

5.2.3 Flora Survey

Flora Quadrats

The locations of vegetation communities, including endangered ecological communities (EEC's), occurring along the proposed pipeline route were verified through the characterisation of all vegetation found to occur within a 20 m x 20 m quadrat placed within the proposed impact zone on each of the sites for which access was available. All species present within each quadrat were recorded with any specimens thought to be threatened species or for which identification was problematic sent to the Herbarium at the Royal Botanic Gardens for verification. Notes were also taken on species dominance, soil type and condition, level of weed invasion and any other signs of disturbance (e.g. clearing, fire, rubbish dumping, and access disturbance). The location of field survey quadrats were captured with a GPS and are shown in Figure 2. All species identified as occurring within the quadrats are listed in Appendix B.

Vegetation Mapping

All remnant vegetation found along the length of the pipeline for which assessment was possible was assigned a vegetation community type based on the DECCW Biobanking Vegetation Types Database for the Hawkesbury Nepean catchment area (DECCW 2009) within which the proposed pipeline occurs. All vegetation communities were also assessed against criteria for endangered ecological communities (EEC). All vegetation communities were then mapped using GIS.

Targeted Threatened Flora Surveys

Targeted surveys were undertaken for threatened flora species which could potentially occur along the proposed pipeline route given known distributions, previous records in the locality and habitat requirements for each species. Random meander transects were focused along areas of proposed impacts in potentially suitable habitat and within immediately adjoining vegetation. The locations of any threatened flora species found were recorded with a GPS and mapped using GIS. Any specimens thought to be threatened species for which identification was problematic were sent to the Herbarium at the Royal Botanic Gardens for verification.

5.2.4 Fauna Survey

The survey design was based on the initial habitat assessment and the likelihood of threatened species identified in the literature review occurring within the survey corridor. All observations were recorded on appropriate pro forma field data sheets. A list of all fauna species recorded during the surveys can be found in Appendix B.

Fauna Habitat Assessment

General fauna habitat assessments were undertaken in specific fauna survey locations (Figure 2) along the proposed pipeline route and adjacent areas, including active searches for potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of

understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, termite mounds and permanent or ephemeral watercourses were noted.

Hollow-bearing trees were surveyed and mapped using a GPS along transects at survey sites within the survey corridor. Based on observations of hollow density within various habitat types along the survey corridor, three broad density classes were derived. Low density areas, typically cleared and agricultural land, were estimated to contain between 0-2.5 hollow bearing trees per hectare. Moderate and high density areas, mostly comprising remnant woodland vegetation or stands of mature trees, were divided into areas with 3-10.5 trees per hectare or 11-15 trees per hectare respectively.

The entire survey corridor was then categorised into the three density classes and broadly mapped using field results and aerial photo interpretation, as presented in Figure 6. Due to access constraints, hollow-bearing tree densities in some areas along the pipeline were extrapolated using aerial photos and/or inspection from nearby areas.

The total area of each density class was calculated in GIS and multiplied by the number of trees per hectare to provide a rough approximation of the number of hollow-bearing trees within the survey corridor.

The condition of the habitat within the survey corridor was taken into consideration, including previous land uses and the effect of these land uses on the survey corridor, notably previous clearing, fire and historical and current agricultural use. Fauna habitats in areas that were not directly surveyed for fauna or habitat values (as above) were extrapolated from either aerial photo interpretation or observation of these areas from a distance. This was primarily due to access constraints.

Habitat quality was based on the level of breeding, nesting, feeding and roosting resources available. Indicative habitat criteria for targeted threatened species (i.e. those recorded as potentially occurring along the proposed pipeline corridor in the TSC and EPBC Act database searches) were identified prior to fieldwork. Habitat criteria were based on information provided in TSC Act species profiles, field notebooks and the knowledge and experience of GHD field ecologists. Habitat assessment assists in the compilation of a comprehensive list of fauna that are predicted within the vicinity of the survey corridor, rather than relying solely on single event surveys that are subject to seasonal limitations and may only represent a snapshot of assemblages present.

Habitat assessments included active searches for the following:

- ▶ Trees with bird nests or other potential fauna roosts;
- ▶ Burrows, dens and warrens;
- ▶ Distinctive scats or latrine sites (of particular relevance for the Spotted-tailed Quoll), owl white wash and regurgitated pellets under roost sites;
- ▶ Tracks or animal remains;
- ▶ Evidence of activity such as feeding scars, scratches and diggings;

- ▶ Caves or similar constructed features (e.g. storm drains) that provide potential roost sites for microchiropteran bats; and
- ▶ Specific food trees and evidence of foraging.

The locations and quantitative descriptions of significant habitat features were captured with a handheld GPS unit and photographed where appropriate.

Diurnal Bird Surveys

A total of 26 bird surveys were conducted along the proposed pipeline corridor. These covered approximately 23.5 km of the corridor, including 12 km of cleared/semi-cleared agricultural land, 10 km of forested habitat and 1 km of riparian habitat (Figure 2). Targeted surveys for diurnal birds were undertaken in all habitat types present with emphasis on those habitats utilised by threatened species. All dedicated surveys for birds were carried out at either dawn to two hours after sunrise or two hours before dusk to sun down (Table 4). Standardised 20 minute surveys involved traversing the subject site, including areas nearby the survey corridor on foot, and stopping at various points along the traverse for five to ten minutes to identify particular species. Water and wading bird species were targeted at any water body encountered. Birds were identified by observation with binoculars and/or call identification.

Diurnal bird surveys also included searches for habitat features of relevance for particular threatened species, including searching for evidence of feeding and signs of bird presence, such as pellets, whitewash, nests etc.

Amphibians and Reptiles

Four active searches for frogs and reptiles, with a total duration of 3 hours were performed within and adjacent to the survey corridor focussing on suitable habitat areas (Figure 2). Banks and stream sides were systematically searched and semi-aquatic vegetation was visually scanned. Shelter sites were carefully lifted and replaced, trunks and decorticating bark were scanned, rock crevices were searched, leaf litter was raked and visual scanning of vegetation for active and foraging specimens was undertaken. Frogs were identified by sight and call.

Survey techniques employed included:

- ▶ Diurnal searches for sheltering or basking frogs and reptiles;
- ▶ Rock, log and debris rolling;
- ▶ Active shelter searches, including exfoliating sandstone in exposed rock outcrop; and
- ▶ Spotlight surveys for nocturnally active species (e.g. frogs and geckos).

Microchiropteran Bat Survey

Stationary Anabat recordings were undertaken in 15 locations in suitable habitat along the proposed pipeline corridor (Figure 2). Recordings commenced approximately half an hour before dusk and continued until the following morning.

Calls collected during the field survey were identified using zero-crossing analysis and AnalookW software (version 3.6g, Chris Corben 2009) by visually comparing call traits (see Appendix A). The analysis of all bat calls was undertaken by GHD ecologists. No reference calls were collected during the survey. The *Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay *et al.* 2004) was used as a guide to call analysis. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency. Pulses separated from another sequence by a period of five seconds were considered to be separate passes. Scattered sequences, where intermittent pulses were not separated by more than five seconds, were recognised as a single pass. Where constant activity was recorded, a single pass was defined as 15 seconds (i.e. one full display screen comprising an Anabat sequence file). Although this method underestimates the number of bat passes when there is continuous activity, the standard unit of time remains consistent (Law *et al.*, 1998; Law *et al.*, 1999).

Spotlighting

There were 13 spotlight searches undertaken for nocturnally active mammals (as well as birds and herpetofauna) including dedicated listening periods for fauna vocalisations, in areas of appropriate habitat along the proposed pipeline route. This covered approximately 6 km of the corridor. Mammals and nocturnal birds were identified by observation under spotlight or by vocalisations heard whilst spotlighting. Each survey involved a series of transects conducted on foot within the survey corridor along the proposed development footprint and within adjacent bushland areas (Figure 2).

Surveys commenced at dusk and targeted areas with trees containing hollows to detect arboreal mammals, forest owls and bats emerging from diurnal roosts to forage. Open water bodies were also targeted at this time to detect species coming to these locations to drink or forage above in the case of microbats. Special attention was given to habitats containing a number of suitable habitat features for threatened species.

Surveys were conducted by two appropriately qualified ecologists for a minimum of 30 minutes over one hectare.

Call Playback

Call playback surveys were conducted for the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Koala (*Phascolarctos cinereus*), Squirrel Glider (*Petaurus norfolcensis*) and Yellow-bellied Glider (*Petaurus australis*) in seven locations (Figure 2). Surveys involved an initial listening period of five minutes followed by call playing for five minutes followed by a listening period of five minutes (undertaken separately for each species), and a final listening period of approximately 10 minutes. Calls were played through a portable MP3 player connected to a (ER-409) 15-watt megaphone. All potential roost sites in the immediate area were then scanned for 10 minutes using spotlights.

Camera Traps

Camera traps were placed in suitable habitat in four locations along the proposed pipeline corridor. Traps were baited with sardines or honey in order to attract targeted species, including the Spot-tailed Quoll (*Dasyurus maculatus maculatus*) and Squirrel Glider (*Petaurus norfolcensis*).

Opportunistic Observations

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Survey effort was concentrated on suitable areas of habitat throughout the course of the flora survey, for instance fallen timber was scanned for reptiles and paddock trees and dams were scanned for roosting birds.

5.3 Conservation significance

The conservation status of species and communities recorded within the survey corridor was determined with reference to the following:

- ▶ TSC Act for State significance; and
- ▶ EPBC Act for National significance.

5.4 Survey Limitations

As discussed in Section 1.2.3 of this report, factors that limited the scope of survey effort undertaken as part of this investigation included:

- ▶ Restricted access to land along the pipeline route;
- ▶ Restricted timeframe to conduct surveys;
- ▶ Timing of surveys and seasonal and vagrant species;
- ▶ Unfavourable weather conditions (e.g. high fire danger, windy and wet weather) impeding survey efforts whilst mobilised for field surveys.

Trapping for small mammals or microbats and reptiles was not undertaken given the absence of suitable habitat types within the construction corridor for some species and timing and seasonal constraints. Survey effort for these fauna groups focused on call identification for microbats (Anabat), and the identification of suitable foraging and roosting habitat for other species within the survey corridor. In the case of mammals, reptiles and amphibians active searches of survey sites for individuals or evidence of their presence were also undertaken.

5.5 DGRs for Survey Effort

Table 7 shows the allocation of survey effort to fulfil the Director-General's survey requirements for threatened fauna species. The table addresses all subject species listed by DECCW, as well as a number of other threatened species considered likely to occur within the study area, which were identified through the desktop assessment process (Section 6).



The Project was constrained by property access and limited timeframes in particular given the timing of access approvals, and it was considered appropriate to:

- ▶ Utilise the available time to focus on assessing habitats along the entire length of the pipeline corridor, especially those habitats consistent with that preferred by threatened species likely to occur;
- ▶ Conduct survey techniques for threatened species that were less time intensive and targeted those species most likely to occur along the alignment based on the habitats present (e.g. bird surveys, call playback, spotlighting, habitat searches, ultrasonic call detection); and
- ▶ Avoid time-intensive methods (e.g. arboreal, pitfall and cage trapping) that were unlikely to add substantial value to the assessment given the thin, linear nature of the construction corridor, the nature of the habitats to be impacted and the limited extent of impact anticipated given measures to avoid and/or minimise clearing.

The DGRs for the Project were received on 14 December 2009. As such, it was not possible to satisfy the survey requirements for a number of species where seasonal survey periods commencing prior to December were identified (e.g. the survey requirements for the Little Whip Snake from mid-August to November).

Some species listed by DECCW were considered unlikely to occur in the survey corridor based on a lack of preferred habitat within the corridor or due to the fact that their current known distribution is outside of the study area. These include the Little Whip Snake, Grassland Earless Dragon, and the Golden Sun Moth. Accordingly, targeted surveys were not undertaken for these species.



