APPENDIX B

ASSESSMENT UNDER THE EPBC ACT

Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The removal of 4.78 ha of native vegetation along 26 km of amended pipeline is required and this vegetation may provide habitat for some species listed under the EPBC Act and some adjacent areas have the potential to support a number of species listed under the EPBC Act. The criteria detailed in the *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines: Matters of National Environmental Significance* (DEH 2006) were used to assess the significance of likely impacts as a consequence of the proposed pipeline and this assessment is detailed below.

Significant Impact Criteria for Endangered Species

Endangered species assessed include:

- Eastern Australian Underground Orchid (*Rhizanthella slateri)*;
- Guthrie's Grevillea (*Grevillea guthrieana)*;
- Regent Honeyeater (*Xanthomyza phrygia*);
- Swift Parrot (*Lathamus discolor*); and
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;

  The Stage 1 GFDA extension consists predominantly of agricultural pastures and the well sites within this area will all be placed within existing cleared land and consequently few direct impacts are expected. Indirect impacts during construction and operation are most likely to also be minimal. However, impacts associated with increased vehicle movements and disturbance are possible.

  The 26 km amended pipeline route has been chosen to avoid areas of intact biodiversity that are most likely to provide habitat for threatened species. There would be a 4.78 ha of remnant / regrowth vegetation removed over the amended pipeline route and some of this could provide habitat for endangered species in the form of small winter flowering trees and habitat, such as fallen logs. However, impacts are unlikely to be substantial given the available surrounding habitat and consequently it is considered that there is unlikely to be a real chance or possibility that this proposal would decrease the size of a population of any of these species.

- Reduce the area of occupancy of the species;

  Around 4.78 ha of potential habitat would be removed. However, high quality resources for these species are available in the adjacent national parks, state forests and other areas of intact vegetation. Therefore, this proposal is unlikely to have a real chance or possibility of reducing the area of occupancy of these species to such an extent as to impact on any endangered species.

- Fragment an existing population into two or more populations;

  The GFDA is located within paddocks and the majority of the proposed amended pipeline route traverses introduced pastures through long established agricultural lands and consequently the locality is currently heavily fragmented. It is unlikely that this proposal would fragment an existing important population into two or more populations as the pipeline trench would be backfilled and only a relatively small amount of vegetation would be cleared and consequently there would be few barriers to movement.

- Adversely affect habitat critical to the survival of a species;

  Habitat has not been identified as critical habitat within the recovery plan for these species or listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEWHA 2009).

- Disrupt the breeding cycle of a population;

  Disruption of the breeding cycle of a population is not anticipated as movement corridors are unlikely to be disrupted within the locality and breeding habitat of any species is unlikely to be substantially altered.

- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

  The proposed Stage 1 GFDA extension and amended pipeline route has largely been chosen to avoid areas of intact biodiversity that are most likely to provide habitat for endangered species. There would be a relatively small amount (4.78 ha along a 26 km linear pipeline) of potential habitat removed for any of these species and this would include removal of eucalypt woodlands and forests along the edges of already cleared vegetation. However, a decrease in the quality of the habitat available along the pipeline route is unlikely to be substantial given the current highly modified nature of the proposed route.

- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

  The nature of the proposal is such that it is possible that weed species could further spread or invade along the cleared ROW or within the GFDA and this could over time further degrade habitat. Consequently, it is recommended that weed management be addressed in the Construction Environmental Management Plan and Operational Environmental Management Plan so as to minimise the risk of invasive species establishment.

- Introduce disease that may cause the species to decline; or

  Disease has not been identified as a threat to any of these endangered species and this proposal is unlikely to introduce or spread disease through these species.

- Interfere with the recovery of the species.

  There are no key habitat sites that would be disrupted by this proposal and consequently it is unlikely to interfere with the recovery of the species.

Conclusion

It is unlikely that any endangered species listed under the EPBC Act would be significantly impacted by this proposal as:

- The additional GFDA and proposed well sites have been chosen to avoid areas of intact native vegetation;
- The pipeline route was selected to, where possible, avoid areas of biodiversity which would be likely to provide habitat for endangered species; and
- Potential impacts could be managed and mitigated.

Significant Impact Criteria for Vulnerable Species

Vulnerable species assessed include:

- Trailing Woodruff (*Asperula asthenes*);
- Leafless Tongue Orchid (Cryptostylis hunteriana);
- Slaty Red Gum (*Eucalyptus glaucina*);
- Tall Knotweed *(Persicaria elatior*);
- Black-eyed Susan *(Tetratheca juncea)*;
- Green and Golden Bell Frog (*Litoria aurea*);
- Long-nosed Potoroo (*Potorous tridactylus tridactylusis)*;
- Grey-headed Flying-fox (*Pteropus poliocephalus*); and
- Large-eared Pied Bat (*Chalinolobus dwyeri*).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species;
- The Stage 1 GFDA extension consists predominantly of agricultural pastures and the well sites within this area will all be placed within existing cleared land and consequently few direct impacts are expected. Indirect impacts during construction and operation are most likely to also be minimal. However, impacts associated with increased vehicle movements and disturbance are possible.

  The amended pipeline route has been chosen to avoid areas of intact biodiversity that are most likely to provide habitat for threatened species. Additionally, the nature of the proposal is such that all activities would be undertaken within a 30 m ROW with many of the current levels of habitat restored on completion of laying of the pipeline. Consequently, it is unlikely that this proposal would lead to a long-term decrease in the size of an important population of a species.

- Reduce the area of occupancy of an important population;

  This proposal requires the construction of a 25 - 30 m ROW along the amended pipeline route the majority of which traverses introduced pastures but also some woodland and forested areas. On completion of laying of the pipeline, the pipeline trench would be backfilled and the current level of habitat restored in the paddock areas. Clearing within areas of native vegetation would be minimised where possible especially where hollow-bearing trees and creeklines occur. Therefore, it is unlikely that this proposal would substantially reduce the area of occupancy of an important population.

- Fragment an existing important population into two or more populations;

  The majority of the proposed pipeline route traverses introduced pastures through long established agricultural lands and consequently the locality is currently heavily fragmented. It is unlikely that this proposal would further substantially fragment an existing important population into two or more populations but clearing would be minimised where possible to reduce risk of this occurring.

- Adversely affect habitat critical to the survival of a species;

  Habitat has not been identified as critical habitat within the recovery plan for these species or listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEWHA 2009).

- Disrupt the breeding cycle of an important population;

  Disruption of the breeding cycle of an important population is not anticipated as movement corridors are unlikely to be substantially disrupted within the locality and the breeding habitat of species is unlikely to be substantially altered.

- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

  The proposed pipeline route has been chosen to avoid areas of intact biodiversity that are most likely to provide habitat for threatened species. However, this proposal does require clearing of around 4.78 ha of native vegetation in a 25 – 30 ROW although this mostly occurs along the edges of already fragmented habitat. Higher quality habitat is available within the locality. Consequently, it is unlikely that this proposal would lead to a reduction in quality of habitat to the extent that a species is likely to decline.

- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

  The nature of the proposal is such that it is possible that weed species could further spread or invade along the cleared ROW. Consequently, it is recommended that weed management be addressed in the Construction Environmental Management Plan and Operational Environmental Management Plan.

- Introduce disease that may cause the species to decline; or

  The fungal pathogen, Frog Chytrid Fungus, is a known threat to amphibians. Chytrid fungus is probably transferred by direct contact between frogs and tadpoles, or through exposure to infected water. This proposal would not involve the moving of frogs or tadpoles, exposing frogs to infected water or handling of frogs in any way.

- Interfere substantially with the recovery of the species.

  It is unlikely that this proposal would interfere substantially with the recovery of any species as the proposed development traverses modified landscapes and any disruption to species is likely to be relatively minor.

Conclusion

It is unlikely that any vulnerable species listed under the EPBC Act would be significantly impacted by this proposal as:

- The additional GFDA and proposed well sites have been chosen to avoid areas of intact native vegetation;
- The pipeline route was selected so as to avoid areas of biodiversity which would be likely to provide habitat for vulnerable species;
- Potential impacts could be managed and mitigated.

Significant Impact Criteria for Migratory Species

Species listed as migratory that were assessed:

- Painted Snipe (*Rostratula benghalensis*);
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);
- Great Egret (*Ardea alba*);
- Cattle Egret (Ardea ibis);
- Latham's Snipe (*Gallinago hardwickii*);
- Ruddy Turnstone (*Arenaria interpres*);
- Sharp-tailed Sandpiper (*Calidris acuminate*);
- Curlew Sandpiper (*Calidris ferruginea*);
- Pacific Golden Plover (*Pluvialis fulva*);
- Common Greenshank (*Tringa nebularia*);
- Bar-tailed Godwit (*Limosa lapponica*);
- Eastern Curlew (*Numenius madagascariensis*);
- Whimbrel (*Numenius phaeopus*);
- Fork-tailed Swift (*Apus pacificus*);
- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Black-faced Monarch (*Monarcha melanopsis*);
- Spectacled Monarch (*Monarcha trivirgatus*);
- Satin Flycatcher (*Myiagra cyanoleuca*);
- Rufous Fantail (*Rhipidura rufifrons*);

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;

  To avoid impacts on migratory and / or marine wader bird populations the proposed amended pipeline route, HDD would be used to pass under the major wader bird habitats of the Hunter River and the Tomago SEPP 14 Coastal Wetlands. Stringent environmental management regimes would also be implemented to protect these habitats against indirect impacts associated with construction and operation. Consequently, it is unlikely that this proposal would modify, destroy or isolate area of important habitat for migratory and / or marine wader bird populations.

- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or

  It is possible that this proposal could exacerbate existing weed invasions through disturbance. Consequently, it is recommended that weed management be addressed in the Construction Environmental Management Plan and Operational Environmental Management Plan so as to minimise the risk of invasive species establishment.

- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

  To avoid disruption to the lifecycle of migratory and / or marine wader bird populations the proposed amended pipeline route would use HDD to pass under the major wader bird habitats of the Hunter River and the Tomago SEPP 14 Coastal Wetlands. Stringent environmental management regimes would also be implemented to protect these habitats against indirect impacts associated with construction and operation. Consequently, it is unlikely that this proposal would modify, destroy or isolate area of important habitat for migratory and / or marine wader bird populations.

Conclusion

It is unlikely that any migratory species listed under the EPBC Act would be significantly impacted by the proposed pipeline route as:

- The construction of the amended pipeline route which has the potential to impact on habitat for these species would be horizontally directionally drilled so as to avoid direct impacts; and
- Potential impacts could be managed and mitigated.

APPENDIX C

ASSESSMENT OF SIGNIFICANCE
UNDER THE EP&A ACT

APPENDIX C

Assessment of Significance

Background

An assessment of the impacts of this proposal on species, populations and ecological communities listed under Schedules 1, 1A and 2 of the TSC Act was undertaken. Although the proposal would be assessed under Part 3A of the EP&A Act, Assessments of Significance were undertaken to determine the significance of impacts of the proposal on endangered ecological communities and populations, and threatened species listed on Schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act) as requested by the Department of Planning. Assessments have been undertaken for guilds of species which have similar habitat requirements. The Grey-crowned Babbler has been considered separately as this species was recorded during this assessment and this species has an extensive population at the eastern end of the project area around the GFDA.

Endangered Ecological Communities

- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions; and
- Swamp oak floodplain forest of the NSW North Coast; Sydney Basin and South East Corner bioregions.

Endangered Populations

- *Cymbidium canaliculatum* population in the Hunter Catchment; and
- *Rhizanthella slateri* population in the Great Lakes LGA.

Flora

- Trailing Woodruff (*Asperula asthenes*);
- Netted Bottle Brush (*Callistemon linearifolius)*;
- Leafless Tongue Orchid (*Cryptostylis hunteriana*);
- Slaty Red Gum (*Eucalyptus glaucina*);
- Guthrie's Grevillea (*Grevillea guthrieana*);
- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*);
- *Maundia triglochinoides*;
- Tall Knotweed *(Persicaria elatior*);
- Scant Pomaderris (*Pomaderris queenslandica)*;
- Eastern Australian Underground Orchid (*Rhizanthella slateri)*;
- Black-eyed Susan *(Tetratheca juncea)*; and
- *Zannichellia palustris.*

Amphibian

- Green and Golden Bell Frog (*Litoria aurea*).

Reptile

- Pale-headed Snake (*Hoplocephalus bitorquatus*).

Water-dependent Birds

- Magpie Goose (*Anseranas semipalmata*);
- Australasian Bittern (*Botaurus poiciloptilus*);
- Black-necked Stork (*Ephippiorhynchus asiaticus*);
- Black Bittern (*Ixobrychus flavicollis*); and
- Painted Snipe (*Rostratula benghalensis*).

Woodland Birds

- Bush Stone-curlew (*Burhinus grallarius)*;
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoria*);
- Barred Cuckoo-shrike (*Coracina lineata*);
- Swift Parrot (*Lathamus discolor*);
- Square-tailed Kite (*Lophoictinia isura*);
- Hooded Robin (*Melanodryas cucullata*);
- Black-chinned Honeyeater (*Melithreptus gularis gularis)*;
- Turquoise Parrot (*Neophema pulchella*);
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis)*;
- Speckled Warbler (*Pyrrholaemus saggitatus)*;
- Diamond Firetail (*Stagonopleura guttata*);
- Regent Honeyeater (*Xanthomyza phrygia*); and
- Glossy Black-cockatoo (*Calyptorhynchus lathami*).

Owls

- Grass Owl (*Tyto capensis*);
- Barking Owl (*Ninox connivens*);
- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

Arboreal Mammals

- Squirrel Glider (*Petaurus norfolcensis*);
- Eastern Pygmy-possum (*Cercartetus nanus*);
- Yellow-bellied Glider (*Petaurus australis*); and
- Koala (*Phascolarctos cinereus*).

