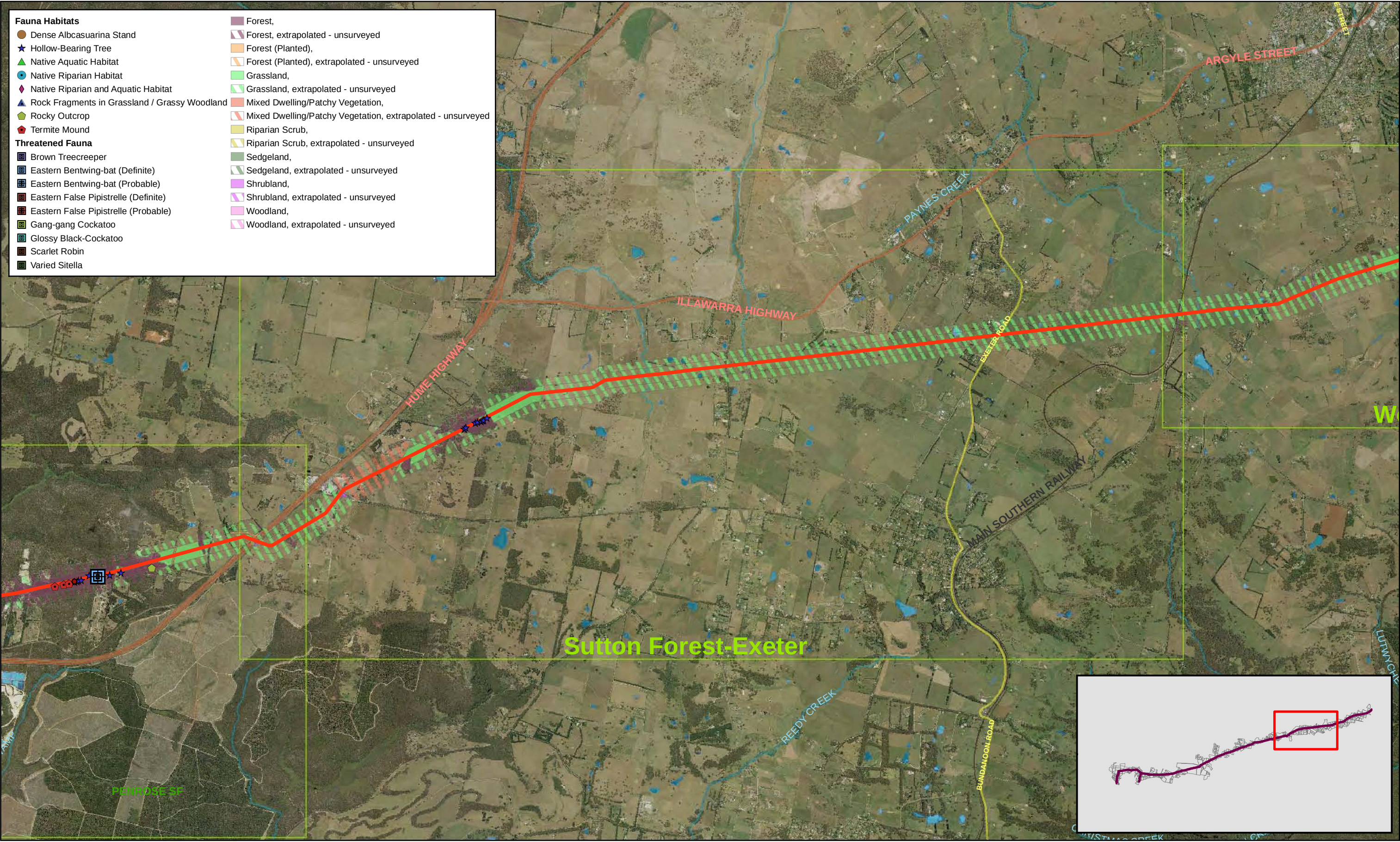
- ▶ 12 were classified as crossings of Major Creeks/Rivers which are all named as follows
 - W3 - Kellys Creek
 - W56 – Uringalla Creek,
 - W52 - Paddys River
 - W57 - Back Creek