Table 7 Rationale of survey effort expended to address DGRs for threatened fauna surveys

Species	Survey requirements from DGRs	NSW DECCW Guidelines* (DEC 2004) (if not specifically stated in DGRs)	Survey Effort	Justification of approach
Barking Owl (<i>Ninox connivens</i>)	Nocturnal call playback (1 site per 100 ha). Identify and map hollow-bearing trees.	N/A	Nocturnal call playback for the 3 owl species combined with spotlighting (at 7 sites). Hollow-bearing trees were identified and mapped at survey sites within the construction and survey corridors.	Call playback at 7 sites within a maximum total footprint of approximately 100ha exceeds the DGRs for owl surveys.
Powerful Owl (<i>Ninox strenua</i>)				Tree-hollow density estimates were extrapolated for areas not able to be accessed to calculate a conservative estimate of tree-hollows within the entire construction and survey corridors.
Masked Owl (<i>Tyto novaehollandiae</i>)	Not stated	Call playback combined with spotlighting with sites more than 1 km apart (if done on the same night)		
Speckled Warbler (<i>Pyrholaemus sagittatus</i>)	Diurnal bird census (45 minute duration) on three occasions each one week apart.	Diurnal bird census using a species-time curve approach, per stratification unit.	Diurnal bird census (using the species-time curve approach with a minimum duration of 20 minutes) on at least one occasion in each section of preferred habitat (a total of 26 sites). Opportunistic sightings of new species were also recorded throughout all survey periods. Habitat assessments.	Length of census was determined using the species-time curve approach as recommended in the DECCW survey guidelines, with surveys generally lasting between 30min and 1hr. Repeated surveys were not carried out at each site in order to maximise coverage of the pipeline corridor.
Diamond Firetail (<i>Stagonopleura guttata</i>)				
Hooded Robin (<i>Melanodryas cucullata cucullata</i>)				
Brown Treecreeper (<i>Climacteris picumnus victoriae</i>)				Survey effort was based upon assessing the habitat characteristics for threatened species likely to occur there, rather than definitive presence-absence sampling regimes, due to time and access constraints
Swift Parrot (<i>Lathamus discolor</i>)	Not stated	Diurnal bird census using a species-time curve approach, per stratification unit.		
Turquoise Parrot (<i>Neophema pulchella</i>)				
Regent Honeyeater (<i>Xanthomyza phrygia</i>)				
Black-chinned Honeyeater (<i>Melithreptus gularis gularis</i>)				



Koala (<i>Phascolarctos cinereus</i>)	Not stated	Call playback (2 sites per stratification unit up to 200 ha) conducted twice on separate nights.	Call playback conducted at least once per site at 7 sites throughout suitable habitat. Koala scat searches under potential food trees within the survey corridor. Spotlighting (13 sites covering approximately 6 km),	Repetition of playback at individual sites occasionally sacrificed in order to maximise sampling of potentially suitable habitat within the project footprint. Overall effort expended (multiple playbacks at 7 sites for a maximum total area of 100ha) exceeds DECCW guidelines. Koala scat searches and general spotlighting surveys supplemented call playback survey effort.
Yellow-bellied Glider (<i>Petaurus australis</i>) Squirrel Glider (<i>Petaurus norfolcensis</i>)	Live-trapping for Squirrel Gliders, map den site and feed tree locations, stag watching, spotlighting, call playback and habitat assessment.	N/A	Habitat assessments and searches for feeding scars, Call playback (7 sites), Hollow-bearing trees were identified and mapped at survey sites within the construction and survey corridors, Spotlighting (13 sites covering approximately 6 km)	Time intensive survey methods (stag watching and live trapping) were not undertaken given the nature of the habitat within the construction corridor and in order to prioritise survey techniques with broader relevance (spotlighting, call playback and habitat assessments) in order to detect as many species as possible. Tree-hollow density estimates were extrapolated for areas not able to be accessed to calculate a conservative estimate of tree-hollows within the entire construction and survey corridors.
Glossy-black Cockatoo (<i>Calyptorhynchus lathamii</i>) Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>)	Diurnal bird surveys, habitat assessments	N/A	Diurnal bird surveys (26 sites), habitat assessments Hollow-bearing trees were identified and mapped at survey sites within the construction and survey corridors	Tree-hollow density estimates were extrapolated for areas not able to be accessed to calculate a conservative estimate of tree-hollows within the entire construction and survey corridors.



Spot-tailed Quoll (<i>Dasyurus maculatus</i>)	Not stated	Cage traps (24 trap nights over 3-4 consecutive nights), spotlighting, search for scats and tracks.	Habitat assessments, spotlighting (in 13 locations covering approximately 6 km), remote motion-sensor cameras (4 sites), searches for latrine sites and tracks.	Cage trapping was not undertaken given the marginal nature of the habitat within much of the construction corridor for this species and the low success rate of this technique outside areas of high density populations of this species. Remote cameras and habitat assessments were used as a substitute, coupled with spotlighting and searches for signs of presence (e.g. latrine sites) according to DECCW guidelines.
Large-eared Pied bat (<i>Chalinolobus dwyeri</i>)	Not stated	Some combination of ultrasonic echolocation call detection and trapping depending on whether the species are high-flying or low intensity echo locators. Identification and mapping of roost sites.	Ultrasonic echolocation call detection (Anabat) (15 nights) and identification and mapping of potential roost sites. Habitat assessments.	Anabat survey effort exceeds DECCW survey guidelines. Habitat assessments and mapping of potential roost sites (to assess the likelihood of species' presence) was prioritised over trapping due to time and access constraints. Tree-hollow density estimates were extrapolated for areas not able to be accessed to calculate a conservative estimate of tree-hollows within the entire construction and survey corridors.
Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>)				
Yellow-bellied Sheath-tail Bat (<i>Saccolaimus flaviventris</i>)				
Greater long-eared Bat (<i>Nyctophilus timoriensis</i>)				
Eastern bentwing bat (<i>Miniopterus schreibersii oceanensis</i>)				
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)				
Large-footed Myotis (<i>Myotis macropus</i>)				
Eastern Freetail bat (<i>Mormopterus norfolkensis</i>)				



Grassland Earless Dragon (<i>Tympanocryptis pinguicolla</i>)	Not stated	Habitat search, pitfall trapping for 24 trap nights from November to March, spotlighting.	Habitat assessments Active searches for reptiles (4 sites for a total of 3 hours)	The desktop review indicated that the study area is outside the known distribution for the Grassland Eared Dragon. As such, survey effort was focussed on habitat assessment and active searches of potential habitat rather than targeted trapping surveys.
Pink-tailed Worm-lizard (<i>Aprasia parapulchella</i>)	Not stated	Habitat search, pitfall trapping for 24 trap nights from November to March, spotlighting.	Habitat assessments, Spotlighting (13 sites covering approximately 6 km). Active searches for reptiles (4 sites for a total of 3 hours)	Due to timing constraints surveys focussed on techniques with broad relevance (e.g. spotlighting) and assessing the likelihood of occurrence of species via habitat assessments coupled with active habitat searches. The Pink-tailed Worm Lizard has a restricted distribution and habitat requirements (rocky substrates). Only limited suitable potential habitat exists in the survey corridor given the long-history of disturbance and modification. Active searches were therefore undertaken in areas of rock outcrop and other potential habitats.
Striped Legless Lizard (<i>Delma impar</i>)	Pitfall trapping for 6 weeks from November to late December.	N/A		The Pink-tailed Worm Lizard has a restricted distribution and habitat requirements (rocky substrates). Only limited suitable potential habitat exists in the survey corridor given the long-history of disturbance and modification. Active searches were therefore undertaken in areas of rock outcrop and other potential habitats. Pitfall trapping for 6 weeks for the Striped Legless Lizard during November and December was not possible due to the receipt of the DGRs in mid December. Only marginal potential habitat for this species is present given the long-history of modification and disturbance within survey corridor.
Rosenberg's Goanna (<i>Varanus rosenbergi</i>)	Record termite mounds, cage trapping over a three-week period from October to November.	N/A	Assessments of preferred habitats. Termite mounds were recorded in parts of the pipeline corridor considered to provide potential habitat for this species.	Cage trapping was not undertaken due to survey timing outside the seasonal requirements and the marginal nature of the potential habitat for this species within much of the construction corridor. Surveys focussed instead on assessing the likelihood of occurrence of this species through habitat assessments.



Little Whip Snake (<i>Suta flagellum</i>)	Active diurnal searches between mid-August and November	N/A	Habitat assessment. Active searches for reptiles (4 sites for a total of 3 hours)	The desktop study indicated that the study area is outside the known distribution for this species. As such, survey effort was focussed on habitat assessment and active searches of potential habitat.
Giant Dragonfly (<i>Petulura gigantea</i>)	Exuviate surveys from November to February.	N/A	Habitat assessment and desktop study to determine likelihood of occurrence.	Surveys prioritised assessing the likelihood of occurrence of this species within the construction corridor through habitat assessments.
Golden Sun Moth (<i>Synemon plana</i>)	Hand-netting during known flight periods in areas with higher than 40% <i>Austrodanthonia</i> .	N/A	Habitat assessment and desktop study to determine likelihood of occurrence.	The desktop study indicated that the study area is outside the known distribution for this species. Preferred <i>Austrodanthonia</i> habitat is not present within the construction corridor. Targeted searches were therefore not undertaken for the Golden Sun Moth.

6. Desktop Assessment Results

6.1 Review of DGR Subject Species

The Director General's Requirements (DGRs) identified 21 species of threatened fauna, 16 species of threatened flora and five (5) endangered ecological communities as likely to occur within the survey corridor. These subject species are presented in Appendix D, along with an assessment of their habitat requirements, likelihood of occurring within the survey corridor and potential for impacts arising from the Project.

Subject species assessed as likely to occur along the pipeline route and likely to be affected by the Project are presented in Section 6.4. Potential impacts on these subject species are discussed in Section 8.

6.2 Threatened Species

6.2.1 Threatened Species Conservation Act

A search of the NSW Wildlife Atlas (DECC, 2009b) was performed to determine the threatened species, populations or ecological communities that have been previously recorded within the locality of the survey corridor and hence could occur subject to the habitats present. This search indicated a number of TSC Act listed species have been previously been recorded within the locality.

The TSC Act listed species are presented in Appendix D along with an assessment of their habitat requirements, likelihood of occurring in the survey corridor and potential for impacts arising from the Project. A number of these species may potentially occur along the pipeline route and be affected by the Project. These species are presented in Section 6.4. Potential impacts on these species are discussed in Section 8.

6.2.2 Fisheries Management Act

The provisions of the *Fisheries Management Act 1994* cover all fish (freshwater, estuarine and marine), aquatic invertebrates and marine plants. The definition of fish includes any marine, estuarine or freshwater fish or other aquatic animal (e.g., oysters, prawns, sharks, rays, starfish, insects and worms), at any stage of their life history. It does not include whales, mammals, birds, reptiles and amphibians.

A desktop search of the biota listed under the FM Act revealed the following threatened freshwater species with the potential to occur within the locality:

- ▶ Macquarie Perch (*Macquaria australasica*)
- ▶ Australian Grayling (*Prototroctes maraena*)
- ▶ Giant Dragonfly (*Petulura gigantea*)

An assessment of the habitat requirements of these species, the likelihood of them occurring along the pipeline route and potential for impacts arising from the Project is presented in Appendix D. Species assessed as likely to occur within the survey corridor

and be affected by the Project are listed in Section 6.4. Potential impacts on these species are discussed in Section 8.

6.3 Matters of National Environmental Significance

An EPBC Act Protected Matters Search (DEWHA, 2009) was performed for the study area, which comprised a 10km area around the pipeline corridor. The search results are presented in Appendix H and are summarised in Table 8. The search results indicate that the following matters of NES have previously been recorded or are predicted to occur within the locality of the pipeline corridor:

- ▶ Three (3) threatened ecological communities (EECs);
- ▶ 25 listed threatened flora species;
- ▶ 18 listed threatened fauna species;
- ▶ 13 migratory species.

Table 8 Summary of EPBC Act Protected Matters Search

MNES	Occurrence within locality
World Heritage Properties	None listed within the survey corridor
National Heritage Places	None listed within the survey corridor
Wetlands of International significance (RAMSAR sites)	None listed within the survey corridor
Commonwealth Marine Areas	None listed within the survey corridor
Endangered Ecological Communities	3 Threatened Ecological Communities are predicted to occur within the locality. For details, see Appendix D.
Threatened Flora	25 species of threatened flora are predicted to occur within the locality. For details, see Appendix D.
Threatened Fauna	18 species of threatened fauna are predicted to occur within the locality. For details, Appendix D.
Migratory Species	13 migratory species are predicted to occur within the locality.
Commonwealth Lands	7 (Not relevant to the Ecological Impact Assessment)
Commonwealth Heritage Places	1 (Not relevant to the Ecological Impact Assessment)
Places on the Register of National Estate	69 (Not relevant to the Ecological Impact Assessment)

MNES	Occurrence within locality
Listed Marine Species	11 (Not relevant to the Ecological Impact Assessment due to the lack of marine habitat in the survey corridor)
Whales and other Cetaceans	None listed in the locality
Critical Habitats	None listed in the locality
Commonwealth Reserves	None listed in the locality
State and Territory Reserves	2 (not located within the pipeline corridor)
Regional Forest Agreements	The pipeline route will not affect the Southern RFA

The EECs, threatened species and migratory species that are predicted to occur within the locality (as summarised in Table 8) are presented in Appendix D, along with an assessment of their habitat requirements, likelihood of occurring in the survey corridor and potential for impacts arising from the Project. A number of the EPBC Act listed biota may potentially occur along the pipeline route and be affected by the Project.