Ground-dwelling Mammals

- Parma Wallaby (*Macropus parma*);
- Long-nosed Potoroo (*Potorous tridactylus tridactylus*);
- Brush-tailed Phascogale (*Phascogale tapoatafa*); and
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*).

Microchiropteran Bats

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Little Bentwing-bat (*Miniopterus australis)*;
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Large-footed Myotis (*Myotis macropus*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii)*; and
- Large-eared Pied Bat (*Chalinolobus dwyeri)*.

Megachiropteran Bat

- Grey-headed Flying-fox (*Pteropus poliocephalus*).

Endangered Ecological Communities

Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions

This vegetation community is listed as an endangered ecological community (EEC) under the TSC Act. It is an open forest which characterises the gentle slopes of depressions and drainage flats on the Hunter Valley floor. It has been recorded from the local government areas of Maitland, Cessnock and Port Stephens (in the Sydney Basin Bioregion) and Muswellbrook and Singleton (in the NSW North Coast Bioregion) but may occur elsewhere in these bioregions (NSW Scientific Committee 2003). Currently only a small area (less than 2% of total) of *Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions* is included in NPWS estate in the Lower Hunter (Wereketa) National Park. Modelling shows that much of the pre-1750 extent of the community has been cleared. Only about 27% (less than 500 ha) of the original distribution survives and this is highly fragmented. Although much of the clearing occurred early in European settlement, clearing still continues at a high rate. Between 1988 and 2001 approx 2380 ha were approved for clearing. In addition to clearing and fragmentation other threats include grazing, weed invasion, altered fire frequency and, locally, rubbish dumping (NSW Scientific Committee 2003).

Swamp oak floodplain forest of the NSW North Coast; Sydney Basin and South East Corner Bioregions.

This vegetation community is listed as an endangered ecological community (EEC) under the TSC Act. It is known from parts of widely distributed LGAs including Great Lakes, Port Stephens, Maitland and Newcastle. The extent of the *Swamp oak floodplain forest* prior to European settlement has not been mapped across its entire range. However, the remaining area of *Swamp oak floodplain forest* is likely to represent much less than 30% of its original range. Major occurrences include: less than 350 ha on the Tweed lowlands; less than 650 ha on the lower Clarence floodplain; less than 400 ha on the lower Macleay floodplain; less than 3,200 ha in the lower Hunter - central Hunter region; less than 5,200 ha in the Sydney - South Coast region; and less than 1,000 ha in the Eden region. Small areas of *Swamp oak floodplain forest* are contained within existing conservation reserves which are unevenly distributed throughout its range and therefore are unlikely to represent the full diversity of the community (DEC 2005a).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not a threatened species.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Two remnant patches of Hunter Lowland Redgum Forest occur between KP 75.3 and 76.2. One patch is located adjacent to the pipeline route at approximately KP 75.3 to 75.4. The other is along the pipeline route from KP 75.7 to 76.2. Both are isolated from other areas of vegetation by Clarence Town Road and Brandy Hill Drive. A 0.23 ha area near the eastern boundary of a patch of remnant Hunter Lowland Redgum Forest (KP 75.7 to 76.2) would be removed for this proposal. This remnant patch contains mature canopy trees but lacks an intact shrub and groundlayer. A path through the trees would be chosen so as to have minimal impact although some trees would need to be removed. This activity is unlikely to have an adverse effect on the extent of the EEC such that its local occurrence is likely to be placed at risk of extinction nor would it be likely to substantially and adversely modify the composition as the shrub and groundlayer are missing and the removal of trees would be minimised. The second remnant patch (KP 75.8) would not be directly impacted. Indirect effects on the two remnant patches would be controlled through fencing, the installation of sedimentation fences and the control of weeds.

Swamp oak floodplain forest occurs adjacent to the proposed pipeline route at around KP 89.5. There would be no direct impacts on this EEC. Indirect impacts would be controlled through the implementation of a stringent Sedimentation and Erosion Control Plan and ensuring that the work areas is fenced off from this vegetation community.

d) in relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

A 0.23 ha area, near the eastern boundary of a patch of remnant *Hunter Lowland Redgum Forest* (KP 75.7 to 76.2) would be removed for this proposal. This would result in further fragmentation of this patch of the EEC as the pipeline route traverses the south-eastern corner. This remnant patch contains mature canopy trees but lacks an intact shrub and groundlayer which probably reflects its grazing history. Removal and fragmentation of this relatively small amount of habitat is unlikely to affect the long-term survival of this EEC. However, only 27% of the original distribution of this EEC remains and this would contribute to the cumulative impacts on the survival of this EEC. The remnant patch along Clarence Town Road (KP 75.3 – 75.4) is already isolated from tracts of vegetation to the north and consequently the laying the pipeline to the north of this patch would not result in further isolation.

The proposed action would not result in the *Swamp oak floodplain forest* being removed or altered and habitat would not become fragmented or isolated from other areas as all proposed works are to be undertaken within pasture improved paddocks to the south of its occurrence.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for either EEC.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

For the *Hunter Lowland Redgum Forest* there are 19 priority action statements (PAS) proposed to help recover this EEC (DEC 2005a). This proposal is unlikely to impede the implementation of any of these priority actions.

For the *Swamp oak floodplain forest* there are 11 priority action statements (PAS) proposed to help recover this EEC (DEC 2005a). This proposal is unlikely to impede the implementation of any of these priority actions.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW one is of relevance to this proposal and this is:

- Clearing of Native Vegetation. A 0.23 ha area of *Hunter Lowland Redgum Forest* would be removed as a part of this proposal. This remnant patch (KP 76.5) of EEC is comprised of mature trees without an intact native understorey due to its history of grazing.

Conclusion

Impacts on *Swamp oak floodplain forest* are not anticipated as a consequence of this proposal. This proposal would however, result in the removal of a 0.23 ha area of *Hunter Lowland Redgum Forest*. The implementation of stringent mitigation measures including a CEMP and OEMP would mitigate against indirect impacts on the remaining *Hunter Lowland Redgum Forest* and *Swamp Oak Floodplain Forest* which occurs adjacent to the pipeline route.

Endangered Populations

Cymbidium canaliculatum population in the Hunter Catchment is listed as an Endangered Population under the TSC Act. The population of *C. canaliculatum* in the Hunter Catchment is at the south-eastern limit of the geographic range for this species. It is most commonly found in White Box (*Eucalyptus albens*) dominated woodlands, usually occurring singly or as a single clump, typically between two and six metres above the ground. It has been found, less commonly, to grow on Slaty Box (*E. dawsonii*), Narrow-leaved Ironbark (*E. crebra*), Grey Box (*E. moluccana*), Rough-barked Apple (*Angophora floribunda*), and Cooba (*Acacia salicina*). The number of plants of *C. canaliculatum* in the Hunter Catchment is currently estimated to be very low, as few as 90. Threats to the population of *C. canaliculatum* in the Hunter Catchment include land clearing and the associated fragmentation of habitat, on-going removal of remnant trees, and illegal collecting (NSW Scientific Committee 2006).