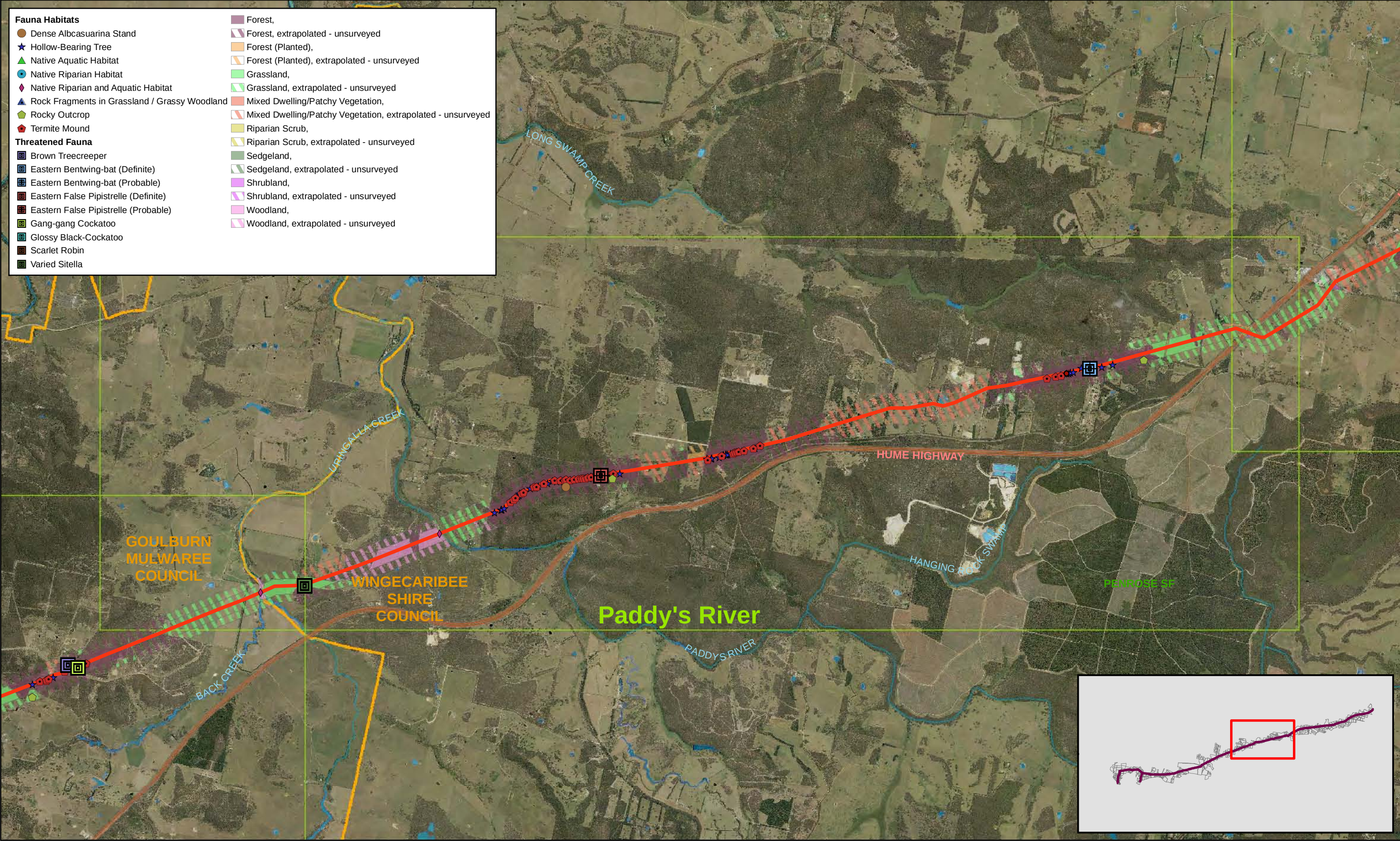


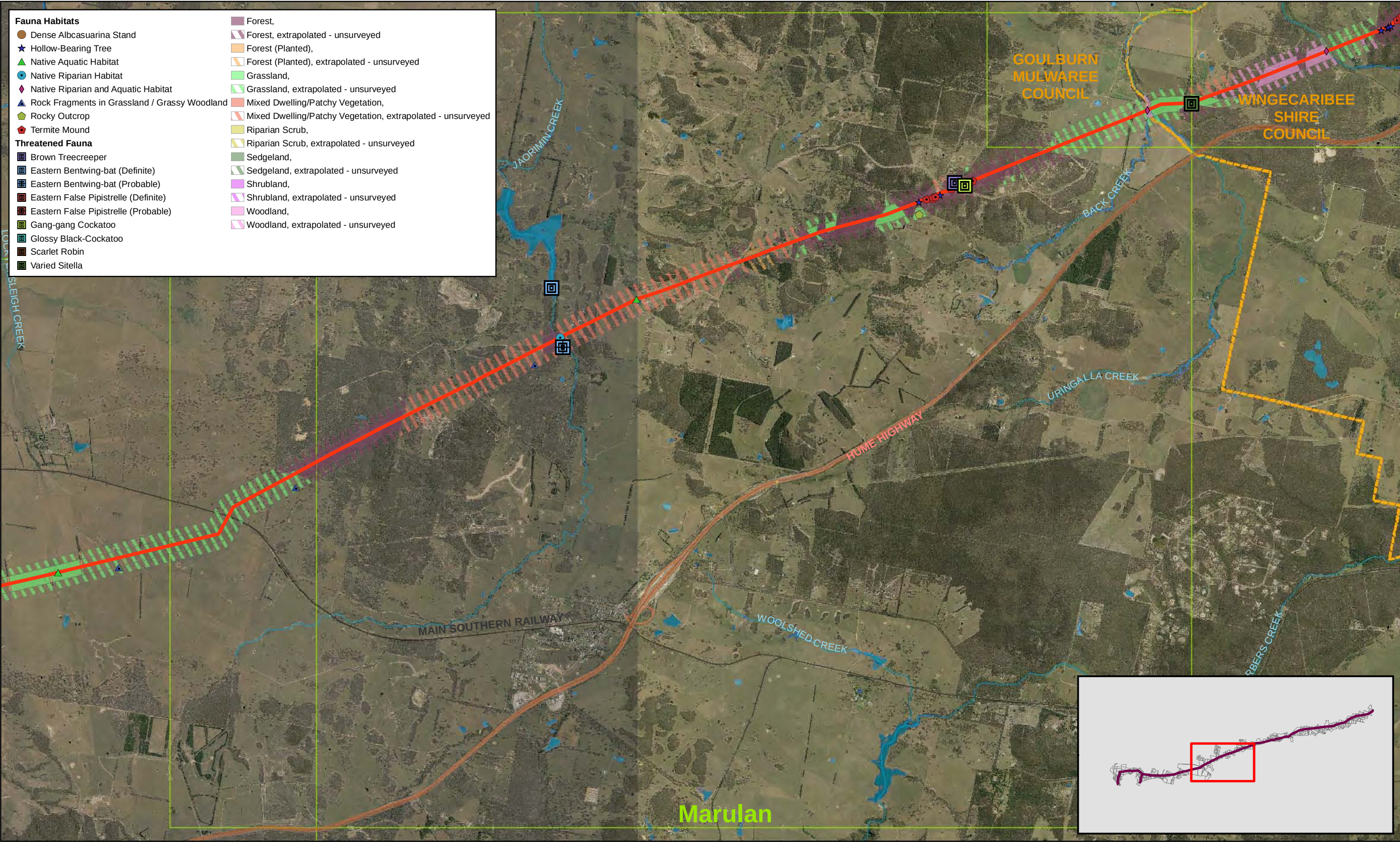
- W69 - Jaorimin Creek
- W84 - Narambulla Creek
- W108 - Boxers Creek
- W120 - Kenmore Creek
- W105, W106, W119 and W131 - Wollondilly River
- ▶ 8 as Moderate Creeks crossings of which six are named as follows:
 - W14 – Medway Rivulet,
 - W22 – Black Bobs Creek;
 - W95 – Osborns Creek; and
 - W122, W123 and W124 – Kenmore Creek.
- ▶ 25 as Minor Creek crossings including three named waterways as follows:
 - W19 – Wells Creek;
 - W27 – Long Swamp Creek; and
 - W81 – Lockyersleigh Creek
- ▶ 93 as Drainage Lines which are all unnamed.

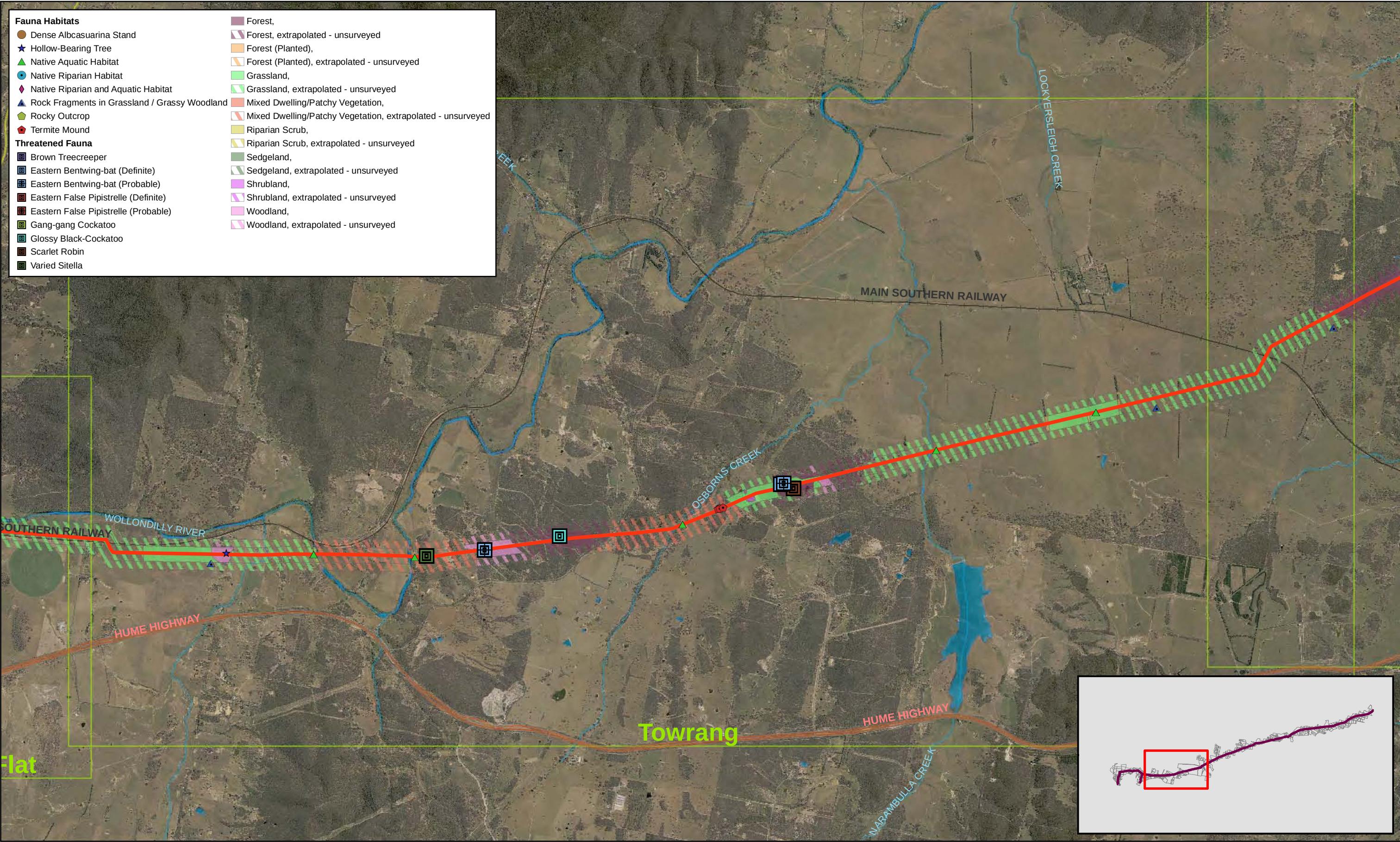
A summary of the aquatic and riparian habitats recorded at major waterway crossings along the survey corridor is provided below in Table 20.











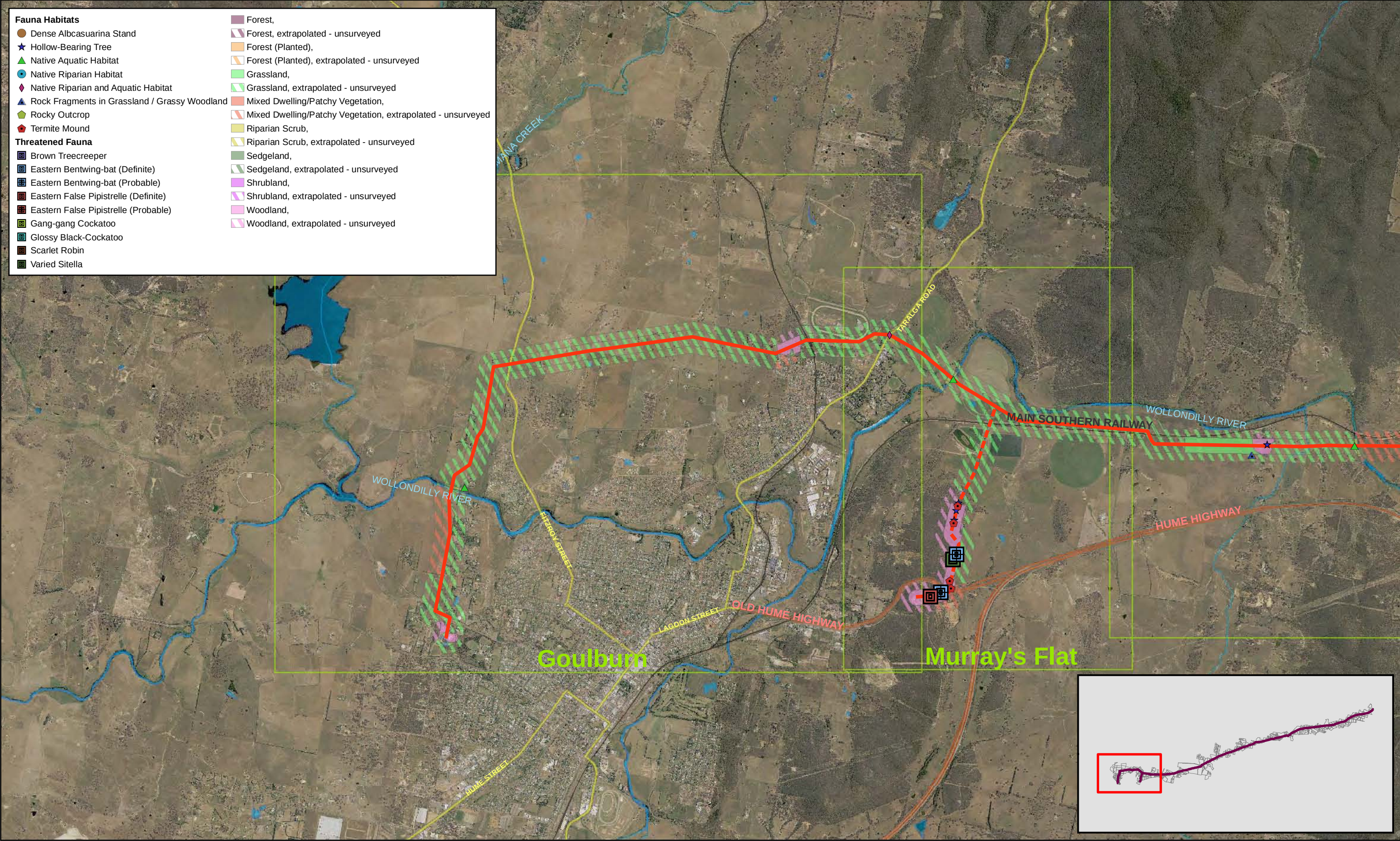
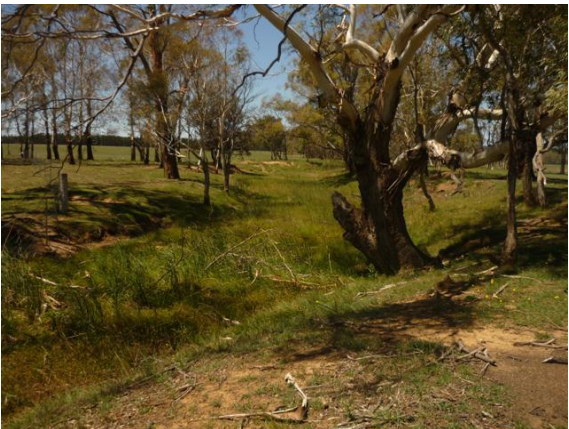