Potentially affected MNES are discussed as part of the assessment of subject species in Section 6.4 below.

6.4 Subject Species

Threatened species and EECs listed under the TSC Act and/or the EPBC Act that have either been recorded within the survey corridor or are considered likely to occur and have the potential to be affected by the Project are listed in the following sections. These subject species were identified based on the assessment of their habitat requirements, likelihood of occurrence within the survey corridor and potential for impacts arising from the Project (Appendix D).

The desktop assessment identified 27 threatened plant species, 28 threatened fauna species and six EECs as subject species with potential to be impacted by the Project.

6.4.1 Threatened Flora Species

The desktop literature review indicates forty-four (44) threatened plant species that have been previously recorded or are predicted to occur within the survey corridor (see Appendix D) with twenty-seven (27) threatened plant species considered to have the potential to occur in the habitats present within the proposed corridor, as listed in Table 9. Of these species, two (2) threatened flora species were recorded along the proposed pipeline route during the current surveys. These species are discussed further in Section 7.1.4.

Table 9 Threatened Plant Species Recorded¹ or Likely to Occur within the Survey Corridor

Scientific Name	Common Name	TSC Act	ECBP Act
<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V
<i>Bossiaea oligosperma</i>	Few-seeded Bossieae	V	V
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	E	V
<i>Carex klaphakei</i>	Klaphake's Sedge	E	-
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V
<i>Diuris aequalis</i>	Buttercup Doubletail	E	V
<i>Eucalyptus aquatica</i>	Broad-leaved Sally	V	V
<i>Eucalyptus macarthurii</i>	Camden Woollybutt	V	-
<i>Gentiana wingecarribensis</i>	Wingecarribee Gentian	E	E
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V
<i>Haloragis exalata</i> subsp. <i>exalata</i> var. <i>laevis</i>	Square Raspwort	V	V
<i>Leucochrysum albicans</i> var. <i>tricolor</i>	Hoary Sunray	-	E
<i>Lysimachia vulgari</i> var. <i>daurica</i>	Yellow Loosestrife	E	-
<i>Persicaria elatior</i>	Tall Knotweed	V	V
<i>Persoonia glaucescens</i>	Mittagong Geebung	E	V
<i>Phyllota humifusa</i>	Dwarf Phyllota	V	V
<i>Pomaderris cotoneaster</i>	Cotoneaster Pomaderris	E	E
<i>Pomaderris delicata</i>	Delicate Pomaderris	E	
<i>Pomaderris pallida</i>	Pale Pomaderris	V	V
<i>Pomaderris sericea</i>	Silky Pomaderris	E	V
<i>Pomaderris walshii</i>	Carrington Falls Pomaderris	CE	
<i>Prasophyllum fuscum</i>	Slaty Leek Orchid	V	V
<i>Prasophyllum uroglossum</i>	Wingecarribee Leek Orchid	E	E

¹ Species recorded during field surveys are in bold type.

Scientific Name	Common Name	TSC Act	ECBP Act
<i>Pultenaea parrisaiae</i> subsp. <i>elusa</i>	Elusive Bush-pea	E	E
<i>Rulingia prostrata</i>	Dwarf Kerrawang	E	E
<i>Thesium australe</i>	Austral Toad Flax	V	V
<i>Zieria murphyi</i>	Velvet Zieria	V	V

6.4.2 Endangered Ecological Communities

At least five endangered ecological communities (EECs) listed under the TSC Act and one EEC recommended for listing have the potential to occur along the proposed pipeline route. These include:

- ▶ Montane Peatlands and Swamps, listed as endangered under the TSC;
- ▶ Natural Temperate Grasslands of the Southern Tablelands (NSW and ACT), listed as endangered under the EPBC Act;
- ▶ Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion, listed as endangered under the TSC Act;
- ▶ Southern Highlands Shale Woodlands in the Sydney Basin Bioregion, listed as endangered under the TSC Act;
- ▶ White Box - Yellow Box - Blakely's Red Gum Woodland, listed as endangered under the TSC Act and critically endangered under the EPBC Act; and
- ▶ Snow Gum – Black Sallee Grassy Woodlands, recommended for listing under TSC Act.

Of these, Southern Highlands Shale Woodlands and Robertson Basalt Tall Open-forest were recorded in the survey corridor. Southern Highlands Shale Woodlands was recorded in the construction corridor. Robertson Basalt Tall Open-forest was not recorded within the construction corridor. White Box Yellow Box Blakely's Red Gum Woodland was recorded in the Marulan area but outside of the survey corridor.

These communities are discussed further in Section 7.1.4.

6.4.3 Threatened Fauna species

The desktop literature review indicates forty-nine (49) threatened fauna species that have been previously recorded or are predicted to occur within the survey corridor (see Appendix D) of which thirty (30) threatened fauna species have the potential to occur within the habitats present within the proposed corridor, as listed in Table 10 below.

Results from a desktop search of the FM Act online database and EPBC online Protected Matters database indicate that two threatened fish species potentially occur within the locality. However an assessment of their preferred habitats, combined with their current known distributions, revealed that both species are unlikely to occur within

waterways crossed by the pipeline (see Appendix D). One other aquatic-dependent species (Giant Dragonfly) was also identified in the desktop search, and is listed below.

Of these species, six (6) threatened fauna species were recorded along the proposed pipeline route during the current surveys, including the Large-footed Myotis which was identified as probably present on the basis of Anabat call identification. A further two species subject to a preliminary determination for listing (NSW TSC Act) were recorded. These are the scarlet robin (*Petroica boodang*) and varied sitella (*Daphoenositta chrysoptera*). These species are discussed further in Section 7.2.3.

Table 10 Threatened Fauna Recorded or with the Potential to Occur due to Habitat Association

Scientific Name	Common Name	TSC Act	EPBC Act
<i>*Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	
<i>*Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	
<i>Neophema pulchella</i>	Turquoise Parrot	V	
<i>Ninox strenua</i>	Powerful Owl	V	
<i>Ninox connivens</i>	Barking Owl	V	
<i>Tyto novaehollandiae</i>	Masked Owl	V	
<i>*Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	
<i>Petroica boodang</i>	Scarlet Robin	Prel.	
<i>Daphoenositta chrysoptera</i>	Varied Sitella	Prel.	
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	
<i>Melanodryas cucullata cucullata</i>	Hooded Robin	V	
<i>Stagonopleura guttata</i>	Diamond Firetail	V	
<i>Dasyurus maculatus maculatus</i>	Spot-tailed Quoll (Southeastern mainland population)	V	E

<i>Phascolarctos cinereus</i>	Koala	V	
<i>Petaurus australis</i>	Yellow-bellied Glider	V	
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V
*Falsistrellus tasmaniensis	Eastern Falsistrellus	V	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtailed Bat	V	
*Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	
†Myotis macropus	Large-footed Myotis	V	
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard	V	V
<i>Delma impar</i>	Striped Legless Lizard	V	V
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	V	
<i>Petrolura gigantea</i>	Giant Dragonfly	E	

V= vulnerable

E= endangered

Prel.= subject to preliminary determination for listing

*** Species recorded in GHD surveys 2009**

† Species identified as probably occurring as a result of call analysis (See Appendix C).

7. Existing Environment

7.1 Flora

The proposed pipeline route passes through a number of vegetation community types, including large sections of primarily cleared agricultural and grazing land containing isolated paddock trees, small isolated stands of remnant native vegetation, larger stands of remnant native vegetation, riparian vegetation, native sedgeland, fragmented and regrowth native vegetation, and exotic plantations and crops (Figure 3).

Areas of cleared agricultural land dominated the Glenquarry, Moss Vale – Werai, Sutton Forest – Exeter, and Murray’s Flat – Goulburn sections of the proposed route. These areas were dominated by a mixture of native and introduced pasture grasses and weeds and were subject to extensive and heavy grazing of cattle and other livestock. These areas contained isolated paddock trees and small stands of remnant vegetation often in a degraded state lacking a shrub layer. Larger patch sizes showed stronger resilience to the impacts of stock, with good levels of native groundcovers occurring within larger stands and occasional diversity within the shrub layer. Creek lines occurring along these sections were often in a degraded state with little to no remnant vegetation occurring along much of the waterbodies, and were often dominated by Willow (*Salix* spp.), regrowth *Acacia* spp., and exotic weeds.

Large stands of native vegetation dominated sections of the proposed pipeline route in the Paddy’s River, Marulan, and Towrang areas and occurred in varying levels of condition and age classes ranging from maturing regrowth to older remnant stands, and from disturbed woodland showing signs of under-scrubbing and grazing pressure through to predominantly undisturbed large remnant stands in good condition.

Vegetation within the canopy stratum along the entire length of the proposed pipeline route was highly diverse and showed signs of disturbance through fire or clearing, affecting the distribution and abundance of canopy species in some locations. Understorey species in most stands of vegetation occurring along the pipeline showed signs of heavy grazing and the effects of drought, with some areas completely devoid of any shrubs and with very low abundances of groundcovers. A highly variable geology throughout the Paddy’s River area also appeared to have an influence on species diversity, with increased diversity of canopy species and transitional communities occurring within this section of the proposed pipeline route.

7.1.1 Flora Species

Field surveys identified a total of 307 species of plants from 62 families occurring within the survey corridor. Fifty (50) of these species (approximately 16%) were exotic species, including noxious weeds such as Blackberry (*Rubus fruticosus aggregate species*) and African Lovegrass (*Eragrostis curvula*). Two (2) species listed as endangered under the EPBC Act were also identified as a result of these surveys (see Section 7.1.3).