Rhizanthella slateri population in the Great Lakes LGA. *Rhizanthella slateri* is restricted to NSW where it is currently known from fewer than 10 locations including Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. The *Rhizanthella slateri* population in the Great Lakes LGA occurs at the known northern limit of the species' range and is disjunct from other known populations of the species. This population is currently the largest known population of this species (DEC 2005a).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not a threatened species.

b) **In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

Cymbidium canaliculatum was not recorded along the proposed pipeline route although another epiphytic orchid, *Dendrobium aemulus*, was recorded on an Ironbark. Whilst it is unlikely that this species occurs along the amended pipeline route, where it is known to occur it occurs at such low densities that retention of each specimen is important. Consequently, it is recommended that each tree be assessed for the presence of this species before removal is undertaken.

Although the amended pipeline route traverses the Great Lakes LGA the pipeline route is outside of the known area of occurrence of this population of *Rizanthella slateri*. Consequently the construction of this amended route of the pipeline is unlikely to place this population at risk of extinction.

c) **In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

I. **Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

II. **Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not a community.

d) **in relation to the habitat of a threatened species, population or ecological community:**

I. **The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

It is unlikely that *Cymbidium canaliculatum* occurs along the amended pipeline route due to its rarity in the region. However, this species occurs at such low population densities within the Hunter Catchment that removal of any specimen may be important to the ongoing survival of this population. Therefore, it is recommended that all trees be assessed for the occurrence of this species before removal.

Known habitat for the *Rhizanthella slateri* population in the Great Lakes LGA would not be altered or removed as a consequence of this proposal.

e) **Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).**

No critical habitat has been listed for either of these endangered populations in the Register of Critical Habitat kept by the Director General of Department of Environment and Climate Change or the Register of Critical Habitat kept by the Director General of Department of Primary Industries.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

DECC has not prepared a recovery plan, threat abatement plan or PAS for these endangered populations. .

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW one is of relevance and this is:

- Clearing of Native Vegetation. Around 4.78 ha of native remnant or regrowth vegetation along 26 km of pipeline route would be removed for this project.

Conclusion

Impacts on either of these endangered populations are unlikely. The occurrence of the known population of *Rizanthella slateri* in the Great Lakes LGA is outside of the impact area of this proposal and because the *Cymbidium canaliculatum* population could occur within the amended pipeline route it is recommended that each tree be assessed for the occurrence of this species before removal.

Flora

Species information: DEC 2005a (Threatened Species Profiles)

Trailing Woodruff (*Asperula asthenes*) is listed as Vulnerable under the TSC Act. It is a low, trailing perennial herb which grows in damp soils often along river banks. It is found in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area. This species was not recorded. However, a previous record of this species has been made from within a 5 km buffer of the project area (AECOM 2009).

Netted Bottle Brush (*Callistemon linearifolius*) is listed as Vulnerable under the TSC Act. It grows in dry sclerophyll forest on the coast and adjacent ranges and is recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. *Callistemon linearifolius* was not recorded during the field surveys. The desktop survey revealed three previous records from within a 5 km buffer of the project area (AECOM 2009).

Leafless Tongue Orchid (*Cryptostylis hunteriana*) is listed as Vulnerable under the TSC Act. It does not have a particularly well defined habitat preference although it is known from swampy heath environments and dry sclerophyll grassy woodlands, mostly in coastal areas. This species was not recorded during the surveys and there are no past records within a 5 km buffer of the site (AECOM 2009).

Slaty Red Gum (*Eucalyptus glaucina*) is listed as Vulnerable under the TSC Act. It is a medium-sized tree to 30 m tall which grows in grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils. This species was not recorded during this study although two records are known from within a 5 km buffer of the project area (AECOM 2009).

Guthrie's Grevillea (*Grevillea guthrieana*) is listed as Endangered under the TSC Act. It grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil. This species was not recorded during this study and there are no records of its occurrence with 5 km buffer of the project area (AECOM 2009).

Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*) is listed as Vulnerable in Schedule 2 of the TSC Act It is distributed sporadically within the central NSW coastal region from south of Sydney to the lower Hunter. It occurs in a range of vegetation types from heath and shrubby woodland to open forest. It generally grows in sandy or light clay soils, usually over thin shales. It often occurs in open, slightly disturbed sites such as along tracks and infrastructure easements. This species was not recorded during this assessment although it was recorded by AECOM (2009) along a section of the pipeline route.

Maundia triglochinoides is listed as Vulnerable under the TSC Act. It grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients and is restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct. This species was not recorded during this study and there are no records of its occurrence with 5 km buffer of the project area (AECOM 2009).

Tall Knotweed (*Persicaria elatior*) is listed as Vulnerable under the TSC Act. It grows in damp sites, especially beside streams and lakes and occasionally in swamp forest. This species was not recorded during this assessment and there are no previous records from within a 5 km buffer of the project area (AECOM 2009).

Scant Pomaderris (*Pomaderris queenslandica*) is listed as Endangered under the TSC Act. It grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks. Scant Pomaderris is widely scattered but not common in north-east NSW but is known from several locations on the NSW north coast. This species was not recorded during this study and there are no records of its occurrence with 5 km buffer of the project area (AECOM 2009).

Eastern Australian Underground Orchid (*Rhizanthella slateri*) is listed as Vulnerable under the TSC Act. Habitat requirements are not well understood but it is known to grow in sclerophyll forest in shallow to deep loams. This species was not recorded during this study and there are no records of its occurrence with 5 km buffer of the project area (AECOM 2009).

Black-eyed Susan (*Tetratheca juncea*) is listed as Vulnerable under the TSC Act. It grows in sandy, occasionally swampy heath and in dry sclerophyll forest; mostly in coastal districts. *Tetratheca juncea* is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. This species was not recorded during this study although two records are known from within a 5 km buffer of the project area (AECOM 2009).

Zannichellia palustris is listed as Endangered under the TSC Act. It is known only from the lower Hunter Region where it grows submerged in fresh or slightly saline stationary or slowly flowing water. This species was not recorded during this study although two records are known from within a 5 km buffer of the project area (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

There would be no direct impacts on known habitat for any of the flora species listed under the Act. Although the amended pipeline route passes through some suitable habitat for these species it is unlikely to have an adverse effect on the life cycle of any of these species such that a local population would be placed at risk of extinction. Environmental management of the site during construction could ensure that adjacent habitat would be protected from the affects of run-off and sedimentation during construction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

None of these are endangered populations.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

None of these are endangered ecological communities.

d) In relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Around 4.78 ha of dry sclerophyll forest in a 25 - 30 m wide strip would be removed as a consequence of this proposal. For those species reliant on creeks for habitat around 0.08 ha would be removed or altered and for *Zannichellia palustris* no suitable habitat would be directly impacted as any potential habitat would be underbored. Any habitat that would be removed for these species would be as a relatively narrow strip (25 – 30 m) and is unlikely to act as a barrier to dispersal for the flora species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No areas of critical habitat have been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery plan or threat abatement plan for any of these species although PAS have been prepared to recover the majority of these species. Provided that clearing of timbered and / or riparian habitat is kept to a minimum, the proposed development will not be inconsistent with any of the priority action statements.