Table 20 Summary of Aquatic and Riparian Habitats at Major Waterway Crossings

Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
W3	Kelly's Creek	Aquatic vegetation (<i>Eleocharis</i> sp. and <i>Phragmites</i> sp.) present in some pools. Pasture grasses elsewhere. Grassy banks with no other riparian vegetation present. Limited habitat for many fauna, though potentially good for frogs.	Low-moderate	
W52	Paddy's River	Good quality aquatic habitat present in creek line. Shrubs, with grassy ground cover, occur on maintained banks within existing gas pipeline easement crossing. Riparian habitat (a mix of exotic and native shrubs and trees) exists at moderate density up- and down-stream of existing gas pipeline crossing. Overall, habitat provides good quality shelter, breeding and foraging resources for fauna. Shrub-dependent birds, frogs and reptiles may utilise this area. Possible foraging habitat for threatened owls.	Moderate	



Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
W56	Uringalla Creek	Existing gas pipeline crossing contains aquatic vegetation, grassy banks and no shrubs/trees. Up- and down-stream riparian habitat contains grassy woodland suitable as foraging habitat for some open country fauna. Fragmentation, isolation, disturbed understorey and lack of some key habitat features limits potential for threatened fauna species to occur. The creek line provides good quality breeding and shelter habitat, including permanent or near-permanent pools of water, for frogs.	Moderate	
W57	Back Creek	Some aquatic vegetation exists. Riparian vegetation consists of grassy woodland and provides limited habitat for a range of fauna. Up- and down-stream riparian habitat contains grassy woodland suitable as foraging habitat for some open country fauna. Fragmentation, isolation, disturbed understorey and lack of some key habitat features limits potential for threatened fauna species to occur.	Moderate	



Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
W69	Jaorimin Creek	Existing gas pipeline crossing contains little riparian habitat for fauna. Grassy banks exist with no shrubs or trees. Up- and down-stream riparian habitat contains complex vegetation, moderate to high densities of coarse woody debris and leaf litter and some connectivity with adjacent woodland and the downstream wetland. This provides potential foraging habitat for a range of threatened fauna such as the powerful owl, brown treecreeper, koala and several birds. This habitat is in relatively good condition though rabbits and wombats are prevalent. Aquatic habitat along creek line is limited, with occasional pools containing no vegetation.	Moderate to high	
W84	Narambulla Creek	Riparian and aquatic habitat for fauna is limited. Grassy banks, sparse aquatic vegetation and seasonal water presence may provide limited shelter resources for frogs and drinking water for larger fauna (e.g. kangaroos)	Low	



Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
W108	Boxers Creek	Boxers Creek contains little riparian or aquatic vegetation. Low grass on banks, very few riparian trees or shrubs and no other shelter provides little habitat for fauna. The presence of seasonal water pools may provide drinking water for some fauna (e.g. kangaroos).	Low	
W105	Wollondilly River	The Wollondilly River contains a low to moderate amount of aquatic and riparian vegetation. Riparian vegetation consists mostly of exotic trees (e.g. <i>Salix</i> sp.) and grasses. The existing gas pipeline crossing is devoid of overstorey vegetation and contains some shrubs. Large deep pools at the crossing may provide important habitat for aquatic fauna. Overall, habitat adjacent to this crossing provides some important resources (e.g. permanent water and shelter) for fauna.	Moderate	

Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
W106	Wollondilly River	The Wollondilly River contains a low to moderate amount of aquatic and riparian vegetation. Riparian vegetation consists mostly of exotic trees (e.g. <i>Salix</i> sp.) and grasses. The existing gas pipeline crossing is devoid of overstorey vegetation and contains some shrubs. Overall, habitat adjacent to this crossing provides some important resources (e.g. permanent water and shelter) for a wide range of aquatic/semi aquatic and terrestrial for fauna.	Moderate	
W119	Wollondilly River	The Wollondilly River contains a low to moderate amount of riparian vegetation and moderate to high amount of aquatic vegetation. Riparian vegetation consists mostly of exotic trees (e.g. <i>Salix</i> sp.) and grasses. The existing gas pipeline crossing is devoid of overstorey vegetation. Aquatic vegetation is dense and provides excellent habitat for frogs. Permanent/near permanent water provides a valuable resource for many aquatic and terrestrial fauna. Overall, habitat adjacent to this crossing provides some important resources (e.g. permanent water and shelter) for a wide range of aquatic/semi aquatic and terrestrial fauna however fragmentation, isolation, disturbed understorey and lack of	Low to moderate	



Reference No.	Waterway	Habitat Features	Habitat Quality	Photo
		some key habitat features limits potential for threatened fauna species to occur.		
W120	Kenmore Creek	This crossing of Kenmore Creek was dominated by exotic grasses and weed species with occasional sedges and rushes occurring at lower densities within the creekline. Tree species included the exotic willow (<i>Salix</i> spp.) with occasional <i>Leptospermum</i> spp. and <i>Acacia</i> spp. present in low densities further along the creek. This section of creekline was dry at the time of survey, providing some habitat value for disturbance tolerant bird and amphibian species however was of limited habitat value for threatened fauna.	Low	
W131	Wollondilly River	The Wollondilly River contains a low to moderate amount of aquatic and riparian vegetation. Riparian vegetation consists mostly of exotic trees (e.g. <i>Salix</i> sp.) and grasses. Large deep pools in this stretch of river may provide important habitat for aquatic fauna. Overall, the riparian and aquatic habitats provide some important resources (e.g. permanent water and shelter) for a wide range of aquatic/semi aquatic and terrestrial fauna however fragmentation, isolation, disturbed understorey and lack of some key habitat features limits potential for threatened fauna species to occur.		



The major creeks/rivers, including the Wollondilly and Paddy's Rivers, are expected to either flow or contain near-permanent water at most times of the year. They would support a diverse aquatic ecological community (e.g. aquatic vegetation, submerged and emergent woody debris) and a range of waterbirds, frogs and reptiles. A number of waterbirds (e.g. Australian wood duck, dusky moorhen) were observed near these crossings. Others would be expected, including additional ducks and water hens, cormorants and kingfishers. Reptiles, such as turtles, and frogs would also be expected to occur in these rivers. One small (approximately 1 ha) wetland was observed north-east of the Goulburn township on Kenmore Creek. This wetland contains a mixture of native and exotic grasses and low forbs. Tree species include the exotic willow (*Salix* spp.) and White Poplar (*Populus alba*). Several frog species were observed calling and the wetland contains suitable habitat for a range of other frog and reptile species.

The existing easement has altered the quality of riparian habitat at the major crossings. The majority of vegetation at these crossings comprises exotic species. The habitats at these rivers are unlikely to support the open water species blue-billed duck (*Oxyura australis*) and freckled duck (*Stictonetta naevosa*) as suitable habitat (large, permanent wetlands with dense fringing vegetation (DEC, 2005)) is not present.

All moderate creeks, minor creeks and drainage lines across the survey corridor are in poor condition and provide little habitat for fauna. Many are eroded and contain little riparian vegetation and a variety of exotic grasses and forbs. They are ephemeral, channel confined streams, which would form a chain of shallow ponds after heavy rain. Accordingly, they are unlikely to support shelter-dependant threatened wetland birds such as the Australian painted snipe (*Rostratula australis*) and Australasian bittern (*Botaurus poiciloptilus*).

7.2.2 Other habitat resources

The DEC (2004) guidelines identify "special habitats" (e.g. water bodies, rocky outcrops and cliffs) that are likely to support specific fauna assemblages. These resources may be significant for threatened species (DECC, 2008b).

Tree Hollows

Tree hollows are important for native fauna as diurnal or nocturnal shelter sites, for rearing young, for feeding, for thermoregulation, and to facilitate ranging behaviour and dispersal. An estimated 15% of all terrestrial vertebrate fauna in Australia are dependent upon tree hollows and for many of these species the relationship is obligate, i.e. no other habitat resource represents an adequate substitute (Gibbons and Lindenmayer, 2002). Accordingly, the field survey included a targeted survey of specific habitat resources in addition to the assessment of the communities described above.