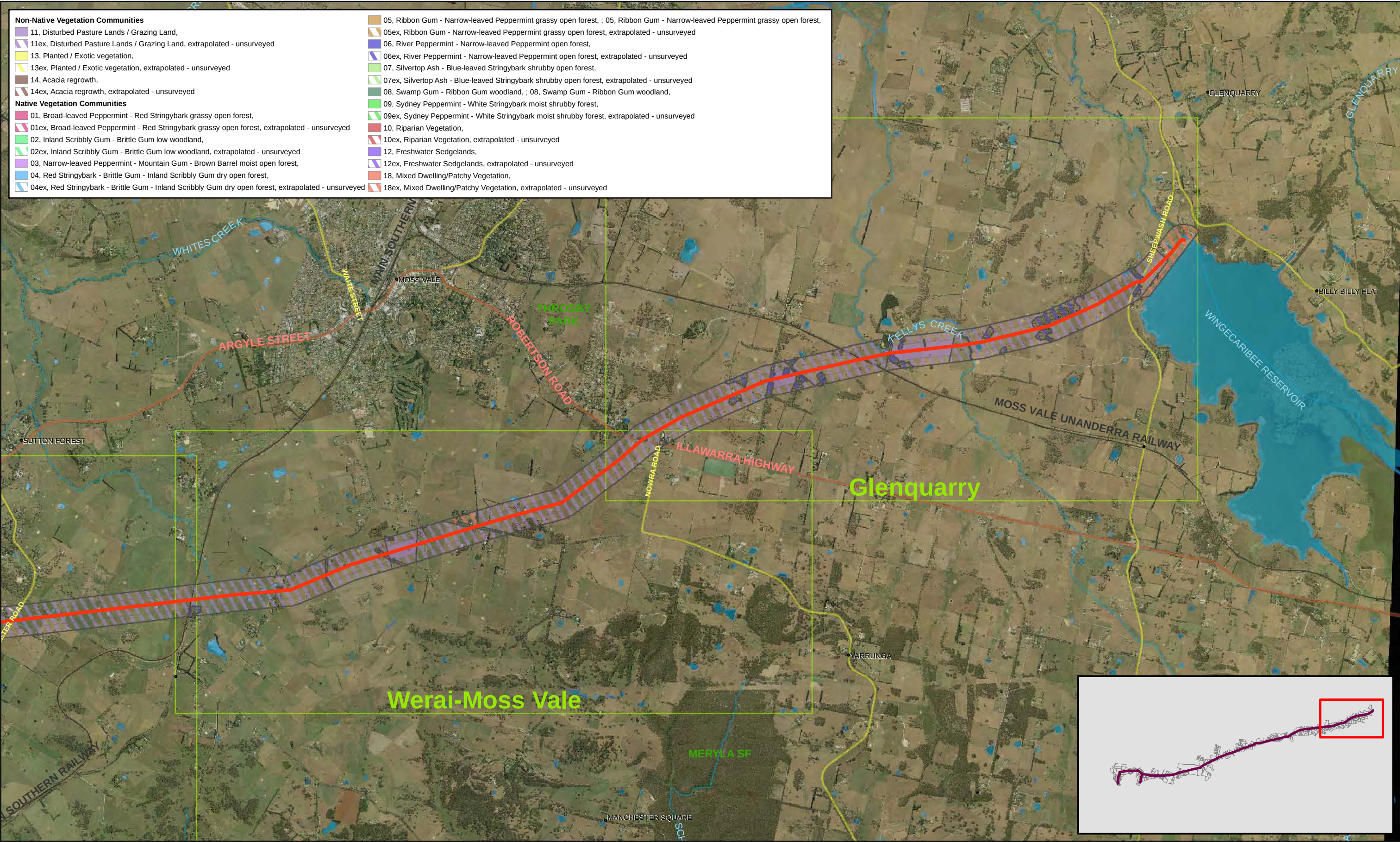


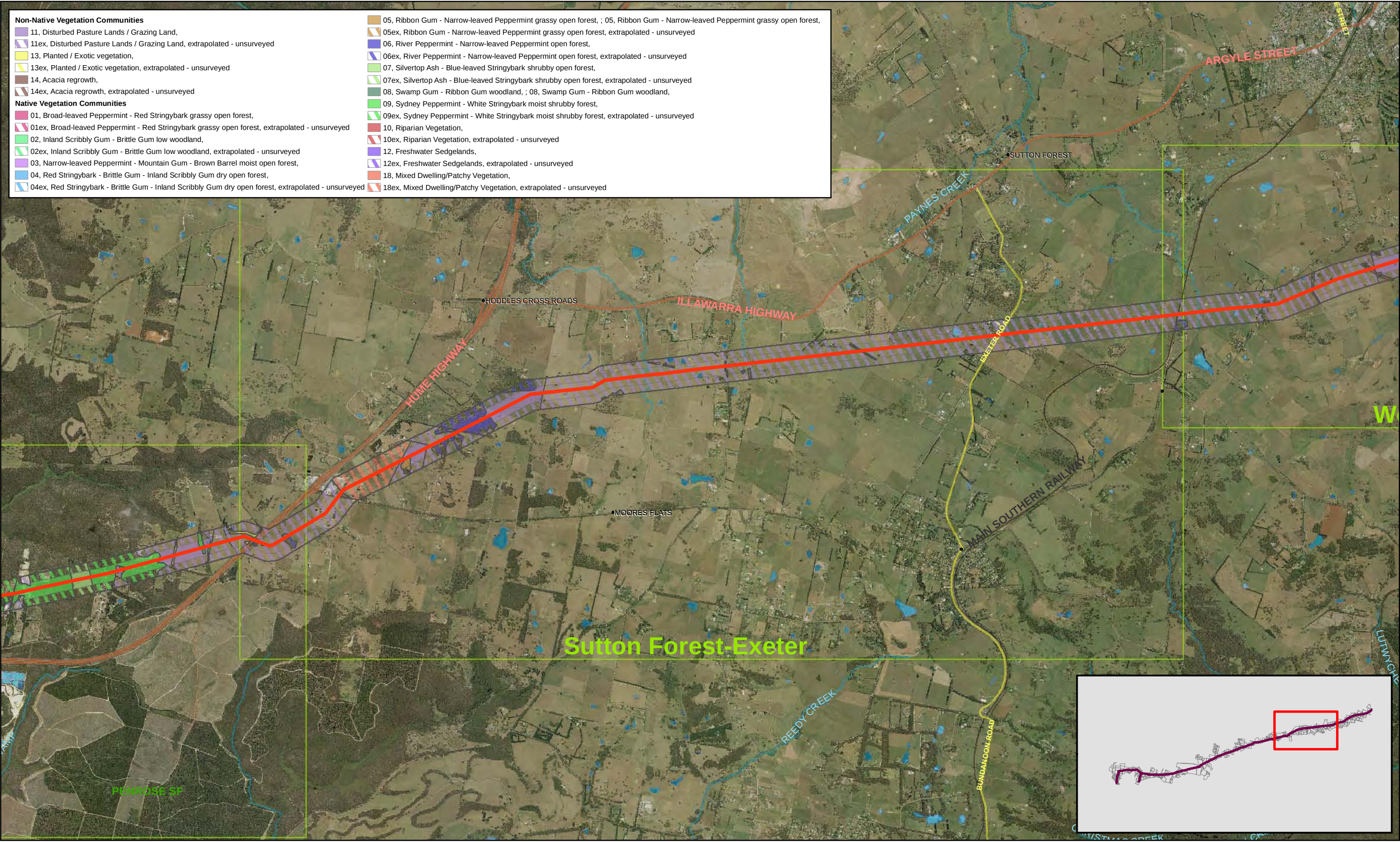
7.1.2 Vegetation Communities

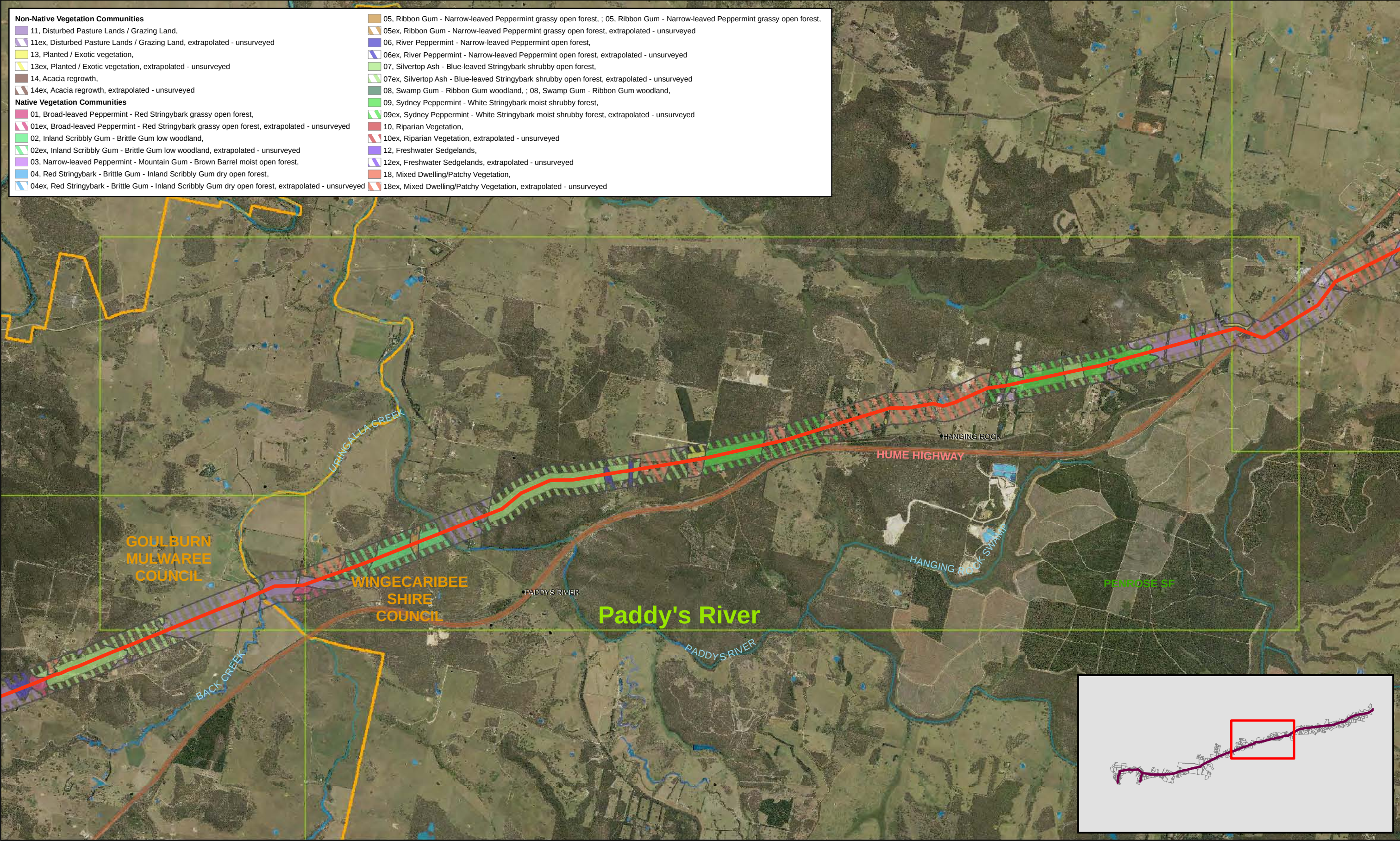
Vegetation communities identified and mapped within the survey corridor are described in Table 11 and their distributions shown in Figure 3. Native vegetation communities occurring along the proposed pipeline route have been assessed against definitions of vegetation types for the Hawkesbury-Nepean Catchment Management Area on the DECCW Biobanking Vegetation Types Database (DECCW 2010), and classified based on a 'best fit' basis within these community types.

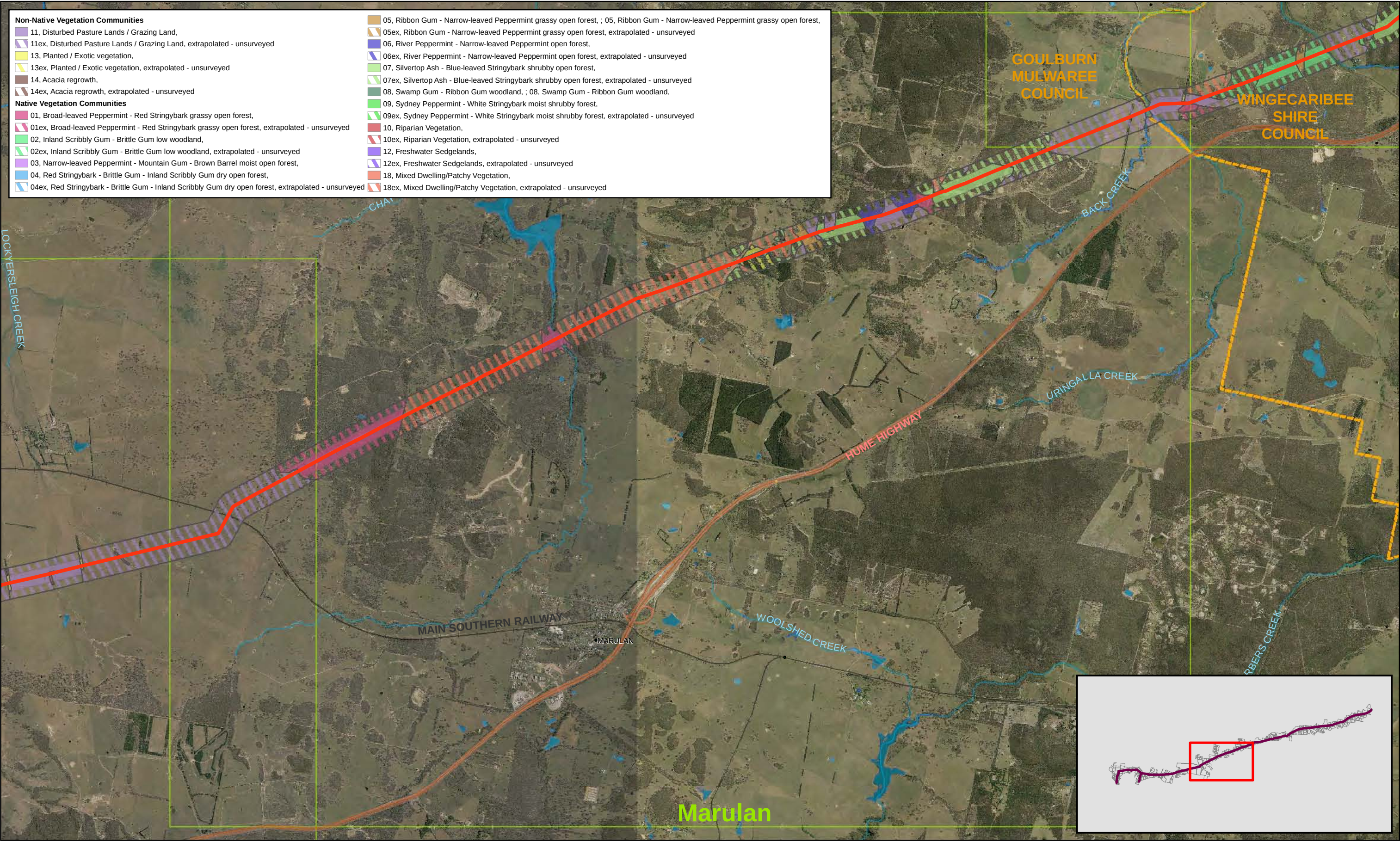
Estimates of the total mapped area of each vegetation community within the 400m survey corridor (as calculated in GIS) are shown in Table 12. A total of 2686 ha of vegetation has been mapped within the survey corridor for the raw water transfer corridor, with 2400 ha within the shorter treated water pipeline. The Disturbed Agricultural and Grazing Land vegetation community occupies most of the survey corridor, with approximately 1958 ha mapped for the raw water pipeline.