However for *Rhizanthella slateri* and *Zannichellia palustris* there have been no PAS prepared to assist with the recovery of these two species. If clearing is kept to a minimum then the proposed development will not be inconsistent with assisting in recovery of these species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW two are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of native remnant or regrowth vegetation along 26 km of amended pipeline route would be removed for this project. To minimise any potential impacts clearing of native vegetation should be kept to a minimum.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands. A number of the threatened flora species are, or may be, dependent on creeks, streams or areas of ponded water. Clearing of riparian vegetation and alteration of flows would be minimised. Significant water bodies and creeks would be horizontally directionally drilled. For other areas, clearing and changes to water flows would be minimised in line with the Construction and Operational Environmental Management Plans for the project.

Conclusion

This proposal is unlikely to significantly alter habitat for any of these plant species to such an extent that at local population would be placed at risk of extinction. The Stage 1 GFDA extension and altered pipeline route have been chosen to avoid areas of intact vegetation where possible. In areas of intact vegetation clearing for the ROW would be minimised to reduce the risk of impacts to any species.

Amphibian

The Green and Golden Bell Frog (GGBF) (*Litoria aurea*) is listed as Endangered under the TSC Act. This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available (DEC 2005a). There have been 140 records from within 5 km of the project site (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

There would be no direct impacts on potential GGBF habitat as all suitable farm dams and waterbodies would be avoided. Environmental management of the site during construction could ensure that such areas would be protected from the affects of run-off and sedimentation during construction through the use of sedimentation fences and revegetation. Consequently, should the GGBF occur in adjacent areas it is unlikely that this species would be impacted by this proposal.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) In relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The Stage 1 GFDA extension area is located within paddocks and the majority of the proposed amended pipeline route traverses introduced pastures through long established agricultural lands and consequently the locality is currently heavily fragmented. It is unlikely that this proposal would fragment an existing important population into two or more populations as the pipeline trench would be backfilled and only a relatively small amount of vegetation would be cleared and consequently there would be few barriers to movement for the GGBF.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

This area has not been identified as critical habitat for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A Draft Recovery Plan (DEC 2005b) for the GGBF has been prepared. This plan lists habitat loss, modification and disturbance, fragmentation and isolation of habitat, disease, predation by introduced fish and water quality as threats. The plan consists of five specific objectives including prevention of further habitat loss. GGBF habitat will not be removed as a result of this proposal and the proposal does not contravene the specific objectives of the draft recovery plan.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Two Key Threatening Processes have potential relevance to this proposal. These are *Predation by Gambusia holbrooki (Plague Minnow)* and *Infection of Frogs by Amphibian Chytrid Causing the disease Chytridiomycosis*. This proposal is unlikely to introduce the Plague Minnow into areas of potential habitat and this proposal would not involve the moving of frogs or tadpoles, exposing frogs to infected water or handling of frogs in any way and consequently it is unlikely that infection in amphibians would be exacerbated.

Conclusion

The Green and Golden Bell Frog is unlikely to be impacted by this proposal as GGBF habitat would not be impacted and with the implementation of stringent environmental management during construction and operation the proposal is unlikely to impact the ecology of the study area and locality.

Reptile

The Pale-headed Snake (*Hoplocephalus bitorquatus*) is listed as Vulnerable under the TSC Act. It is generally found in dry eucalypt forests and woodlands, cypress woodland and occasionally rainforest or moist eucalypt forest. It prefers streamside areas, particularly in drier habitats. During the day, it shelters between loose bark and tree trunks, or in hollow trunks and limbs of dead trees (DEC 2005a). This species was not recorded during the survey and no records exist within 5 km of the project site (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha of potential foraging and nesting habitat for this species would be removed. It is unlikely that this proposal would place a local population of this species at risk of extinction as the woodland which would be removed occurs along already cleared margins of habitat. More extensive and higher quality habitat would occur in neighbouring intact vegetation communities.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) In relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Around 4.78 ha in a 25 - 30 m wide strip of potential habitat would be removed. It is unlikely that this habitat would represent important habitat as it is already fragmented and isolated from higher quality habitat in nearby intact vegetation. It is unlikely that this proposal would fragment an existing important population into two or more populations as the pipeline trench would be backfilled and only a relatively small amount of vegetation would be cleared and consequently there would be few barriers to movement

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There are 13 priority action statements (PAS) proposed to help recover this species (DEC 2005a). This proposal is unlikely to impede the implementation of any of these priority actions.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW one is of relevance and this is:

- Clearing of Native Vegetation. Around 4.78 ha of native remnant or regrowth vegetation along 26 km of amended pipeline route would be removed for this project.

Conclusion

Although around 4.78 ha of potential is to be removed for the implementation of the project it is unlikely to on this species to such an extent that a local population would be put at risk of extinction as vegetation removal would occur in a relatively narrow strip and along mostly disturbed margins.

Water-dependent Birds

Species information: DEC 2005a (Threatened Species Profiles), Pizzey and Knight 2001.

The Magpie Goose (*Anseranas semipalmata*) is listed as Vulnerable under the TSC Act. It is still relatively common in the Australian tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s, there have been an increasing number of records in central and northern NSW. Vagrants can still follow food sources to south-eastern NSW. It is mainly found in shallow wetlands (60-100 cm deep) with dense growth of rushes or sedges. It is equally at home in aquatic or terrestrial habitats, where it is often seen walking and grazing on grasses, bulbs and rhizomes. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off. This species was not recorded during the survey but 17 previous records exist within 5 km of the project site (AECOM 2009).

The Black-necked Stork (*Ephippiorhynchus asiaticus*) is listed as Endangered under the TSC Act. The Black-necked Stork is increasingly uncommon in southern Australia. It inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands. This species was not recorded during the survey but 81 previous records exist within 5 km of the project site (AECOM 2009).