The majority of hollow-bearing (habitat) trees were recorded within forest and woodland habitats within the survey corridor, although there were also widely scattered large hollow-bearing paddock trees recorded within grazed pasture grasslands. Ground-based field surveys may underestimate the quantity of important tree hollows present in a vegetation community. Conversely, many hollows visible from the ground may not have the required depth, orientation or other attributes required to constitute suitable shelter (Gibbons and Lindenmayer 2002). Therefore, visual observations of tree-hollows taken from the ground are believed to provide a reasonably accurate estimate of the quality and quantity of tree-hollows within the survey corridor. Overall the survey corridor is likely to contain limited quantities of these resources to support local populations of many hollow-dependant fauna.

The results of the tree-hollow survey and assessment are presented in Table 21.

Table 21 Estimates of Hollow Bearing Trees within the 400m survey corridor

Density Class	HBT (Treated Pipeline)		HBT (Raw Pipeline)	
	Hectares	Estimated number of trees	Hectares	Estimated number of trees
Low (0-2.5 trees/ha)	2287.00	0 - 5718	2666.60	0-6667
Medium (3-10.5 trees/ha)	390.52	1172 - 4100	315.71	947-3315
High (11-15 trees/ha)	243.33	2677 - 3650	243.33	2677 - 3650
Total Survey Corridor	2920.85	3849 - 13468	3225.64	3624 - 13632

The formation and availability of tree hollows is dependent on a variety of factors, including fire history, management history, climatic conditions and biological activity (Gibbons and Lindenmayer 2002), and as such is highly variable between areas and extrapolation from other landscapes is unreliable. The density classes used in this report were therefore developed from the results of targeted searches for hollow-bearing trees along the corridor, rather than attempting to conform to the results of previous studies on hollow-bearing trees in other ecosystems. Numbers of hollow bearing trees occurring in each density class have therefore been presented as a range, recognising that these calculations incorporate significant spatial variation and inaccuracy.

The results in Table 21 support field observations that most of the pipeline route contains low densities of hollow-bearing trees. Of the total survey corridor (2920.85 ha) for the treated water pipeline, 2287ha has been classed as low density, which is 78% of the survey corridor. The spatial variability of hollow-bearing trees is such that anywhere between 3849 and 13468 hollow-bearing trees could be present within the survey corridor for the treated water pipeline. Similar results were found for the raw water pipeline.

Forest and woodland habitats within the survey corridor generally contain low to moderate densities of hollow-bearing trees (Figure 6), with only some areas containing moderate to high densities. Occasional large hollow-bearing trees exist in disturbed cleared agricultural land. Habitat trees are mostly absent from the eastern sections of the proposed pipeline corridor (i.e. Glenquarry, Wera, Moss Vale, Sutton Forest, Exeter). A few small forest patches in grazed agricultural land, and one roadside patch (Iona Park Road), contain low-moderate densities of these trees. The Paddy's River and Marulan sections contain several significant patches of forest containing habitat trees. The combination of these trees, a complex vegetation structure and the presence of other key habitat features (e.g. rocky outcrops or termite mounds) indicate potentially important habitat for threatened fauna. These areas provide food, shelter and breeding resources for both predators and prey. Forest along the western section of the corridor (Towrang, Murray's Flat and Goulburn) typically contain no or low densities of habitat trees.

Hollow-bearing trees may provide suitable diurnal roost sites for tree-roosting microbats, including the threatened eastern freetail bat (*Mormopterus norfolkensis*), little bent-wing bat (*Miniopterus australis*), eastern bent-wing bat (*Miniopterus schreibersii*) greater broad-nosed bat (*Scoteanax rueppellii*) and eastern falsistrelle (*Falsistrellus tasmaniensis*). They are also likely to support native parrots, including the sulphur-crested cockatoo (*Cacatua galeritai*), yellow-tailed black-cockatoo (*Calyptorhynchus funereus*) and threatened species such as the gang-gang cockatoo, glossy black-cockatoo and powerful owl (*Ninox strenua*). Few roosting trees for owls were observed along the proposed pipeline corridor.

The survey corridor contains reasonable amounts of standing and fallen dead timber which would provide shelter and foraging resources for native invertebrates, reptiles and small terrestrial mammals.



Rock Outcrops

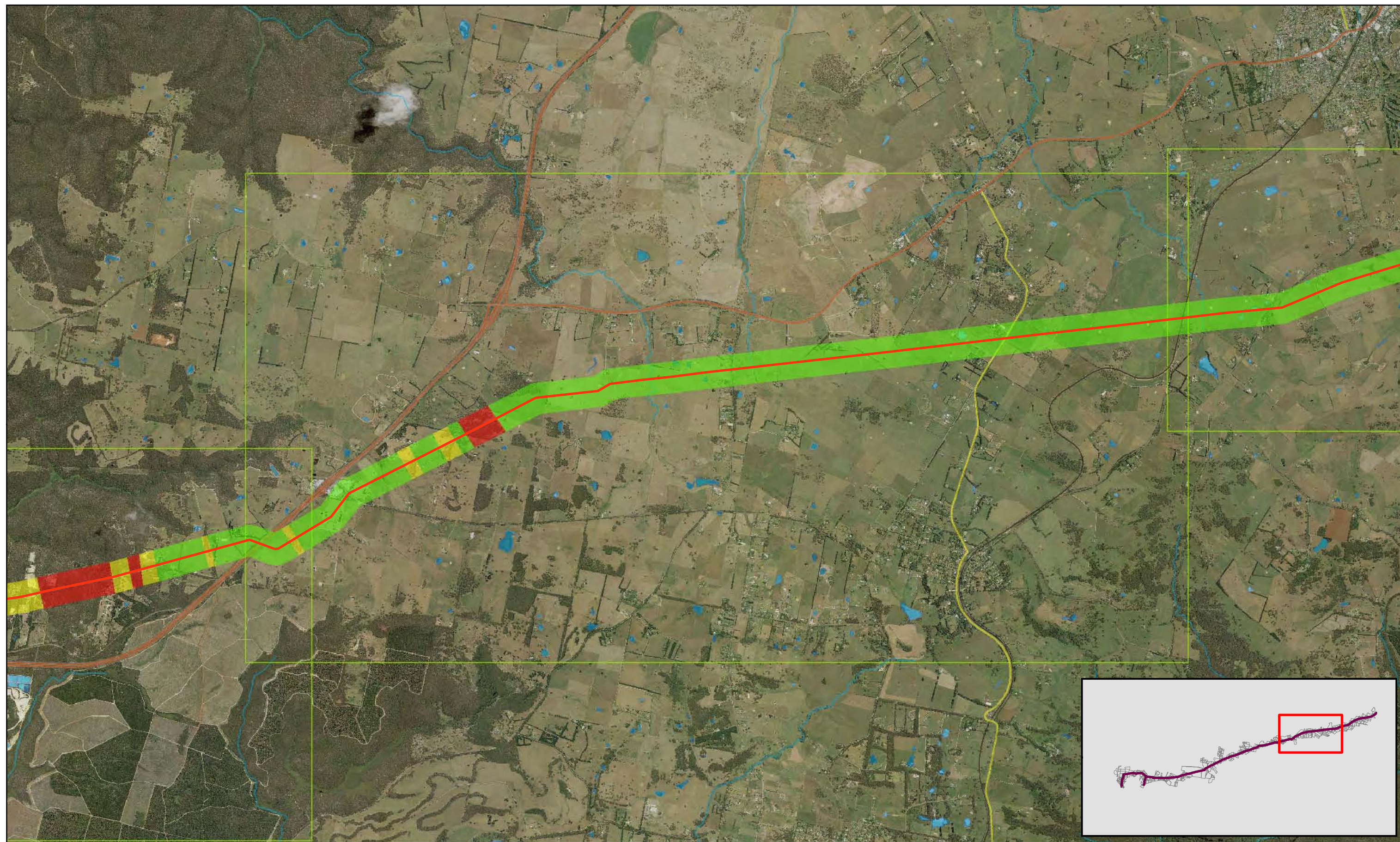
Rocky outcrops were present within forest areas in the eastern end of the Paddy's River section of the pipeline route. These outcrops contain some large boulders and fragments. These areas may be used by the spotted-tailed quoll. No areas of fissures or overhangs were observed however suitable habitat for diurnal roost sites for microbats may exist. No caves large or sheltered enough were located to provide suitable sites for maternity colonies.

There were no other large rock outcrops or substantial amounts of rock fragments observed in the survey corridor. There were moderate amounts of small conglomerate fragments which would provide good shelter for small native vertebrates. Lower slopes contain small areas of granitic rock outcrops, with moderate quantities of rock fragments. This may provide marginal shelter and foraging habitat for pink-tailed worm lizard (*Aprasia parapulchella*); however, the survey corridor does not contain large amounts of schist or other platy rock fragments that provide optimum habitat for the species (DECC, 2008_b). Large rock outcrops and fragments were identified within stringybark/black she-oak forest adjacent to the survey corridor.

Termite Mounds

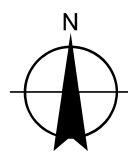
Termite mounds are an important food, shelter and breeding resource for a wide range of fauna. Termites themselves are a crucial source of food and their mounds provide shelter for birds, mammals and reptiles, including the threatened Rosenberg's Goanna. This species of goanna utilises termite mounds for nesting. The survey corridor generally contained low to moderate quantities of termite mounds, with the majority occurring in relatively undisturbed native vegetation in the Paddy's River sector (see Figure 1). Termite mounds are mostly absent from the eastern sectors of the proposed pipeline corridor (i.e. Glenquary, Werai, Moss Vale, Sutton Forest, Exeter), as shown in Figure 5.