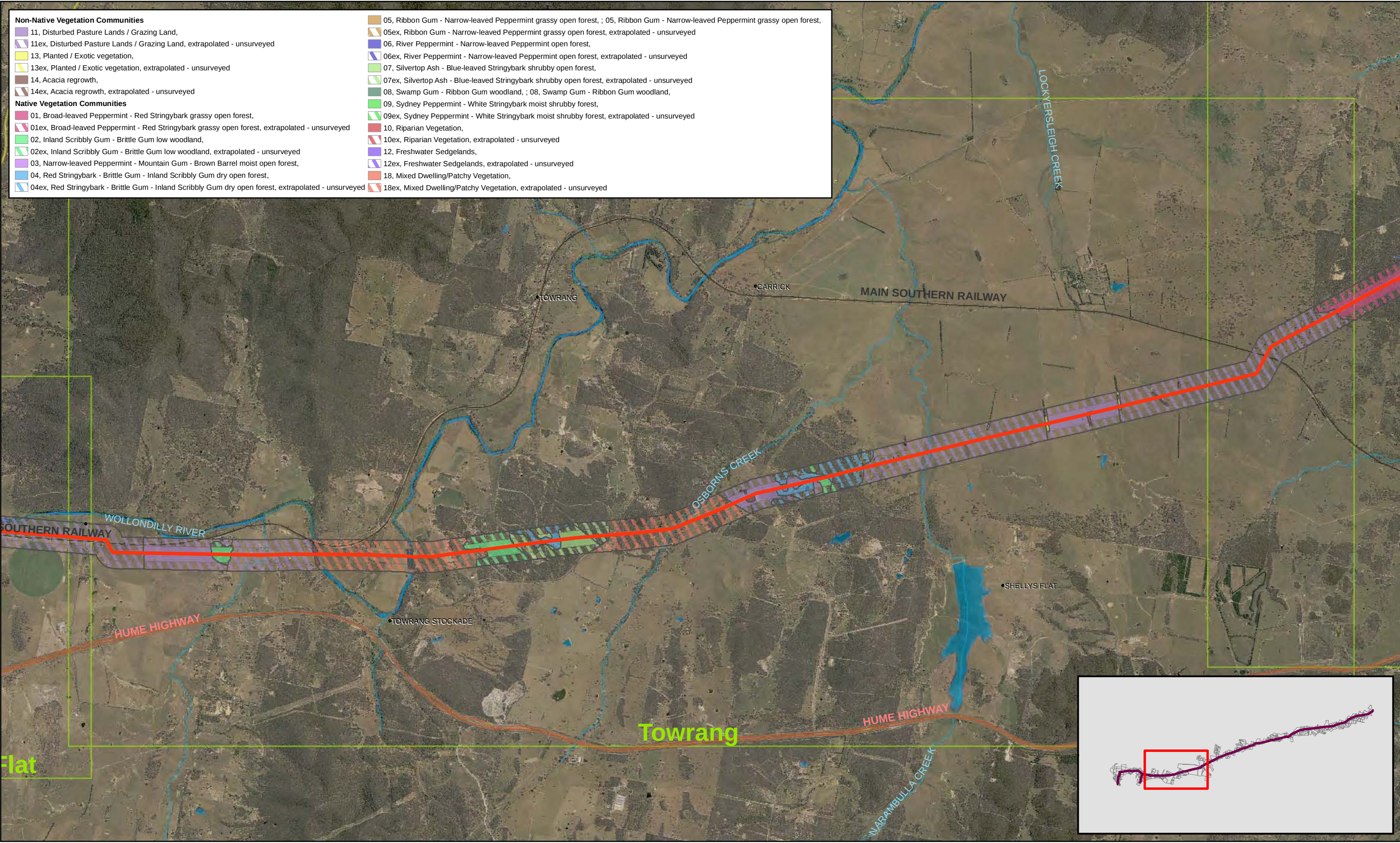
Table 13 provides the area of each vegetation type in each of the six sectors along the pipeline easement.











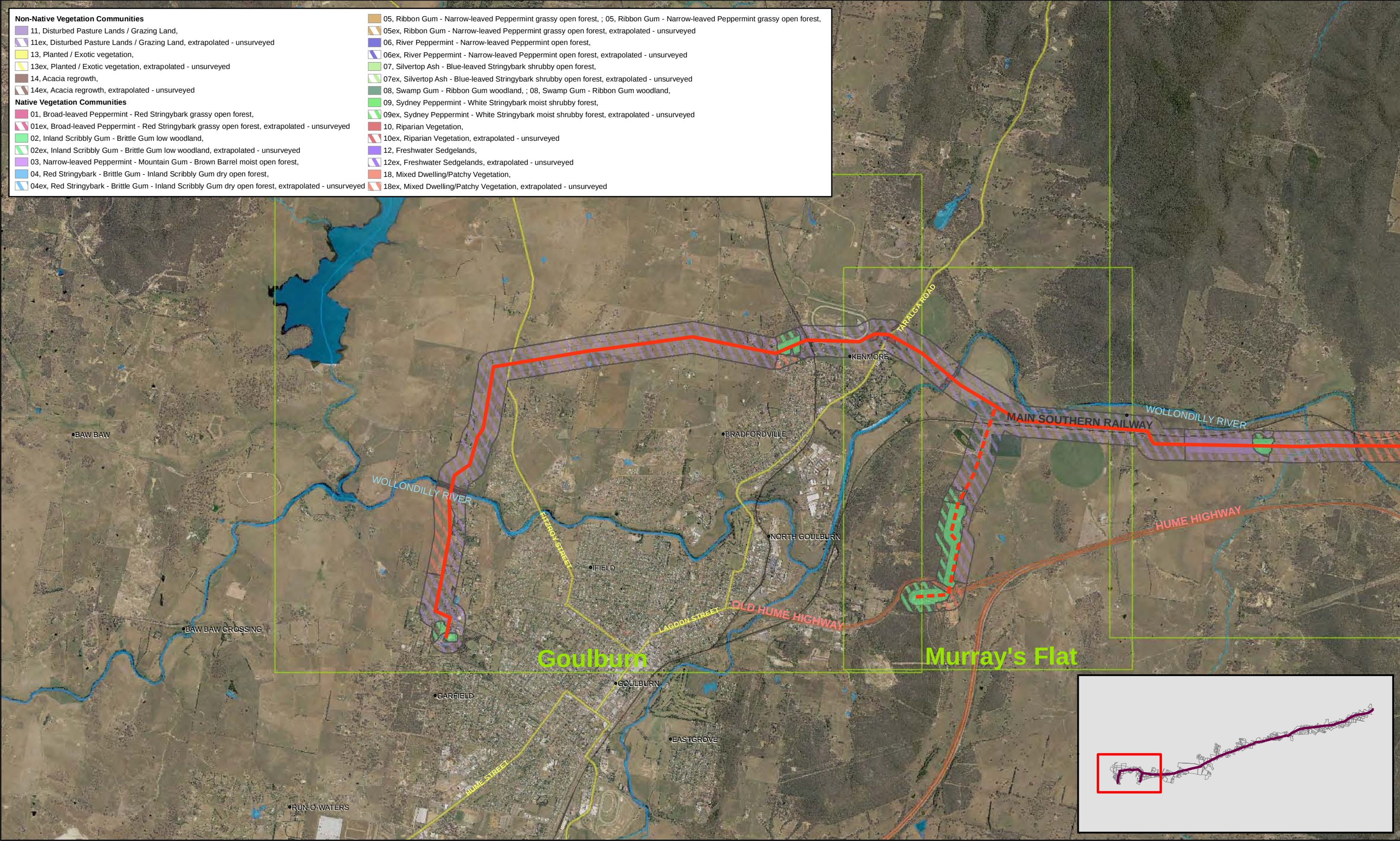




Table 11 Vegetation Communities recorded within the Survey Corridor (see Figure 3)

Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills of the South Eastern Highlands.	This community was dominated by Broad-leaved Peppermint (<i>Eucalyptus dives</i>) and Red Stringybark (<i>E. macrorhyncha</i>) with Argyle Apple (<i>E. cinerea</i>), Inland Scribbly Gum (<i>E. rossii</i>), Apple Box (<i>E. bridgesiana</i>), Narrow-leaved Peppermint (<i>E. radiata</i>), Brittle Gum (<i>E. mannifera</i>), Silvertop Ash (<i>E. sieberi</i>), and Ribbon Gum (<i>E. viminalis</i>) also occurring less frequently. Individuals of Blakely's Red Gum (<i>E. blakelyi</i>), Black Gum (<i>E. aggregata</i>), Yellow Box (<i>E. melliodora</i>), and Cabbage Gum (<i>E. amplifolia</i>) were also recorded infrequently within this community on some sites. A sparse shrub layer included <i>Acacia decurrens</i> , <i>Acacia parramattensis</i> , and <i>Cassinia</i> spp., with a groundlayer of grasses and herbs including <i>Microlaena stipoides</i> , <i>Aristida warburgii</i> , <i>Austrodanthonia</i> spp., <i>Goodenia hederacea</i> , and <i>Lomandra filiformis</i> .	This community has a localised distribution along the proposed pipeline route, occurring on hills and flats within the Marulan and Towrang areas. This community was in a moderate to good condition with low weed invasion.	Part of Southern Highlands Shale Woodlands (SHSW) in Sydney Basin Bioregion
Inland Scribbly Gum - Brittle Gum low woodland of the eastern tablelands, South Eastern Highlands.	This community occurs in various canopy compositions from mono-specific stands of Inland Scribbly Gum (<i>E. rossii</i>) to co-dominated stands containing Inland Scribbly Gum (<i>E. rossii</i>), Brittle Gum (<i>E. mannifera</i>), Argyle Apple (<i>E. cinerea</i>) and Broad-leaved Peppermint (<i>Eucalyptus dives</i>). Understorey species included sparse occurrences of <i>Allocasuarina littoralis</i> , <i>Persoonia linearis</i> , <i>Banksia spinulosa</i> , <i>Dillwynia sieberi</i> , <i>Leptospermum trinervium</i> , <i>Lomandra</i> spp., <i>Leucopogon</i> spp., and <i>Xanthorrhoea</i> spp. Dominant groundcover species included <i>Caustis recurvexa</i> , <i>Lomandra</i> spp., <i>Dianella revoluta</i> , and <i>Pomax umbellata</i> .	This community occurs on shallow sandy loam soils typically on exposed crests and slopes. This community was generally in a good condition along the pipeline route with little to no weed invasion present; however some stands showed signs of disturbance through grazing and lacked an understorey. This community was widely distributed between the Paddy's River and Goulburn – Murray's Flat sections of the pipeline route.	No



Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands	This community was dominated by Narrow-leaved Peppermint (<i>E. radiata</i>), Brown Barrel (<i>E. fastigata</i>), River Peppermint (<i>E. elata</i>) and White Stringybark (<i>E. globoidea</i>) with a highly modified understorey. Shrub layer was absent due to grazing and clearing. The groundlayer contained a mix of introduced and native grasses, exotic weeds and was in a highly modified and grazed state.	This community has a localised distribution along the pipeline, occurring on high basalt outcrops within the Moss Vale – Weraï area as small isolated stands of remnant vegetation, however does not occur within the proposed footprint of the pipeline route. This community was in a moderate to low condition and was exposed to grazing and clearing.	Part of Robertson Basalt Tall Open-forest (RBTO) in Sydney Basin Bioregion
Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest of the tablelands of the South Eastern Highlands.	This community occurs as mono-specific stands of Red Stringybark (<i>E. macrorhyncha</i>) with occasional occurrences of Yellow Box (<i>E. melliodora</i>) or as mixed stands of Inland Scribbly Gum (<i>E. rossii</i>), Red Stringybark (<i>E. macrorhyncha</i>), Brittle Gum (<i>E. mannifera</i>), and Blue-leaved Stringybark (<i>E. agglomerata</i>) with infrequent occurrences of Sydney Peppermint (<i>E. piperita</i>), Blakely's Red Gum (<i>E. blakelyi</i>) and Cabbage Gum (<i>E. amplifolia</i>) in some areas. The understorey is open with a varied shrub layer including <i>Acacia decurrens</i> , <i>Cassinia</i> spp., and <i>Podolobium ilicifolium</i> . The groundcover is sparse and dominated by a mixture of native grasses and herbs including <i>Dianella revoluta</i> , <i>Patersonia sericea</i> , <i>Austrodanthonia</i> spp., <i>Einadia nutans</i> , <i>Austrostipa</i> spp., <i>Lomandra filiformis</i> , and <i>Cheilanthes sieberi</i> .	This community occurred on low undulating rises as well as upper slopes and ridge crests and was in moderate to good condition, with some weed invasion in smaller patches. This community was not widespread and occurred primarily within the Towrang area of the proposed pipeline route.	No



Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Ribbon Gum - Narrow-leaved Peppermint grassy open forest on basalt plateaux of the Sydney Basin and South Eastern Highlands.	This community occurs as tall woodland or forest community dominated by Ribbon Gum (<i>Eucalyptus viminalis</i>) and/ or Narrow-leaved Peppermint (<i>E. radiata</i>), with a sub or co dominant occurrence of Cabbage Gum (<i>E. amplifolia</i>) in areas. Understorey was varied and ranged from sparse to localised dense occurrences of <i>Allocasuarina littoralis</i> , <i>Bursaria spinosa</i> , <i>Acacia decurrens</i> , and <i>Rubus parviflorus</i> , with a groundcover dominated by litter with occasional occurrences of <i>Themeda australis</i> , <i>Goodenia hederacea</i> , <i>Lomandra filiformis</i> , <i>Microlaena stipoides</i> , <i>Austrodanthonia spp.</i> , <i>Einadia hastata</i> , and <i>Pteridium esculentum</i> .	This community occurred in valleys and along low-lying drainage areas in the Sutton Forest – Exeter area of the proposed pipeline route and was not wide spread. This community was in a degraded condition, being subject to heavy grazing, underscrubbing, and drought with weeds present in the understorey.	Part of Southern Highlands Shale Woodlands (SHSW) in Sydney Basin Bioregion
River Peppermint - Narrow-leaved Peppermint open forest on sheltered escarpment slopes, Sydney Basin and South East Corner	This community was dominated by River Peppermint (<i>E. elata</i>), Narrow-leaved Peppermint (<i>E. radiata</i>) and Camden Woollybutt (<i>E. macarthurii</i>), with Blue-leaved Stringybark (<i>E. agglomerata</i>) and Ribbon Gum (<i>E. viminalis</i>) also occurring. A subcanopy was often present and included tall scattered <i>Acacia decurrens</i> and <i>Acacia falciformis</i> . The shrub layer was localised in wetter areas and included dense patches of <i>Leptospermum polygalifolium</i> , with <i>Cassinia spp.</i> and <i>Indigofera australis</i> also common. The groundlayer was dense and diverse and included <i>Pteridium esculentum</i> , <i>Lomandra longifolia</i> , <i>Rubus parvifolius</i> , <i>Clematis aristata</i> , and <i>Microlaena stipoides</i> .	This community occurred as gully forest within the Paddy's River areas and on open undulating plains and low lying regions in the Glenquarry and Weraí – Moss Vale areas.	Part of Southern Highlands Shale Woodlands (SHWS) in Sydney Basin Bioregion



Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges of the north east South Eastern Highlands.	This community was dominated by Silvertop Ash (<i>E. sieberi</i>) and Blue-leaved Stringybark (<i>E. agglomerata</i>) with Inland Scribbly Gum (<i>E. rossii</i>), White Stringybark (<i>E. globoidea</i>), and Brittle Gum (<i>E. mannifera</i>) occurring in varying densities across the extent of this community. The understorey varied from open to dense and included a variety of species including <i>Persoonia linearis</i> , <i>Allocasuarina littoralis</i> , <i>Platylobium ilicifolium</i> , <i>Cassinia</i> spp., <i>Acacia</i> spp., <i>Leptospermum</i> spp., and <i>Exocarpos cupressiformis</i> . Groundcover species occurred at a moderate density and included <i>Dianella revoluta</i> , <i>Pomax umbellata</i> , <i>Austrodanthonia</i> spp., <i>Lomandra</i> spp., <i>Goodenia hederacea</i> , <i>Microlaena stipoides</i> , <i>Pteridium esculentum</i> and <i>Pattersonia</i> spp.	This community occurs primarily on ridges and dry slopes along the Paddy's River, Marula and Towrang sections of the pipeline route, and largely occurred as larger remnant stands with some smaller isolated stands occurring in agricultural lands. This community showed little signs of weed invasion and was in a moderate to good condition across its extent.	No
Swamp Gum - Ribbon Gum woodland on poorly-drained flats of the South Eastern Highlands.	This community was dominated by Ribbon Gum (<i>E. viminalis</i>) and/or Snow Gum (<i>E. pauciflora</i>), with Swamp Gum (<i>E. ovata</i>), Narrow-leaved Peppermint (<i>E. radiata</i>), and Inland Scribbly Gum (<i>E. rossii</i>) also occurring. The understorey consisted of introduced species including Sweet Briar (<i>Rosa rubignosa</i>) and Blackberry (<i>Rubus fruticosus</i>) with Spear Thistle (<i>Cirsium vulgare</i>), <i>Vulpea bromoides</i> , <i>Hypochaeris radicata</i> and other exotic grasses dominating the groundcover. Native species including <i>Lomandra longifolia</i> , <i>Dichondra repens</i> and <i>Einadia nutans</i> also occurred in lower frequencies.	This community occurred along sections of Uringalla Creek in the Paddy's River section of the pipeline route as well as along roadside in the Glenquarry – Werai-Moss Vale area. It occurred as a highly cleared community with invasion of introduced grasses and weeds from adjacent areas of agricultural land.	Part of Southern Highlands Shale Woodlands (SHSW) in Sydney Basin Bioregion



Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Sydney Peppermint – Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin (DECCW 2010)	This community was dominated by Sydney Peppermint (<i>E. piperita</i>) with Silvertop Ash (<i>E. sieberi</i>), Narrow-leaved Peppermint (<i>E. radiata</i>) and White Stringybark (<i>E. globoidea</i>) also occurring. The understorey included a diversity of shrubs including <i>Allocasuarina littoralis</i> , <i>Acacia longifolia</i> , <i>Petrophile peduncularis</i> , <i>Persoonia</i> spp., <i>Bossiaea obcordata</i> , and <i>Podolobium ilicifolium</i> . The groundlayer contained a diverse suite of grasses and herbs including <i>Caustis recurvexa</i> , <i>Pteridium exculentum</i> , <i>Lomandra</i> spp., <i>Entolasia marginata</i> , <i>Pomax umbellata</i> , and <i>Goodenia hederacea</i> .	This community occurred on undulating terrain as larger remnant patches along the Paddys River section of the proposed pipeline route, and was in a moderate to good condition with little to no weed invasion in most areas.	Part of Southern Highlands Shale Woodlands (SHSW) in Sydney Basin Bioregion
Degraded Riparian Creeklines	This community included riparian vegetation dominated by <i>Acacia</i> spp., scattered <i>Eucalyptus</i> spp., and weed trees including Willow (<i>Salix</i> spp.) and White Poplar (<i>Populus alba</i>). Some areas also contained small stands of <i>Leptospermum</i> spp., with <i>Lomandra longifolia</i> and introduced weeds also occurring. In-stream aquatic vegetation included <i>Typha orientalis</i> , <i>Phragmites australis</i> , <i>Schoenoplectus validus</i> , <i>Juncus usitatus</i> , <i>Juncus continuous</i> , <i>Eleocharis</i> spp., and <i>Carex appressa</i> occurring in areas of standing water.	This community occurred along creeklines and rivers often exposed to grazing and/or heavy clearing along the pipeline route. This community ranged in condition depending on disturbance levels, and contained varying levels of weed species.	No
Disturbed Agricultural and Grazing Land	This community included a range of modified or disturbed agricultural and grazing land and was comprised of primarily introduced species including pasture grasses and weeds, with isolated remnant trees occurring throughout. These areas had a variable component of native grasses, herbs and shrubs present depending on disturbance levels, seasonal variations, and stocking rates, though most areas were heavily grazed and showed low abundances of native species present.	Disturbed Agricultural and Grazing Land dominates the Glenquarry, Moss Vale – Werai, Sutton Forest – Exeter, and Murray’s Flat – Goulburn sections of the proposed pipeline route. These areas contained a high level of introduced weeds with some areas containing dense stands of Serrated Tussock grass (<i>Nasella trichotoma</i>), a declared noxious weed for the Goulburn – Mulwarree LGA.	No, although may contain isolated trees or small remnant stands that constitute part of an EEC.



Vegetation Community	Description of Vegetation	Landscape position and condition	EEC Status
Freshwater Swamps	This community included areas dominated by native sedges occurring in standing swamp areas. Canopy and shrub layers were generally absent, with dense stands of sedges and rushes including <i>Scheonoplectus validus</i> , <i>Typha domingoensis</i> , <i>Juncus usitatus</i> , <i>Centella spp.</i> , <i>Cyperus spp.</i> , <i>Eleocharis spp.</i> , and <i>Carex appressa</i> . Weed species including <i>Paspalum dilatatum</i> and <i>Phalaris aquatica</i> occurred along drier edges abutting adjacent grassland areas.	This community occurred in low lying areas adjacent to creeks or rivers with areas of permanent standing water within the Murray's Flat – Goulburn area. Weed encroachment occurred along edges.	No
Planted / Exotic Vegetation	Included planted stands of <i>Pinus Radiata</i> and other introduced trees, as well as planted native species along roadways. Shrub and ground layers were usually absent or containing introduced weeds.	Occurred along fence lines, as windbreaks in paddocks, stock shelter belts, plantation forests, and along roadways.	No
Acacia regrowth	Included stands dominated by regrowth Acacia's including <i>A. melanoxylon</i> , <i>A. mearnsii</i> , <i>A. decurrens</i> , and <i>A. parramattensis</i> . Canopy layer was usually absent, or represented by isolated native or exotic tree species. Groundlayer included a mixture of introduced and native grasses, with a high level of exotic weeds present.	Acacia regrowth occurred primarily along roadsides and disturbed creeklines particularly in the eastern end of the proposed pipeline route.	No



Table 12 Mapped Area of Vegetation Communities Recorded within the 400m Survey Corridor (for Raw and Treated Water Pipeline Options)