The Black Bittern (*Ixobrychus flavicollis*) is listed as Vulnerable under the TSC Act. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. It inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

The Painted Snipe (*Rostratula benghalensis*) is listed as Endangered under the TSC Act. It prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. It nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The impacts on creeks, drainage lines and or wetland areas would be spatially and temporally limited with 0.08 ha of riparian vegetation proposed for removal. Areas of particular sensitivity would be underbored using HDD, including the major creek and river crossings and the SEPP 14 wetlands. Therefore it is unlikely that this proposal would impact these species such that a local viable population is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

None of these are endangered populations.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

None of these are endangered ecological communities.

d) In relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The habitat for water dependent birds would be protected as major drainage lines and creeks would be underbored and SEPP 14 wetlands which are likely to provide habitat for a range of waders would also be HDD. The removal or disturbance of other habitat would be minimal and temporary and is unlikely to substantially remove, modify, fragment or isolate habitat over current levels.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No areas of critical habitat have been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery plan or threat abatement plan for any of these species although PAS have been prepared to recover the majority of these species. Provided that clearing of creek lines and wetland areas is kept to a minimum, the proposed development will not be inconsistent with any of the priority action statements.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW two are of relevance and these are:

- Clearing of Native Vegetation. Around 0.08 ha of riparian vegetation along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum; and

- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands. A number of the threatened flora species are, or may be, dependent on creeks, streams or areas of ponded water. Clearing of riparian vegetation and alteration of flows would be minimised. Significant water bodies and creeks would be horizontally directionally drilled. For other areas, clearing and changes to water flows would be minimised in line with the Construction and Operational Environmental Management Plans for the project.

Conclusion

With the implementation of stringent environmental management measures it is considered that this proposal is unlikely to significantly alter habitat for any of these water bird species to such an extent that a local population would be placed at risk of extinction as areas with significant resources for water dependent birds would be underbored using HDD.

Woodland Birds

Species information: DEC 2005a (Threatened Species Profiles), Pizzey and Knight 2001.

Bush Stone-curlew (*Burhinus grallarius*) is listed as Endangered under the TSC Act. Habitat for this species occurs in open forests and woodlands with sparse grassy ground layer and fallen timber. It is nocturnal and is especially active on moonlit nights. In south-east Australia, it is either rare or extinct throughout its former range. This species was not recorded during the survey but one previous record exists within 5 km of the project site (AECOM 2009).

Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoria*) is listed as Vulnerable under the TSC Act. The eastern subspecies lives in eastern NSW in eucalypt woodlands through central NSW and in coastal areas with drier open woodlands, such as the Hunter Valley and Clarence Valley. This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

Barred Cuckoo-shrike (*Coracina lineata*) is listed as Vulnerable under the TSC Act. It inhabits a wide range of habitats including rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses. This species is rare in NSW and would normally occur north of the study area. This species was not recorded during the survey but one previous record exists within 5 km of the project site (AECOM 2009).

Swift Parrot (*Lathamus discolor*) is listed as Endangered under the TSC Act. The Swift Parrot migrates to the Australian South East mainland between March and October to feed on winter flowering species such as Swamp Mahogany, Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). They commonly use lerp infested trees including Grey Box (*E. macrocarpa*), Grey Box (*E. moluccana*) and Blackbutt (*E. pilularis*). This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act. It is found in a variety of timbered habitats including dry woodlands and open forests especially along timbered watercourses. This kite's home range is estimated to occupy around 100 km2. This species was not recorded during the survey but one previous record exists within 5 km of the project site (AECOM 2009).

Hooded Robin (*Melanodryas cucullata*) is listed as Vulnerable under the TSC Act. It inhabits structurally diverse drier eucalypt woodlands, forests, scrubs with fallen timber. This species was not recorded during the survey but no previous records exist within 5 km of the project site (AECOM 2009).

Black-chinned Honeyeater (*Melithreptus gularis gularis*) is listed as Vulnerable under the TSC Act. It occurs in open forests and woodlands dominated by box and ironbark eucalypts generally west of the Great Dividing Range. This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

Turquoise Parrot (*Neophema pulchella*) is listed as Vulnerable under the TSC Act. It lives on the edge of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. This parrot prefers to feed in the shade of a tree and spends majority of day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. This species was not recorded during the survey but four previous records exist within 5 km of the project site (AECOM 2009).

Speckled Warbler (*Pyrrholaemus saggitatus*) is listed as Vulnerable under the TSC Act. It inhabits Eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. This species was not recorded during the survey but five previous records exist within 5 km of the project site (AECOM 2009).

Diamond Firetail (*Stagonopleura guttata*) is listed as Vulnerable under the TSC Act. It occurs in open eucalypt forest, mallee and acacia scrubs. It is widely distributed in NSW although it is not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

Regent Honeyeater (*Xanthomyza phrygia*) is listed as Endangered under the TSC Act. It inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak (*Casuarina cunninghamiana*). Regent Honeyeaters inhabit woodlands with a significantly high abundance of bird species. Potential habitats should have large numbers of mature trees, high canopy cover and abundance of mistletoes. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 25 - 30 m wide strip of Eucalypt woodland would be cleared as a part of this proposal and some of this could potentially provide foraging and some roosting habitat for these woodland species. Removal of this amount of potential foraging habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The removal of up to 4.78 ha of woodland, which may form foraging habitat for these species, may marginally reduce the amount of foraging habitat available. However, this is unlikely to substantially impact foraging resources for these species as significant resources occur nearby. It is unlikely that habitat connectivity for any of these woodland bird species would be disturbed as these species are highly mobile and construction for the ROW would only require removal of 25 - 30 m of vegetation, the majority of which is introduced grasslands. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites. .

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

PAS have been prepared for all species. Provided that clearing of creek lines and wetland areas is kept to a minimum, the proposed development would not be inconsistent with any of the for any of the species provided as much native forest as possible is kept particularly along roads and watercourses and that pre-clearance surveys ensure that no trees containing nests of the Square-tailed Kite are removed during construction.

A national Regent Honeyeater (*Xanthomyza phrygia*) Recovery Plan 1999-2003 has been prepared (Menkhorst *et al.* 1999). This proposal would not be inconsistent with the six objectives of this plan. There are also 32 PAS designed to help this species recover (DECC 2009) and this proposal would also be in alignment with the envisaged outcomes of these.

A national Swift Parrot (*Lathamus discolor*) Recovery Plan 2001-2005 has been prepared by the Swift Parrot Recovery Team (Swift Parrot Recovery Team 2001). Of the six objectives, *Objective 3 Reduce the incidence of collision*, is the most relevant to this proposal. To ensure that this objective is met within this context, speed limits would be stringently enforced across of the work sites to lessen the risk of death or injury of any birds from collision with vehicles or machinery. There are also 10 PAS designed to help this species recover (DEC 2005a) and this proposal would also be in alignment with the envisaged outcomes of these.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW three are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum;
- Loss of Hollow-bearing Trees. It is inevitable that hollow-bearing trees would be lost during clearing for this project. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and the need for their retention; and
- Removal of dead wood and dead trees. Some stag trees may be removed during construction of this proposal. Consequently, the final survey line for the pipeline route should take into consideration the importance of stag trees as nesting and roosting sites for some bird species and hence the need for their retention.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging and / or roosting habitat would be relatively minimal given the substantial resources available in the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved and that no current nest trees for the Square-tailed Kite are removed.