1:45,000 (at A3)
0 0.5 1 1.5 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55



Legend

- Proposed Pipeline Alignment
- (Raw Water)
 - - - (Treated Water)
 - Sector boundary
- Primary Road
- Arterial Road
- Railway
- Lakes, Dams
- Rivers, Creeks
- Local Government Area

Habitat Tree Density

- Zero - Low (0 - 2.5 trees/ha)
- Low - moderate (3 - 10.5 trees/ha)
- High (11-15 trees/ha)



CLIENTS | PEOPLE | PERFORMANCE



Goulburn Mulwaree Council
Highlands Source Project

Job Number 23-13312-15
Revision 0
Date 19 APR 2010

Habitat Tree Density
Sector: Sutton Forest-Exeter

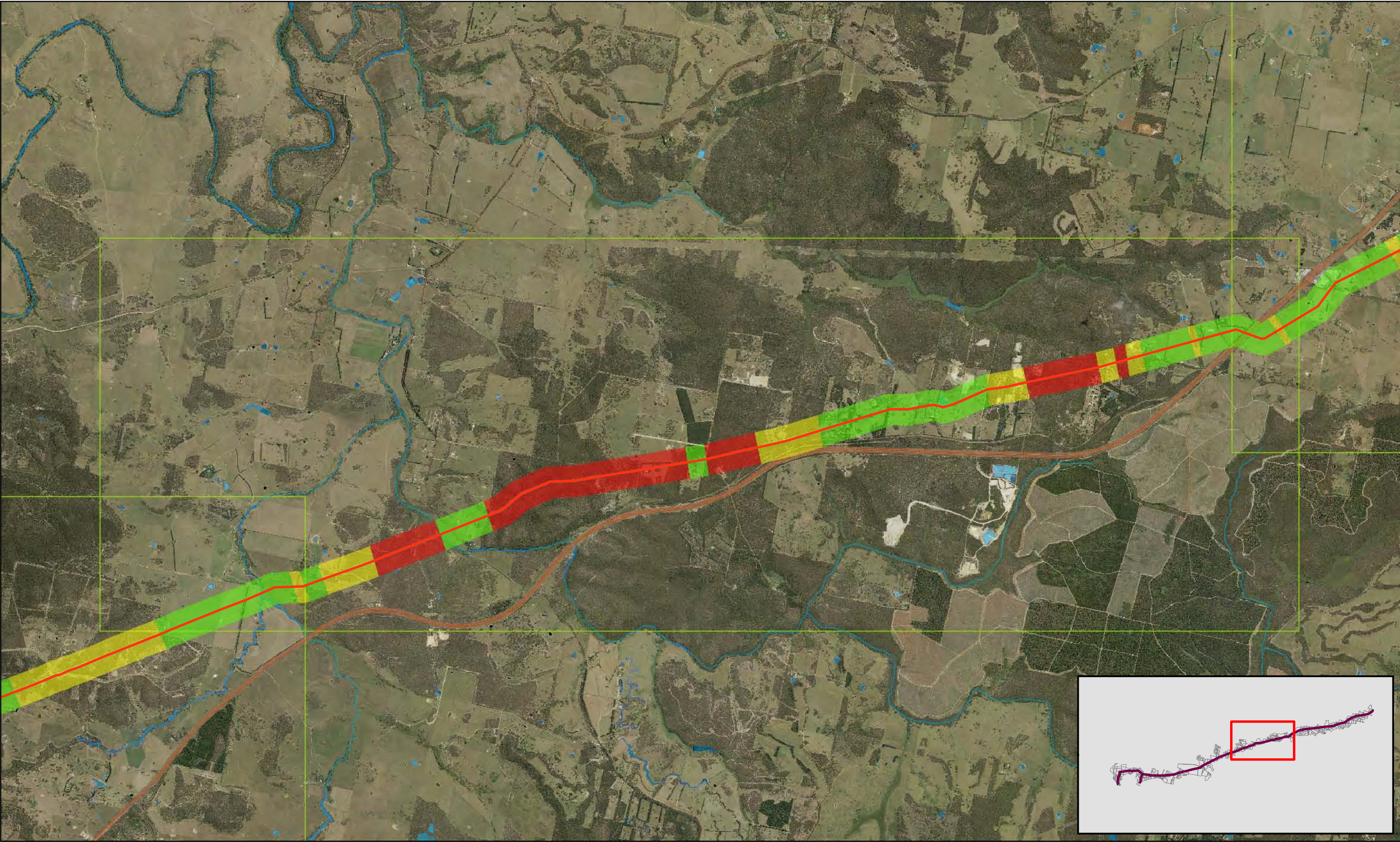
Figure 6 (b)