Vegetation Community	Conservation Status	400m Corridor (ha) (Treated)	400m Corridor (ha) (Raw)
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills of the South Eastern Highlands	EEC (SHSW)	83.65	83.65
Inland Scribbly Gum - Brittle Gum low woodland of the eastern tablelands, South Eastern Highlands		140.54	101.63
Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands	EEC (RBTO)	0.49	0.49
Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest of the tablelands of the South Eastern Highlands		43.11	43.11
Ribbon Gum - Narrow-leaved Peppermint grassy open forest on basalt plateaux of the Sydney Basin and South Eastern Highlands	EEC (SHSW)	12.68	12.68
River Peppermint - Narrow-leaved Peppermint open forest on sheltered escarpment slopes, Sydney Basin and South East Corner	EEC (SHSW)	83.34	83.34
Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges of the north east South Eastern Highlands		230.72	230.72
Swamp Gum - Ribbon Gum woodland on poorly-drained flats of the South Eastern Highlands	EEC (SHSW)	4.99	4.99
Sydney Peppermint – Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin	EEC (SHSW)	129.37	129.37
Degraded Riparian Creeklines		5.88	11.69
Freshwater Swamps (sedgelands?)		0.48	0.63
Disturbed Agricultural and Grazing Land		1638.13	1957.61
Planted / Exotic Vegetation		22.86	22.86
Acacia regrowth		3.34	3.34
Mixed Dwelling/Patchy Vegetation		530.45	550.23
	Total	2399.59	2686.12



Table 13 Extent of Mapped Vegetation Communities within 400m Survey Corridor (by Sector)

Vegetation Community	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
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills of the South Eastern Highlands.	0.00	0.00	0.00	6.66	76.99	0.00	0.00	0.00	83.65	83.65
Inland Scribbly Gum - Brittle Gum low woodland of the eastern tablelands, South Eastern Highlands.	0.00	0.00	0.00	53.73	0.00	34.14	52.68	0.20	140.54	88.06
Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.49
Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest of the tablelands of the South Eastern Highlands.	0.00	0.00	0.00	0.00	0.00	43.11	0.00	0.00	43.11	43.11
Ribbon Gum - Narrow-leaved Peppermint grassy open forest on basalt plateaux of the Sydney Basin and South Eastern Highlands.	0.00	0.00	2.09	3.69	6.90	0.00	0.00	0.00	12.68	12.68
River Peppermint - Narrow-leaved Peppermint open forest on sheltered escarpment slopes, Sydney Basin and South East Corner	32.27	1.66	28.59	4.53	16.28	0.00	0.00	0.00	83.34	83.34
Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges of the north east South Eastern Highlands.	0.00	0.00	0.00	99.07	95.61	36.04	0.00	0.00	230.72	230.72
Swamp Gum - Ribbon Gum woodland on poorly-drained flats of the South Eastern Highlands.	0.00	1.80	0.00	1.36	1.83	0.00	0.00	0.00	4.99	4.99
Sydney Peppermint – Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin	0.00	0.00	0.00	129.37	0.00	0.00	0.00	0.00	129.37	129.37
Degraded Riparian Creekline and Aquatic Vegetation	0.00	1.52	0.00	1.58	0.00	2.79	0.00	5.81	5.88	11.69
Disturbed Agricultural and Grazing Land	247.33	243.96	432.52	105.51	117.77	359.14	0.00	0.60	1506.23	1506.83
Freshwater Sedgelands	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.48	0.50
Planted / Exotic Vegetation	2.63	0.46	1.31	8.35	8.08	2.04	0.00	0.00	22.86	22.86
Mixed Dwelling/Patchy Vegetation	19.60	4.77	33.24	117.66	196.51	150.12	9.04	0.12	530.94	522.03
Acacia regrowth	0.00	1.05	1.43	0.00	0.00	0.86	0.00	0.00	3.34	3.34



7.1.3 Threatened Flora Species

The desktop literature review indicates 47 threatened plant species that have been previously recorded or are predicted to occur within the survey corridor (see Appendix D) with 27 threatened plant species considered to have the potential to occur in the habitats present within the proposed corridor. These species are presented in Section 6.4.1.

Two threatened flora species were recorded during the field investigations for this assessment:

- ▶ Camden Woollybutt (*Eucalyptus macarthurii*); and
- ▶ Hoary Sunray (*Leucochrysum albicans* var. *tricolor*)

Camden Woollybutt (*Eucalyptus macarthurii*)

Camden Woollybutt (*Eucalyptus macarthurii*) listed as a vulnerable species under the NSW TSC Act, was recorded at a number of locations during targeted flora surveys. This species occurred as a component of the River Peppermint - Narrow-leaved Peppermint open forest vegetation community.

Camden Woollybutt occurred from the start of the proposed pipeline route at Glenquarry through to Paddys River, with the largest populations occurring in the Paddys River, Moss Vale-Werai and Glenquarry areas.

Approximately 310 individuals of Camden Woollybutt were recorded as occurring within the survey corridor and associated access tracks (Paddy's River population) of the proposed pipeline. Individuals ranged from coppicing juveniles occurring along the edge of the existing easement and small access track, through to large mature trees. The population recorded along the Paddy's River section of the pipeline within a large tract of remnant vegetation, contained a wide variety of sizes and age classes and showed healthy signs of regeneration. Other stands occurring along the Illawarra Highway and Iona Park Road were primarily isolated individuals or small degraded stands of semi mature and mature trees, with only the Illawarra Highway population showing signs of recruitment. More individuals of this species may occur in areas of vegetation not surveyed due to access restrictions, particularly within the Glenquarry and Werai – Moss Vale areas; however this species is anticipated to occur in relatively low densities in these areas if it is present.

Hoary Sunray (*Leucochrysum albicans* var. *tricolor*)

Hoary Sunray (*Leucochrysum albicans* var. *tricolor*) listed as endangered under the EPBC Act, was recorded on the edge of Inland Scribbly Gum – Brittle Gum low woodland vegetation. A small number of individuals were recorded within vegetation occurring 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 pipeline construction corridor at this location, and was not recorded at any other site along the proposed pipeline route.

No other threatened species were recorded during targeted surveys; however suitable habitat for a number of listed species does occur within sections of the proposed route containing intact remnant vegetation, riparian and swampy areas and some areas of grassland not exposed to on-going disturbance such as grazing, clearing or heavy weed infestation.

Potential impacts on these species have been discussed further in Section 8 of this report.

7.1.4 Endangered Ecological Communities

Three endangered ecological communities (EEC's) were recorded during the field surveys, as follows:

- ▶ Southern Highlands Shale Woodlands, listed as endangered under the TSC Act, was the only EEC recorded in the survey corridor and within the proposed construction corridor;
- ▶ Robertson Basalt Tall Open-forest, also listed as endangered under the TSC Act, was recorded immediately adjacent to the survey corridor, but did not occur within the survey or construction corridors; and
- ▶ White Box Yellow Box Blakely's Red Gum Woodland, listed as endangered under the TSC Act and critically endangered under the EPBC Act, was recorded within the Marulan area outside of the survey corridor.

The mapped extents of these communities within the survey corridor are shown in Figure 4 and summarised in Table 14.

Table 14 Area of EEC mapped within 400m survey corridor (in hectares)

Area of Proposed Pipeline Route	EEC	Mapped Area of EEC within 400m corridor
Glenquarry	Southern Highlands Shale Woodlands	32.27
Weraï – Moss Vale	Southern Highlands Shale Woodlands	3.46
	Robertson basalt Tall Open-forest	0.49
Sutton Forest – Exeter	Southern Highlands Shale Woodlands	30.69
Paddy's River	Southern Highlands Shale Woodlands	145.60
Marulan	Southern Highlands Shale Woodlands	102.00
Towrang	Southern Highlands Shale Woodlands	0
Goulburn – Murray's Flat (Treated)	Southern Highlands Shale Woodlands	0
Goulburn – Murray's Flat (Raw)	Southern Highlands Shale Woodlands	0
Total (Treated)		314.51
Total (Raw)		314.51

Southern Highlands Shale Woodlands in the Sydney Basin Bioregion

Southern Highlands Shale Woodlands (SHSW) was the most extensive EEC within the survey corridor in a widespread distribution from the Glenquarry - Marulan area.

The majority of this EEC occurred as small stands of remnant vegetation of varying condition within the Glenquarry and Sutton – Exeter areas in grazing and agricultural land subject to edge effects, stock trampling, clearing, rubbish dumping, and weed invasion. Large stands exist within the Paddy's River and Marulan sectors within broader stands of native vegetation and are in moderate to good condition, with little to no grazing, clearing or weed invasion present in most stands.



The vegetation communities occurring within the proposed pipeline corridor that form a component of this EEC are listed in Table 15.

Table 15 SHSW EEC vegetation types recorded and mapped within the survey corridor

Vegetation Community	Area mapped in GIS (ha)	% Cleared in CMA*
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills of the South Eastern Highlands	83.65	80
Ribbon Gum - Narrow-leaved Peppermint grassy open forest on basalt plateaux of the Sydney Basin and South Eastern Highlands	12.68	95
River Peppermint - Narrow-leaved Peppermint open forest on sheltered escarpment slopes, Sydney Basin and South East Corner	83.34	10
Swamp Gum - Ribbon Gum woodland on poorly-drained flats of the South Eastern Highlands	4.99	80
Sydney Peppermint – Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin	129.37	20
Total	314.03	

* Extent of vegetation community that has been cleared within the Hawkesbury Nepean Catchment (DECCW 2010)

Approximately 314.03 ha of Southern Highlands Shale Woodland EEC occurs within the survey corridor, with an estimated 4.32 ha to be removed within the construction corridor for the proposed pipeline. An assessment on the impacts of the proposed pipeline on this EEC can be found in Appendix G and is discussed in Section 8.5.3 of this report.

All vegetation communities with current cleared community estimates of greater than 70% (DECCW 2010) and therefore high conservation significance occur within this EEC type and therefore have not been assessed separately.

Robertson Basalt Tall Open-forest (RBTO) in the Sydney Basin Bioregion

The RBTO EEC was recorded as two small isolated stands within the Werai - Moss Vale area in vegetation occurring adjacent to the survey corridor. These stands were in moderate to low condition with little to no understorey present, high weed invasion, and subject to regular grazing and clearing of the understorey.

The vegetation community that constitutes a component of this EEC occurring within close proximity to the proposed pipeline corridor is listed in Table 16. This EEC had a highly localised distribution and was not found to occur in any areas of vegetation to be impacted by the proposed pipeline route.



Table 16 RBTO EEC Vegetation Types Recorded and Mapped within the Survey Corridor

Vegetation Community	Area mapped in GIS (ha)	% Cleared in CMA* Estimate rounded to nearest 5%
Narrow-leaved Peppermint - Mountain Gum - Brown Barrel moist open forest on high altitude ranges, northern South Eastern Highlands	0.49	30

* Extent of vegetation community that has been cleared within the Hawkesbury Nepean Catchment (DECCW 2010)

White Box Yellow Box Blakely's Red Gum Woodland

Stands of vegetation that qualify as White Box Yellow Box Blakely's Red Gum Woodland EEC ('Box Gum Woodland') were observed within the Marulan area, several kilometres outside of the survey corridor. As this vegetation is not part of the survey corridor and will not be affected (directly or indirectly) by the Project, it is not considered in the assessment of impacts on EECs in this report.