Grey-crowned Babbler

Grey-crowned Babbler (GCB) (*Pomatostomus temporalis temporalis*) (eastern subspecies) is listed as Vulnerable under the TSC Act. This species is found throughout large parts of northern Australia and in south-eastern Australia. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. This species is a laborious flyer so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. GCBs feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses (DEC 2005a).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal would not directly impact on any known breeding or foraging areas of this species but given that this species is relatively common especially in the northern section of the project area indirect impacts may occur. The Grey-crowned Babbler appears to be relatively disturbance tolerant as this bird has been observed foraging and nesting in gardens, parks and small remnants, along fence boundaries and man-made structures near major roads (Parsons Brinckerhoff 2005). However, this species is a laborious flyer and is known to feed on the ground placing it at risk of being struck by construction traffic which would increase temporarily during drilling operations. To avoid bird strike stringent traffic management should be implemented and traffic flow, vehicle speed and vehicle numbers entering and leaving the sites should be controlled.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- **I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

- **I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

Although the amended pipeline route and the Stage 1 GFDA extension are likely to provide foraging habitat from time to time, the removal of some of this habitat would not substantially further fragment or isolate habitat for this species as habitat is already patchily distributed. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat listed for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Although the Grey-crowned Babbler Retention Plan – Gloucester Shire Council (Parsons Brinckerhoff 2005) deals with potential family groups outside of the study area, several of the management measures are applicable to management of the GCB within the study area and these are:

- Habitat protection and maintenance: to maintain and protect woodland remnants that form part of a corridor network and other habitats that have potential for regeneration for the longer term benefit of the species; and
- Road and traffic management: prevent / reduce the incidence of collision of GCB with motor vehicles through the implementation of go slow areas and increasing public awareness through signage.

A Construction Environment Management Plan would ensure that vegetated areas are protected, through fencing where appropriate and education of personnel to raise awareness of the importance of this species. Stringent traffic management would also be implemented to ensure that the incidence of collision does not increase due to the increase of traffic and it will address such matters as traffic numbers, traffic speed and traffic flow.

DECC have also identified five strategies to help recover the species (DEC 2005a) and these include community and land-holder awareness, development and implementation of protocols and guidelines, habitat rehabilitation / restoration, research and survey / mapping and habitat assessment. None of the actions of this proposal are inconsistent with any of the strategies or actions outlined in the PAS.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW one is of relevance:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum.

Conclusion

This proposal is unlikely to have a significant impact on foraging resources given that resources of equal or higher quality are available within the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation is protected and conserved and stringent traffic management is enforced.

Cockatoos

Gang-gang Cockatoo (*Callocephalon fimbriatum*) is listed as Vulnerable under the TSC Act. In summer it is found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter it moves to lower altitudes in drier more open eucalypt forests and woodlands, and is often found in urban areas (DEC 2005a). This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

Glossy Black-cockatoo (*Calyptorhynchus lathami*) is listed as Vulnerable under the TSC Act. It inhabits open forest and woodlands and feeds on Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*). It requires large vertical hollows for nesting (DEC 2005a). This species was not recorded during the survey but eight previous records exist within 5 km of the project site (AECOM 2009).

a) **In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

Around 4.78 ha in a linear strip of Eucalypt woodland and riparian area would be cleared as a part of this proposal and this could potentially provide foraging habitat for these species as the majority of the wooded areas of the amended pipeline route comprised eucalypt woodland and Forest Oak, a preferred feed tree for the Glossy Black-cockatoo was recorded along some sections of the amended pipeline. Removal of this amount of potential foraging habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route. Pre-clearance surveys for potential nest trees of the Glossy Black-cockatoo should be undertaken to ensure none are removed.

b) **In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

Not an endangered population.

c) **In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
   I. **Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
   II. **Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not an endangered ecological community.

d) **in relation to the habitat of a threatened species, population or ecological community:**
   I. **The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
   II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
   III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The removal of up to 4.78 ha of woodland, which may form foraging habitat for these species, may marginally reduce the amount of foraging habitat available. However, this is unlikely to substantially impact foraging resources for these species as significant resources occur nearby. It is unlikely that habitat connectivity for any of these woodland bird species would be disturbed as these species are highly mobile and construction for the ROW would only require removal of 25 - 30 m of vegetation, the majority of which is introduced grasslands. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites. .

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for either of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery plan or threat abatement plan for either of these species although PAS have been prepared . Provided that clearing of creek lines and wetland areas is kept to a minimum, the proposed development will not be inconsistent with any of the priority action statements.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW three are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum;
- Loss of Hollow-bearing Trees. It is inevitable that hollow-bearing trees would be lost during clearing for this project. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and the need for their retention and any potential nest trees for the Glossy Black-cockatoo should be retained; and
- Removal of dead wood and dead trees. Some stag trees may be removed during construction of this proposal. Consequently, the final survey line for the pipeline route should take into consideration the importance of stag trees as nesting and roosting sites for some bat species and hence the need for their retention.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging habitat would be relatively minimal given the substantial resources available in the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved and that no potential nest trees for the Glossy Black-cockatoo are removed.

Owls

Species information: DEC 2005a (Threatened Species Profiles), Pizzey and Knight 2001

The Grass Owl (*Tyto capensis*) is listed as Vulnerable under the TSC Act. Grass Owls have been recorded occasionally in all mainland states of Australia but appear to be more commonly recorded in northern and north-eastern Australia. In NSW they are more likely to be found in the north-east. Grass Owl numbers often increase when rodent numbers increase. They are found in areas of tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on flood plains. They rest by day in a ‘form’ - a trampled platform in a large tussock or other heavy growth. They also nest in trodden-down grass.

The Barking Owl (*Ninox connivens*) is listed as Vulnerable under the TSC Act. It forages throughout woodlands, grassy woodlands, forests and into grasslands for about 250 m. It breeds in hollow-bearing trees with hollows >20 cm diameter. This species was not recorded during the survey but three previous records exist within 5 km of the project site (AECOM 2009).

The Powerful Owl (*Ninox strenua*) is listed as Vulnerable under the TSC Act. It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It roosts in dense vegetation comprising species such as Turpentine, Black She-oak, Blackwood, Rough-barked Apple, Cherry Ballart and a number of eucalypt species and nests in large hollows in unlogged forests. The home range of a pair ranges from 300 - 1,500 ha depending on habitat type. This species was not recorded during the survey but 11 previous records exist within 5 km of the project site (AECOM 2009).

The Masked Owl (*Tyto novaehollandiae*) is listed as Vulnerable under the TSC Act. It occurs in dry eucalypt forests and woodlands. A pair's home-range is estimated to range between 500 to 1,000 ha. This owl roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. This species was not recorded during the survey but two previous records exist within 5 km of the project site (AECOM 2009).