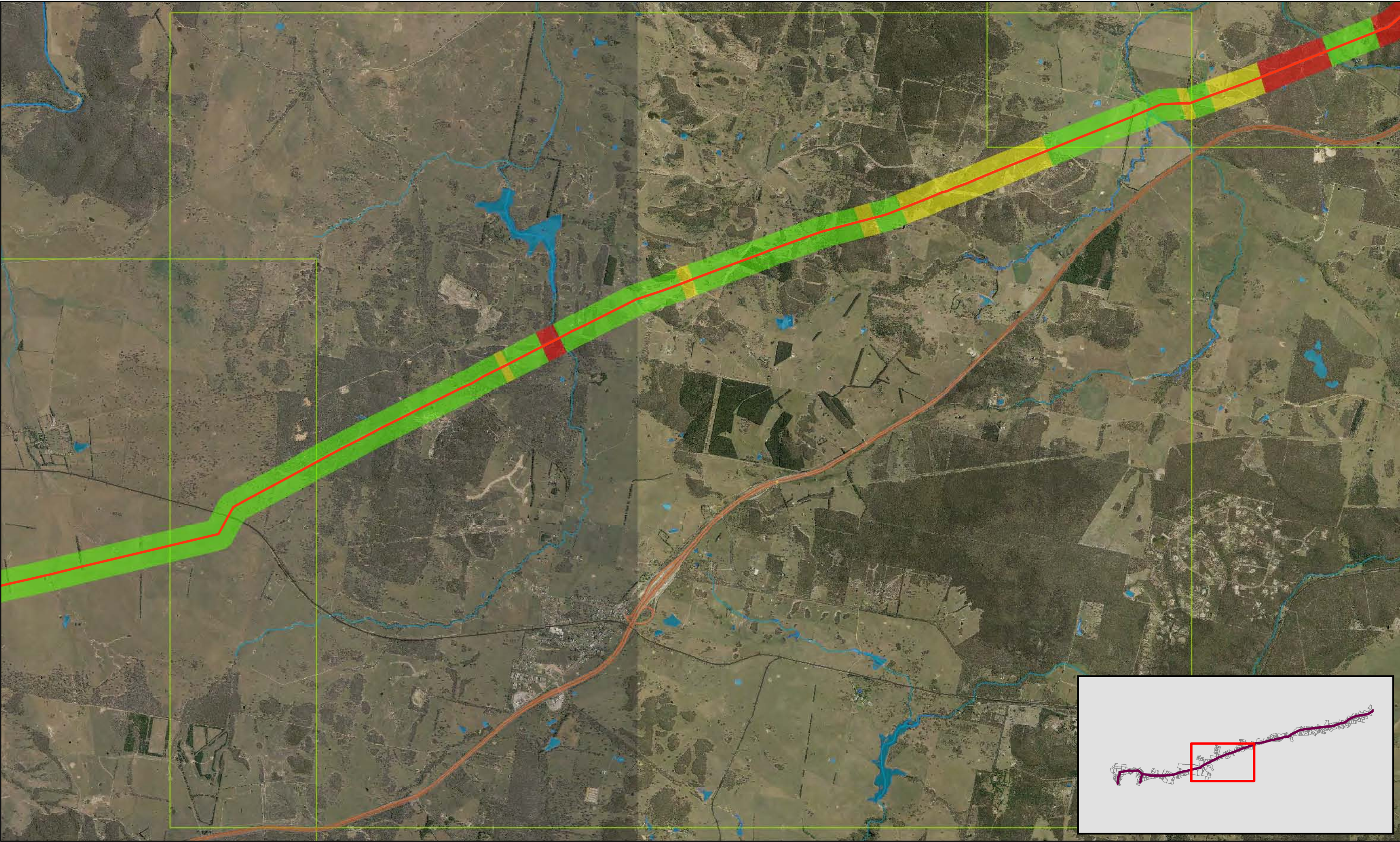
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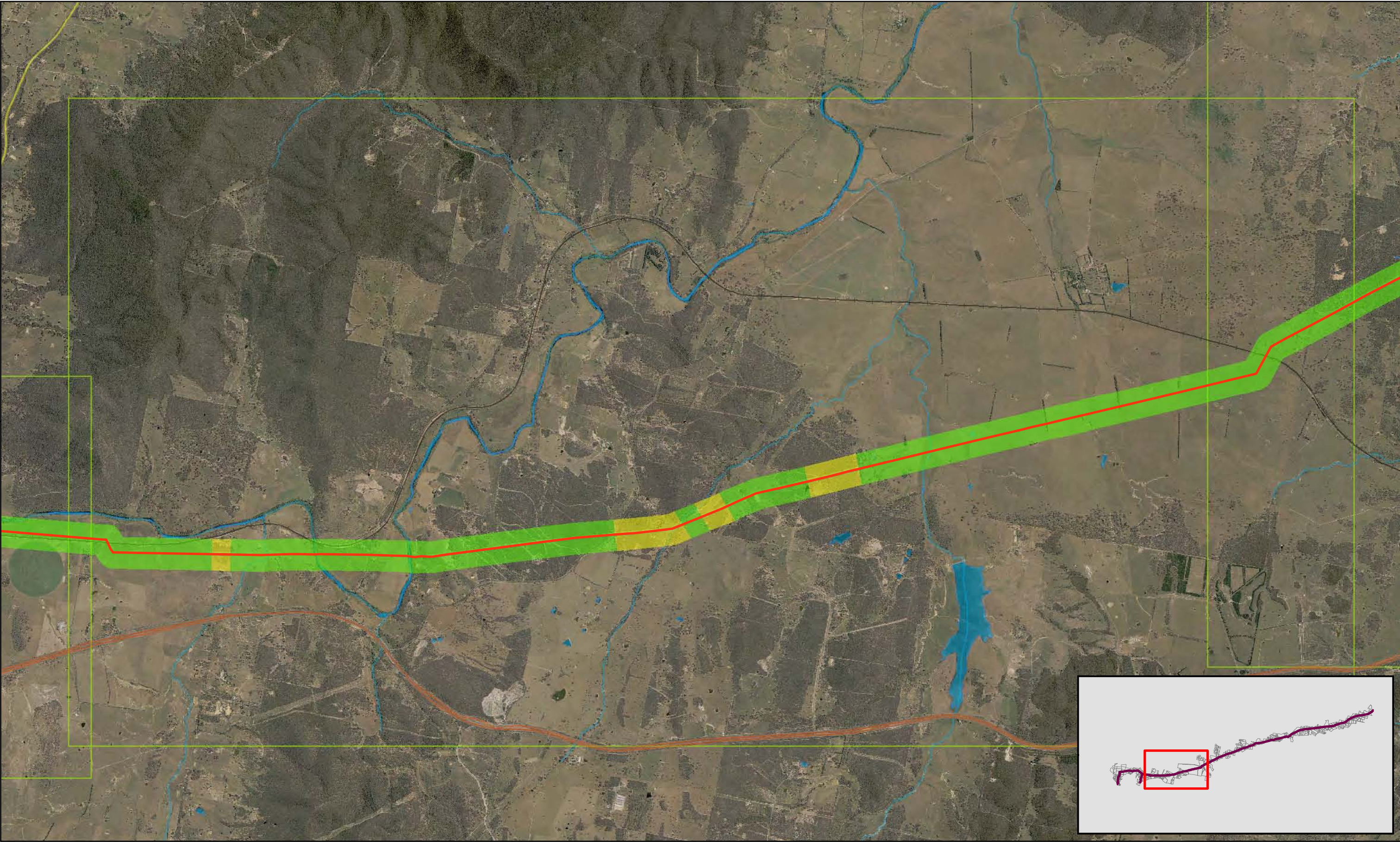
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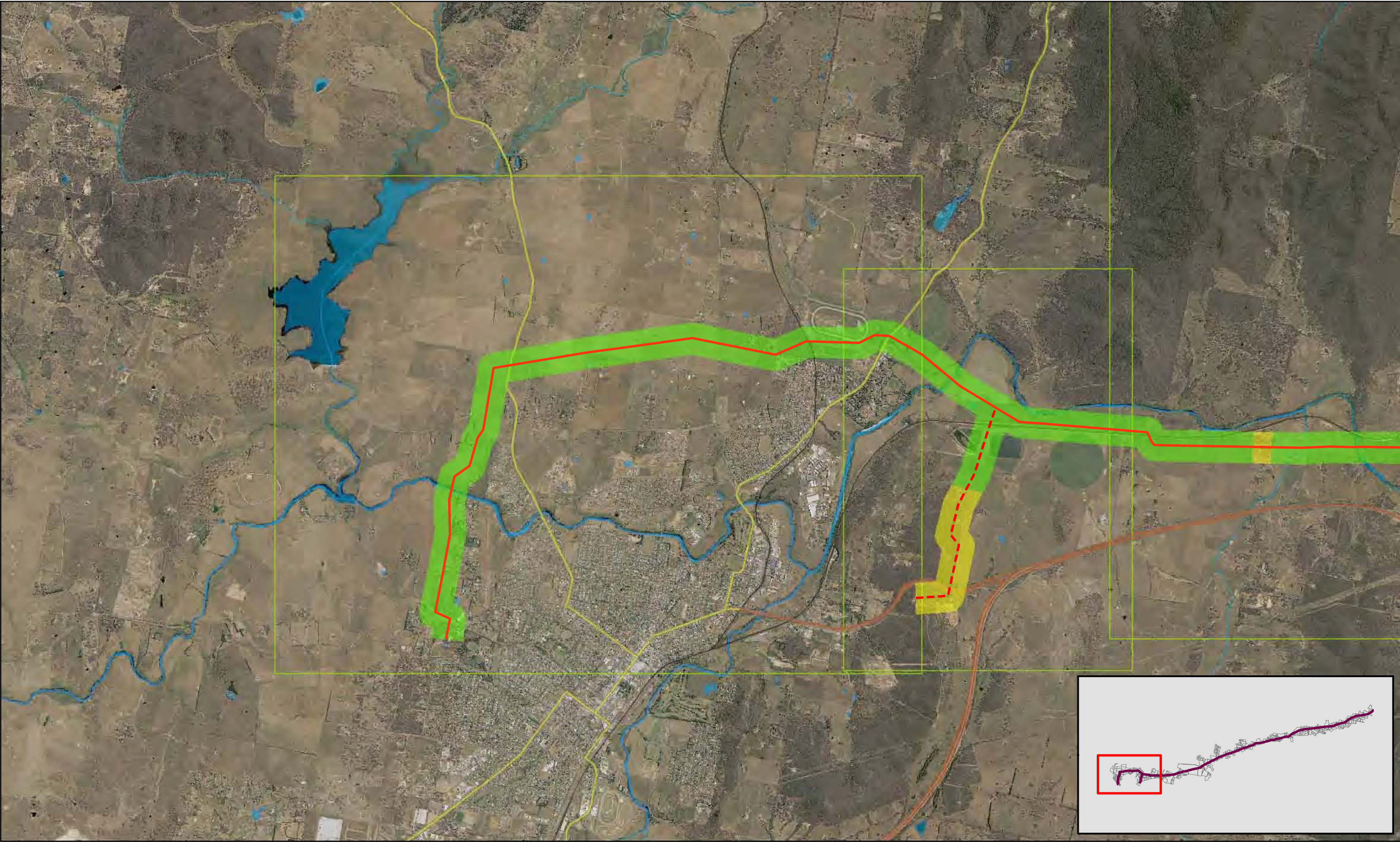
Data Source: NSW Lands Dept: crownlands, roadsegments, railways, hydroarea, hydroline, localgovernmentarea, npwreserve, stateforest - 2007. Created by: ccharalambou, trbellwood, bahambly, qjchung

Level 7, 16 Marcus Clarke Street Canberra ACT 2601 T 61 2 6113 3200 F 61 2 6113 3299 E cbrmail@ghd.com.au W www.ghd.com.au











7.2.3 Fauna Species

The field surveys recorded a total of 139 species, including eight species of frogs, five reptiles, 98 birds and 28 mammals (including microchiropteran bats) (Appendix B).

Birds

There was a moderate diversity of native birds within the survey corridor. These included species from a range of guilds (i.e. species with different niches or lifestyles) which suggests the survey corridor and surrounds provides diverse and potentially important habitat for native birds (Keast *et al.*, 1985).

Recorded species included:

- ▶ The threatened gang-gang (*Callocephalon fimbriatum*) and glossy black-cockatoos (*Calyptrorhynchus funereus*);
- ▶ Dry sclerophyll forest and woodland species including the white-throated treecreeper (*Cormobates leucophaea*), striated thornbill (*Acanthiza lineata*), red-browed finch (*Neochmia temporalis*) and the threatened brown treecreeper (*Climacteris picumnus*);
- ▶ Open country species such as the Australian magpie (*Gymnorhina tibicen*), Australian raven (*Corvus coronoides*), yellow-rumped thornbill (*Acanthiza chrysorrhoa*) and red-capped robin (*Petroica goodenovii*);
- ▶ Waterbirds, including Pacific black duck (*Anas superciliosa*), dusky moorhen (*Gallinula tenebrosa*) and Australian wood duck (*Chenonetta jubata*);
- ▶ Raptors including the wedge-tailed eagle (*Aquila audax*), brown goshawk (*Accipiter fasciatus*) and Australian kestrel (*Falco cenchroides*); and
- ▶ Species that migrate annually such as the dollarbird (*Eurystomus orientalis*) and common koel (*Eudynamys scolopacea*).

Mammals (with the exception of Microchiropteran Bats)

Native mammals observed included the common and widespread eastern grey kangaroo (*Macropus giganteus*), common wombat (*Vombatus ursinus*), common brushtail possum (*Trichosurus vulpecular*) and common ringtail possum (*Pseudocheirus peregrinus*) in woodland and grassland across the survey corridor. Red-necked wallabies (*Macropus rufogriseus*) were observed in steeper country with intact forest and rock outcrops. Sugar gliders (*Petaurus breviceps*) were noted feeding on eucalyptus blossoms. Exotic species included the European rabbit (*Oryctolagus cuniculus*), European hare (*Lepus europeaus*) and the fox (*Vulpes vulpes*).

Reptiles

Diurnal reptiles were relatively sparse, most likely reflecting the level of survey effort undertaken but also the disturbed and open nature of much of construction corridor. A single three-toed skink (*Hemiergis decresiensis*) was recorded sheltering under a piece of corrugated iron and a number of jacky lizards (*Amphibolurus muricatus*) were observed in stringybark and gum forests.

Frogs

A moderate diversity and abundance of frogs were recorded within the survey corridor. Common eastern froglets (*Crinia signifera*) were abundant and calling in permanent open wetlands and ephemeral drainage lines and ponds across the survey corridor. Whistling tree frogs (*Litoria verreauxii*) and spotted



marsh frogs (*Limnodynastes tasmaniensis*) were observed sheltering beneath rocks and woody debris in grassland and woodland. Beeping toadlets (*Crinia parinsignifera*) and Perrons' tree frog (*Litoria peroni*) were heard calling from farm dams.