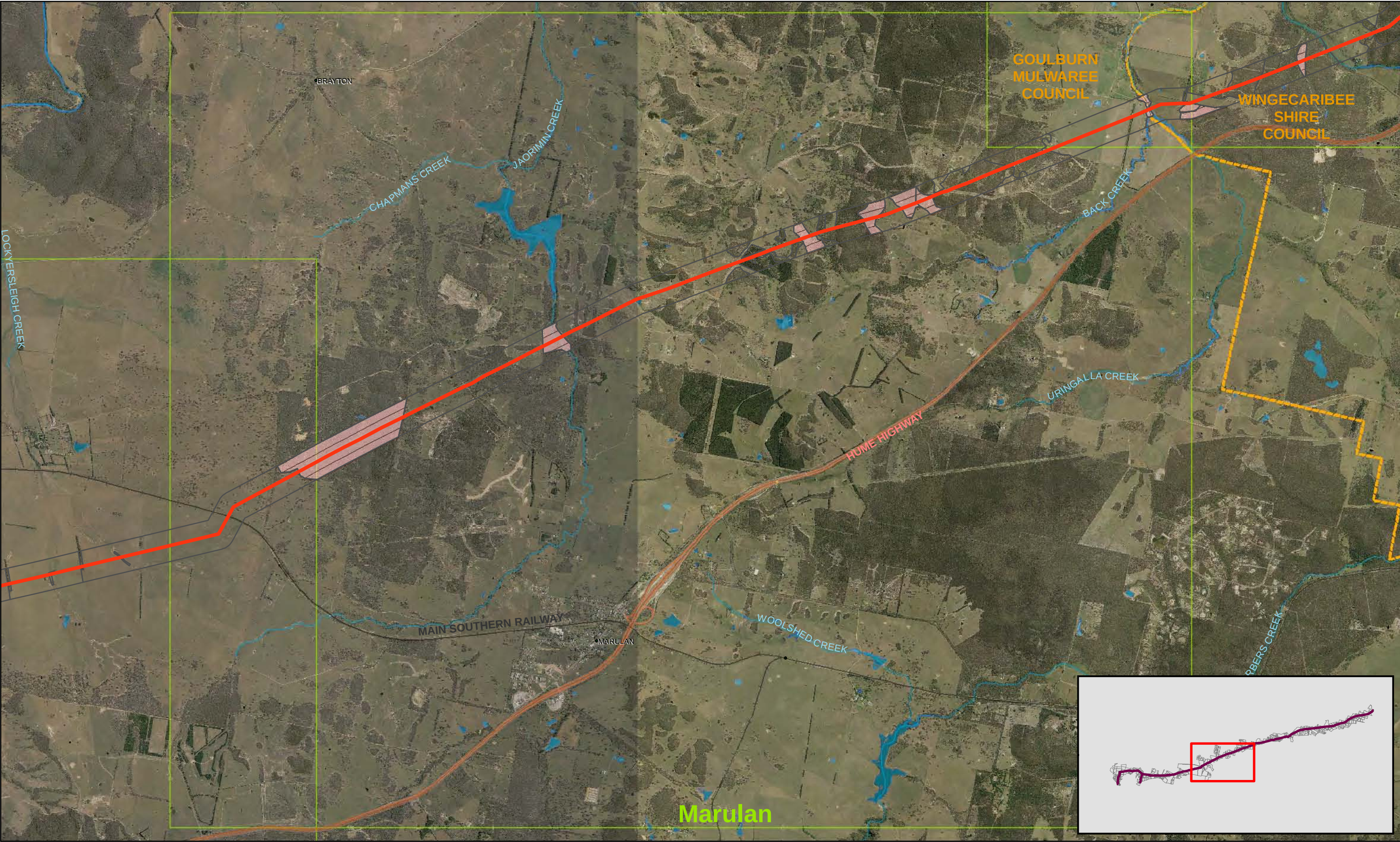
Additionally, some stands of vegetation within the survey corridor contain scattered individuals of Blakely's Red Gum (*Eucalyptus blakelyi*) and/or Yellow Box (*Eucalyptus melliodora*), which are both indicator species for Box Gum Woodland. However, these species are minor elements of the canopy stratum of the communities within which they were recorded; they are neither dominant nor co-dominant species within these communities or stands of vegetation. As such, stands of vegetation within the survey corridor do not constitute the Box Gum Woodland EEC.

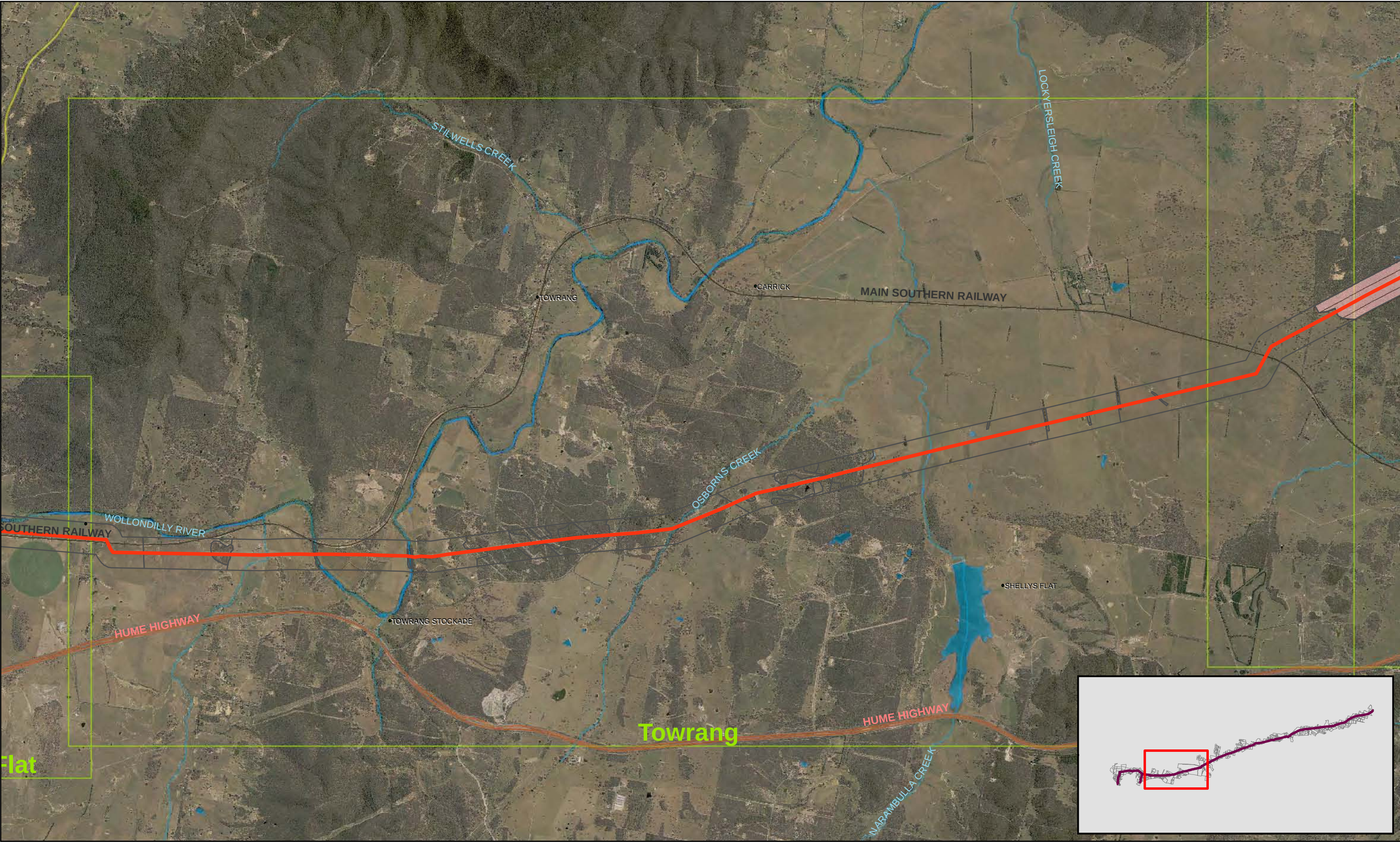
Hence, the Box Gum Woodland EEC was not recorded within the survey corridor. Moreover, it is considered unlikely that Box Gum Woodland occurs within the unsurveyed parts of the survey corridor based on habitat characteristics.

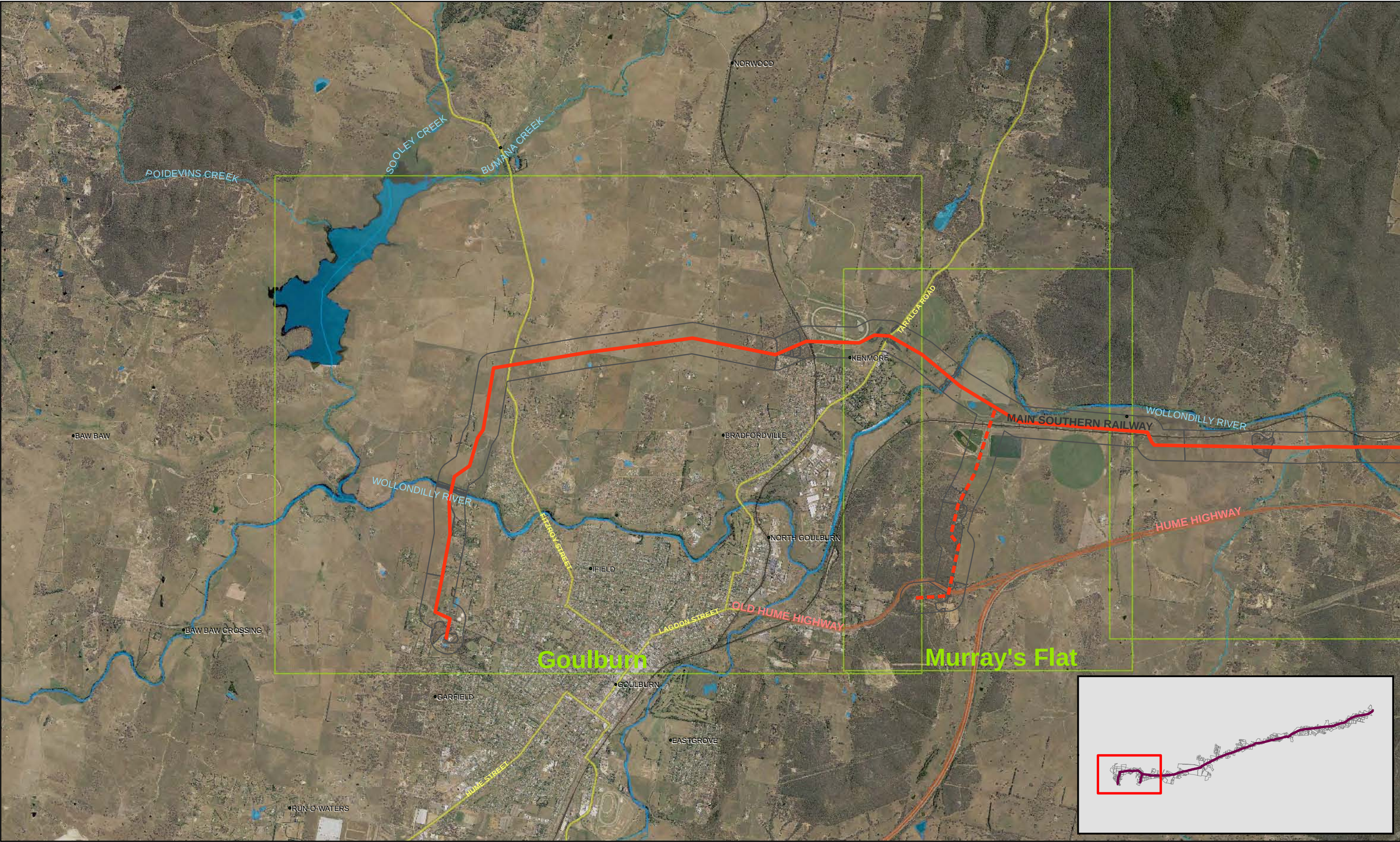












7.1.5 Noxious Weeds

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds in local government areas. Landowners and occupiers must control noxious weeds according to the control category specified in the Act. Public authorities must control noxious weeds according to the control category to the extent necessary to prevent their spread to adjoining land.

Twelve noxious weeds in the Goulburn-Mulwaree LGA were recorded as occurring within the survey corridors during surveys (Table 17). These species were scattered throughout the survey corridor, with some areas containing higher density than others. Blackberry and Willow were particularly prominent along creeks and rivers, with other weeds such as Paterson's Curse, St John's Wort and Fireweed occurring predominately as pastoral weeds or along the existing easement. The most common and widespread noxious weed found within the survey corridor was Serrated Tussock, which was found invading native bushland edges from surrounding paddocks and along the existing easement.

Small isolated and disturbed stands of native bushland subject to livestock grazing and regular disturbance were the most susceptible to invasion by noxious weeds from adjacent open pasture areas.

Table 17 Noxious weeds declared in the Goulburn – Mulwaree LGA recorded in the survey corridor

Common name	Scientific name	Control category*
African boxthorn	<i>Lycium ferocissimum</i>	4
African lovegrass	<i>Eragrostis curvula</i>	4
Blackberry	<i>Rubus fruticosus</i>	4
Fireweed	<i>Senecio madagascarensis</i>	4
Lantana	<i>Lantana species</i>	4
Paterson's curse	<i>Echium plantagineum</i>	4
Prickly pear	<i>Opuntia species</i>	4
Scotch thistle	<i>Onopordum species</i>	4
Serrated tussock	<i>Nasella trichotoma</i>	4
St John's Wort	<i>Hypericum perforatum</i>	3
Sweet briar	<i>Rosa rubiginosa</i>	4
Willows	<i>Salix species</i>	5

*Category 3: 'the plant must be fully and continuously suppressed and destroyed'.

Category 4: 'the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority'.

Category 5: 'the requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with'.