Microchiropteran Bats

Remote Anabat surveys were completed at 15 locations (Figure 2) for one night each during one of three survey periods (16-20 November 2009, 7-11 December 2009 and 11-15 January 2010), resulting in over 150 hours of survey effort over the entire survey. Due to the extremely large amount of data collected, a sample of the files was analysed (see Appendix C).

10 of a possible 19 species known or expected to occur within the locality were definitely identified as a result of Anabat call analyses (see Appendix C). It is considered likely that given the high levels of bat activity and small sample (1921 of 7317) of files analysed that additional species would occur within the survey corridor, including threatened species.

Exotic Species

The predatory red fox was sighted numerous times within the survey corridor. It is expected that the cat (*Felis catus*) would also occupy the survey corridor. The presence of these predators may reduce the likelihood of some native animals occurring along the pipeline route, such as medium sized mammals like the brush-tailed rock wallaby (*Petrogale penicillata*) or spot-tailed quoll (*Dasyurus maculatus*).

A significant proportion of the survey corridor is agricultural land and stocked with sheep and domestic cattle. Moderate numbers of rabbits were noted. These species may compete with native herbivores and suppress growth of palatable native herbs and grasses.

Soil Pathogens

Phytophthora cinnamomi ('Phytophthora') is a soil borne pathogen that spreads in plant roots in warm, moist conditions. Phytophthora infects a large range of species resulting in a range of symptoms including reduced health or plant death, though some plants show no apparent symptoms. Phytophthora may contribute to plant death when plant health is exacerbated by other stresses (e.g. waterlogging, drought, and wildfire) (DEC 2005).

Phytophthora may occur in areas with an annual rainfall greater than 600 mm (McDougall and Summerell, 2003). Mean annual rainfall ranges from 965.3 to 635.7mm between Moss Vale and Goulburn. Hence, Phytophthora could be present within the locality based on broad climatic factors. However, no direct observations of Phytophthora dieback were observed within the survey corridor as part of the current study.

7.2.4 Threatened Fauna Species

Terrestrial Fauna

Six threatened species were observed during the field surveys (November and December 2009, January 2010) (Appendix B). These included:

- ▶ Gang-gang cockatoo (*Callocephalon fimbriatum*) – Vulnerable (NSW TSC Act);
- ▶ Glossy black-cockatoo (*Calyptorhynchus lathami*) – Vulnerable (NSW TSC Act);
- ▶ Brown treecreeper (*Climacteris picumnus victoriae*) – Vulnerable (NSW TSC Act);

- ▶ Eastern bentwing bat (*Miniopterus schreibersii oceanensis*) – Vulnerable (NSW TSC Act)
- ▶ Large-footed myotis (*Myotis macropus*); and
- ▶ Eastern falsistrellus (*Falsistrellus tasmaniensis*) - Vulnerable (NSW TSC Act).

Two species that are under a preliminary listing (NSW TSC Act) were recorded. These are the scarlet robin (*Petroica boodang*) and varied sitella (*Daphoenositta chrysoptera*).

The gang-gang Cockatoo was heard in the Marulan section of the corridor close to Red Hills Road. No sighting occurred. Overstorey vegetation contained a mix of ages and sizes, including scattered hollow-bearing trees. Some trees were flowering. Patch size was relatively small though the extent of surrounding habitat was significant.

Two individuals of the glossy black-cockatoo were observed flying over the proposed pipeline corridor in the Towrang section close to Carrick Road. They were not utilising the habitats within the corridor at the time of sighting. No casuarinas were observed in the locality. There are historic records of this species occurring within 10 km of the proposed pipeline corridor (DECC 2009).

The brown treecreeper (two individuals) was observed foraging in the Marulan section of the proposed pipeline corridor close to Red Hills Road. Overstorey vegetation contained a mix of ages and sizes, including scattered hollow-bearing trees. Some trees were flowering. Low mid-storey vegetation was present though sparse. There was a moderate to high density of fallen timber and leaf litter providing high quality foraging habitat for the species. Patch size was relatively small though the extent of surrounding (partly fragmented) habitat was significant. There was no evidence of recent fire.

The eastern bentwing bat was recorded via Anabat analysis in two locations along the proposed pipeline corridor. The first record was in the Marulan section along Jaorimin Creek. This creek contained good quality habitat for a wide range of fauna, including volant mammals. The recording was taken above water on the edge of a freshwater lake. The second recording was in the Towrang section between Rampion Hills Road and Osborns Creek. Habitat was moderate in quality and contained several relatively small patches of remnant vegetation. The species is a cave-dweller and can forage long distances from the roost site (up to 65 km has been recorded) (Churchill 2009).

The Eastern Falsistrellus and Large-footed Myotis were recorded via Anabat analysis in the Goulburn section of the proposed pipeline corridor, near to the Old Hume Highway. The habitat contained a moderate density of hollow-bearing trees (where they generally may roost) and was of considerable size (>50 ha). It was fragmented by several vehicle tracks though these may create foraging opportunities for the eastern falsistrellus.

An additional two species that are under a preliminary listing (NSW TSC Act) were recorded. These are the scarlet robin (*Petroica boodang*) and varied sitella (*Daphoenositta chrysoptera*). The scarlet robin was recorded in the Towrang section between Rampion Hills Road and Osborns Creek. The Varied Sitella was recorded in three locations along the proposed pipeline corridor: Goulburn (to the north of the Old Hume Highway), Towrang (between the Wollondilly River and Carrick Road) and Paddy's River (about 500 m east of where the proposed pipeline crosses Uringalla Creek).

A number of sugar gliders (*Petaurus breviceps*) were observed during the spotlight surveys. No squirrel gliders (*Petaurus norfolcensis*) were observed. Squirrel glider habitat shares some similar components with that of the sugar glider. Both species require tree hollows for shelter and abundant food such as nectar, the gum of certain acacias and the gum of certain eucalypts. These habitat characteristics were

located in the survey corridor in several locations (see Figure 5). It is possible that the squirrel glider exists in these locations.

The preliminary environment assessment and subsequent field habitat assessments indicate the potential presence of a further 26 threatened fauna species listed under the TSC or EBPC Acts. The full list of threatened fauna, including their conservation status, habitat requirements, previous records and likelihood of occurrence is presented in Appendix D. A review of the specific habitat requirements of these species, and the habitat present within the survey corridor allowed a number of these species to be eliminated as having low likelihood of occurrence ('unlikely') along the proposed pipeline route.

A total of seven further threatened species, not recorded during field surveys, were considered to have a high likelihood of occurrence within the survey corridor based on the presence of suitable foraging and roosting habitat and recent records in the local area. These include:

- powerful owl (*Ninox strenua*);
- speckled warbler (*Pyrrholaemus sagittatus*);
- diamond firetail (*Stagonopleura guttata*);
- koala (*Phascolarctos cinereus*);
- yellow-bellied glider (*Petaurus australis*);
- squirrel glider (*Petaurus norfolcensis*);
- little bentwing-bat (*Miniopterus australis*).

A further 18 species may utilise habitats within the survey corridor on an occasional or opportunistic basis (see Appendix D.) and are presented below. These include:

- swift parrot (*Lathamus discolor*);
- turquoise parrot (*Neophema pulchella*);
- barking owl (*Ninox connivens*);
- masked owl (*Tyto novaehollandiae*);
- regent honeyeater (*Xanthomyza phrygia*);
- black-chinned honeyeater (eastern sub-species) (*Melithreptus gularis gularis*);
- hooded robin (*Melanodryas cucullate*);
- spotted-tailed quoll (*Dasyurus maculatus*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*);
- greater long-eared bat (south-eastern form) (*Nyctophilus timoriensis*);
- greater broad-nosed bat (*Scoteanax ruepellii*).
- large-footed myotis (*Myotis macropus*);
- eastern freetail bat (*Mormopterus norfolkensis*);
- pink-tailed worm-lizard (*Aprasia parapulchella*);
- striped legless lizard (*Delma impar*);



- ▶ rosenberg's goanna (*Varanus rosenbergi*);
- ▶ giant dragonfly (*Petrolura gigantea*); and

Aquatic Fauna

Results from a desktop search of the online database and EPBC online Protected Matters database indicate that two aquatic species listed under the FM Act and/or the EPBC Act potentially occur within the survey corridor. However an assessment of their preferred habitats, combined with their current known distributions, revealed that both species are unlikely to occur within the survey corridor (see Appendix D.). On this basis, there are not likely to be any adverse effects on threatened aquatic species as a result of construction and operation of the Project.

7.2.5 Patch Sizes and Connectivity

The main patches of forest in the survey corridor (i.e. in Marulan and Paddy's River) are large and have excellent connectivity with native vegetation to the north. These may support healthy local populations of a range of native birds, mammals and reptiles including patch-size dependant species such as the speckled warbler. Smaller patches isolated by surrounding pasture and farm structures would support open country bird species and a limited suite of native reptiles and mammals. The connectivity of forest habitat within the survey corridor to that to the north would allow the movement of native birds, some reptiles, arboreal mammals and potentially small terrestrial mammals. Land to the south, west and east features a matrix of patchy open woodland and grassland. These areas have similar habitat value to the survey corridor and would combine to form a large area of habitat suitable for open country and woodland species.

The development footprint for the pipeline itself is located mostly within agricultural land devoid of canopy trees and shrubs. It passes through several patches of relatively large forest.

The proposed pipeline crosses the Wollondilly River near Goulburn. The riparian corridor features stretches of intact riparian forest alternating with willow (*Salix* sp.) infestations and cleared agricultural land. The riparian zone provides limited near-continuous habitat corridor for aquatic species, waterfowl and semi-aquatic, frogs, reptiles and mammals.

7.3 Regional Biodiversity Corridors

The pipeline does not approach the boundaries of gazetted National Parks, the nearest being Tarlo River National Park approximately 10 km to the north and Morton National Park approximately 10 km to the south.

Parts of the proposed pipeline route cross through vegetation communities that are included in corridor mapping prepared by Hawkesbury Nepean CMA (2005). The vegetated corridors crossed by the pipeline are the Abercrombie River to Morton National Park corridor around the Murrays Flats and Nattery Hill areas towards the western end of the pipeline, and the Bargo to Morton National Park corridor around the Penrose State Forest within the eastern section of the pipeline (Ecological Australia 2009).

The Abercrombie River to Morton NP corridor connects the highland communities of the Blue Mountains with those in Morton NP. It contains an east west altitudinal and rainfall gradient that connects dry forests and woodlands and escarpment moist forests between the South-western Slopes and Southern



Highlands. This Corridor falls within the Abercrombie to Blue Mountains Regional Pathway, and the Southern Highlands Regional Pathway, providing a connection between the two (DECC 2007).

The Bargo to Morton NP corridor connects the Nattai Sandstone landscape and Bargo area with the sandstone country of Morton NP. This corridor also falls within the Southern Highlands Regional Pathway (DECC 2007).

7.4 Matters of National Environmental Significance

The EPBC Act MNES previously recorded or predicted to occur within the locality are listed in Section 6. These biota were assessed on their habitat requirements and likelihood of occurring in the survey corridor (Appendix D). The assessment concludes that six threatened fauna species, 22 flora species, no threatened ecological communities and 13 migratory species listed under the EPBC Act are likely to occur in the pipeline easement and hence could be affected by construction and operation of the Project.

7.4.1 Threatened Fauna Species

No threatened fauna species listed under the EPBC Act were recorded during field surveys. However, assessment of likelihood of occurrence (Appendix D. reveals that six threatened fauna species listed under the EPBC Act could occur within the pipeline easement and be affected by the Project:

- ▶ regent honeyeater (*Xanthomyza phrygia*) – endangered.
- ▶ spotted-tailed quoll (*Dasyurus maculatus maculatus*) – endangered.
- ▶ brush-tailed rock wallaby (*Petrogale penicillata*) – vulnerable.
- ▶ large-eared pied bat (*Chalinolobus dwyeri*) – vulnerable.
- ▶ pink-tailed worm-lizard (*Aprasia parapulchella*) – vulnerable.
- ▶ striped legless lizard (*Delma impar*) – vulnerable.

7.4.2 Threatened Flora Species

A total of 22 flora species listed under the EPBC Act (6 Endangered, 16 Vulnerable) are assessed as likely to occur in the pipeline easement and therefore could be affected by construction works (Section 6).

Of these species, targeted searches revealed only one species, the Hoary Sunray (*Leucochrysum albicans* var. *tricolor*). This species is listed as endangered under the EPBC Act. A small number of Hoary Sunray was recorded on the edge of Inland Scribbly Gum – Brittle Gum low woodland vegetation, adjacent to the proposed raw water pipeline route behind an existing structure at the Goulburn water treatment plant. This species was not recorded within the proposed construction corridor at this location, and was not recorded at any other location along the survey corridor.

7.4.3 Migratory Species

The EPBC Act contains a list of species that are considered to be migratory in Australia. This includes all native fauna listed on migratory fauna agreements to which Australia is a signatory: the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention. A total of seven listed migratory species were recorded during the field surveys (Appendix B). These were from the families Accipitridae (goshawks and kites), Falconidae (falcons) and



Anatidae (ducks). All raptors and one duck species were observed within the survey corridor. The Grey Teal and Pacific Black Duck were incidental sightings, though they are likely to utilise suitable habitat within the corridor.

A total of 13 listed migratory species are predicted to occur within the locality based on the results of the Protected Matters search. The results include a range of birds that are grouped as 'migratory terrestrial species', 'migratory wetland birds' and 'migratory marine species' (Appendix D.). Two species of bird, the Great Egret and Cattle Egret, are listed under two different categories. Hence, there are actually 11 migratory species listed in the results.

The migratory birds listed in the search results are wide ranging and nomadic across NSW and could occur within the pipeline easement on a transient or temporary basis, depending on season, weather patterns and breeding cycles. Some, such as the Fork-tailed Swift, are usually recorded in flight and are unlikely to occupy the corridor. Wetland species, such as the egrets, and the Painted Snipe, could occur within the swampy habitats recorded within the survey corridor from time to time. However, none of the wetland habitats recorded is of particular significance for wetland birds and none would form an important ecological resource for breeding or migration for migratory wetland species.

Hence, the survey corridor is considered to form only marginal foraging habitat for migratory species listed under the EPBC Act and such species are not likely to occur, other than in flight or temporarily during foraging or migrations.

7.5 Threatening Processes

A 'key threatening process' (KTP) is defined under the TSC Act as 'a threatening process specified in Schedule 3' of the Act. A 'threatening process' is defined as 'a process that threatens, or may have the capability to threaten the survival or evolutionary development of species, populations or ecological communities'.

The following KTPs are known or anticipated to be currently operating within the survey corridor:

- ▶ Predation by the European red fox;
- ▶ The degradation of native riparian vegetation along New South Wales water courses;
- ▶ Competition and grazing by the feral European rabbit and hare; and
- ▶ Invasion of native plant communities by exotic perennial grasses

The following KTPs would have operated previously, given the modified vegetation communities present within the survey corridor:

- ▶ Clearing of native vegetation;
- ▶ Loss of hollow-bearing trees;
- ▶ Removal of dead wood and dead trees; and

The proposed activity will directly contribute to the operation of six key threatening processes (KTPs):

- ▶ Clearing of native vegetation;
- ▶ Loss of hollow-bearing trees;
- ▶ Removal of dead wood and dead trees;
- ▶ The degradation of native riparian vegetation along New South Wales water courses;



- ▶ Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.
- ▶ Invasion of native plant communities by exotic perennial grasses.

The extent and severity of the likely contribution of the Project to the operation of these processes is described in Section 8.

7.6 Groundwater Dependent Ecosystems

The study of Groundwater Dependent Ecosystems (GDEs) is still in its infancy, and relatively little is known about the distribution and requirements of such ecosystems (DECCW 2009). GDEs fall into two main categories: those dependent on surface expression of groundwater (e.g. wetlands, swamps) and those that rely on subsurface water within the rooting depth of vegetation (e.g. riparian forests, arid zone ecosystems) (Eamus 2009).

A desktop study has identified a range of sites where GDEs may occur within the locality (Table 22). GDEs known to occur in the pipeline easement include all riparian and aquatic vegetation, which is mapped on Figure 5 ('sedgeland' and 'riparian scrub' habitat categories, described in Section 7.2.1). Riparian and aquatic vegetation will also be encountered at creek crossings along the pipeline route (Section 7.2.1).

Other GDEs identified as potentially occurring within the locality include upland swamps (or 'hanging swamps') or peatlands. The EPBC Act listed Temperate Highland Peat Swamps on Sandstone EEC, represented at Wingecarribee Swamp, and the TSC Act listed Montane Peatlands and Swamps EEC are both present in the locality (See Appendix D). Neither of these communities was recorded in the survey corridor, and they were considered unlikely to occur based on their known distribution and habitat requirements (Appendix D). No evidence of upland swamps or hanging swamps was recorded within the survey corridor.

Table 22 Identified Groundwater Dependent Ecosystems

Ecosystem Type	Description	Number of Identified GDEs in NSW
Aquifers and karst	Underground aquifer and cave ecosystems	1 528
Terrestrial vegetation	Require groundwater to sustain growth and transpiration during dry periods, or Groundwater necessary for perennial survival in arid areas	113
Wetlands	Wetlands that are at least seasonally flooded or waterlogged	20
River baseflow	Many streams in Australia have groundwater discharge as a baseflow component	0



Ecosystem Type	Description	Number of Identified GDEs in NSW
Estuarine and near-shore marine systems	Depend on groundwater discharge to provide a suitable habitat or environment Groundwater discharge may be direct off-shore discharge or baseflow into streams that discharge to the ocean.	5
Terrestrial fauna	Groundwater, as river baseflow or discharge into a spring or pool, is an important source of drinking water across semi-arid and arid Australia	0

Modified from DECCW 2009.

7.7 Wetlands

Results of the field surveys reveal that one wetland occurs northeast of the Goulburn township on Kenmore Creek and the construction corridor would likely intersect this wetland². Others may potentially occur in low lying areas adjacent to creeks or rivers within areas of permanent standing water within the Murray's Flat – Goulburn area. It is proposed to deviate the pipeline during the detailed design phase to avoid impacts on the Kenmore Creek wetland.

EECs relating to upland or hanging swamps, including the EPBC Act listed Temperate Highland Peat Swamps on Sandstone EEC (represented at Wingecarribee Swamp), and the TSC Act listed Montane Peatlands and Swamps EEC, are both present within the locality. However, none of the wetlands recorded within the survey corridor constitute upland swamps or hanging swamps. Hence, these EECs are not present within the survey corridor.

Two wetlands listed in the Directory of Important Wetlands in Australia occur within 10 km of the proposed pipeline corridor. These include the Wingecarribee Swamp and Hanging Rock Swamp. The Wingecarribee swamp lies upstream of the Wingecarribee Reservoir, approximately 5 km southeast of the eastern end of the pipeline corridor. The Hanging Rock Swamp is located upstream along Paddy's River to the south of the Hume Highway near Hanging Rock Road in the Paddy's River sector.

No wetlands of International Significance (Ramsar Sites) were revealed within a 10 km buffer of the survey corridor in an EPBC Protected Matters Database search.

² Reference number W122 in the Geomorphology study for this project.