The Sooty Owl (*Tyto tenebricosa*) is listed as Vulnerable under the TSC Act. It occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. This owl roosts by day in the hollow of a tall forest tree or in heavy vegetation. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 23 - 30 m wide strip of eucalypt woodland would be cleared as a part of this proposal and this could potentially provide at least foraging habitat for all of the owls except the Grass Owl. Removal of this amount of potential foraging habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

For the Grass Owl disturbance to grassed and tussocky areas within paddocks would be minimal and temporary. Substantial areas of foraging and nesting habitat would remain within the locality and consequently it is unlikely that this species would be adversely affected or placed at the risk of extinction as a consequence of this proposal.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The proposal is such that the removal of habitat would be within a 25 to 30 m wide strip which although may fragment habitat for less mobile species it is unlikely to disrupt local populations of these owls. The proposal would only temporarily disrupt potential habitat for the Grass Owl as paddocks areas would be revegetated after laying of the pipeline.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A draft recovery plan for the Barking Owl (NPWS 2003a) has been prepared. It contains five objectives. Of relevance is Objective 3 which requires the undertaking of threat abatement and mitigation, and requires the protection of habitat and especially large hollow-bearing trees. This proposal may remove some potential habitat but is unlikely to remove nesting habitat due to the already modified nature of the woodlands and forests. There are also seven PAS designed to help recover this species (DEC 2005a). This proposal is not inconsistent with any of them.

A recovery plan for the Powerful Owl has been produced (DEC 2006). Removal of some foraging and habitat for this proposal would be inconsistent with Objective 4 which states *Manage and protect habitat off reserves and state forests*. However, although this proposal may remove some potential habitat it is unlikely to remove nesting habitat due to the already modified nature of the woodlands and forests.

A recovery plan for the Masked Owl has been prepared (DEC 2006). Removal of some foraging and habitat for this proposal would be inconsistent with Objective 4 which states *Manage and protect habitat off reserves and state forests*. However, although this proposal may remove some potential habitat it is unlikely to remove nesting habitat due to the already modified nature of the woodlands and forests.

A recovery plan for the Sooty Owl has been prepared (DEC, 2006). Removal of some foraging and habitat for this proposal would be inconsistent with Objective 4 which states *Manage and protect habitat off reserves and state forests*. However, although this proposal may remove some potential habitat it is unlikely to remove nesting habitat due to the already modified nature of the woodlands and forests and the primary habitat of the Sooty Owl, which is sheltered gullies, would not be directly impacted.

There has not been a recovery plan or threat abatement plan prepared for the Grass Owl. Five PAS have been prepared for the Grass Owl and this proposal would not be inconsistent with any of the objectives of these PAS (DEC 2005a).

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW three are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum;
- Loss of Hollow-bearing Trees. It is inevitable that hollow-bearing trees would be lost during clearing for this project. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and the need for their retention; and
- Removal of dead wood and dead trees. Dead wood and some stag trees may be removed during construction of this proposal. It is recommended that deadwood be moved aside during construction and then replaced in a haphazard manner once the pipeline has been backfilled and restoration undertaken.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging habitat would be relatively minimal. It is considered unlikely that roosting habitat for any of the woodland species of owl would be significantly altered as much of the woodland and forests along the amended pipeline route are currently degraded and suffer from edge effects. Grass Owl habitat would only be disrupted temporarily as the pasture sites would be returned to their current condition.

Arboreal Mammals

Species information: DEC 2005a (Threatened Species Profiles)

Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act. It inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest with heath understorey in coastal areas and it prefers mixed species stands with a shrub or *Acacia* midstorey. The Squirrel Glider requires abundant tree hollows for refuge and nest sites. This arboreal species has estimated home ranges of 0.65 to 8.55 ha. This species was not recorded during the survey but 12 previous records exist within 5 km of the project site (AECOM 2009).

Eastern Pygmy-possum (*Cercartetus nanus*) is listed as Vulnerable under the TSC Act. It inhabits a range of habitats including rainforest, sclerophyll forest and woodland to heath, with a preference for heath and woodland. It forages on banksias, eucalypts and callistemon. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

Yellow-bellied Glider (*Petaurus australis*) is listed as Vulnerable under the TSC Act. It occurs in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soil. Family groups occupy home ranges of between 20 ha and 85 ha. This species was not recorded during the survey but one previous record exists from the larger pipeline area (AECOM 2009).

Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the TSC Act. The Koala is patchily distributed in NSW. Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. This species was not recorded during the survey but 281 previous records exist from the 5 km of the project area (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 25 - 30 m wide strip of eucalypt woodland would be cleared as a part of this proposal and this could potentially provide foraging habitat for these species as the majority of the wooded areas of the amended pipeline route comprised eucalypt woodland. Removal of this amount of potential foraging habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) **in relation to the habitat of a threatened species, population or ecological community:**

   I. **The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
   II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
   III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The removal of up to 4.78 ha of woodland, which may form foraging habitat for these species, may slightly reduce the amount of foraging habitat available. However, this is unlikely to substantially impact foraging resources for these species as significant resources occur nearby. It is unlikely that habitat connectivity for any of these arboreal mammals would be disturbed as these species are mobile and construction for the ROW would only require removal of 25 - 30 m of vegetation, the majority of which is introduced grasslands. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA Extension and amended pipeline route traverse agricultural land, powerline easements and mine sites. .

Areas which have been mapped as 'Preferred' Koala Habitat along Deadmans Creek in the Port Stephens Council Comprehensive Koala Plan of Management (Port Stephens Council 2002) would be underbored to protect the integrity of these areas.

e) **Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).**

Critical habitat has not been declared for any of these species.

f) **Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.**

A recovery plan for the Yellow-bellied Glider has been prepared (NPWS 2003b). Of the five objectives only Objective 2 would be inconsistent with the outcomes of this project as this objective aims 'To encourage and assist in improving the protection and management of the Yellow-bellied Glider and its habitat'. Small areas of potential habitat for this species would be lost as a consequence of this proposal. Whilst specific feed trees were not recorded within these areas there is the potential that some of this area could form part of the home range of a family group. Therefore it is important to retain as much habitat for this species as possible including hollow-bearing trees.

Whilst a recovery plan has not been prepared for the Squirrel Glider there are nine PAS to assist in the recovery of this species (DEC 2005a). Two of the objectives address the retention of hollow-bearing trees. Therefore, the retention of hollow-bearing trees should be given high priority in areas of potential habitat along the amended pipeline route.

A recovery plan has been prepared for the Koala (DECC 2008b). It details seven objectives to assist with the recovery of the species. The proposal is not inconsistent with the stated outcomes of these objectives especially given that areas which have been mapped as 'Preferred' Koala Habitat along Deadmans Creek in the Port Stephens Council Comprehensive Koala Plan of Management (Port Stephens Council 2002) would be underbored to protect the integrity of these areas. Other habitat along the amended pipeline route is marginal as much of it is already fragmented and isolated from larger tracts of wilderness.

Whilst a recovery plan has not been prepared for the Eastern Pygmy Possum there are seven PAS to assist in the recovery of this species (DEC 2005a). Two of the objectives address the retention of hollow-bearing trees. Therefore, the retention of hollow-bearing trees should be given high priority in areas of potential habitat along the amended pipeline route.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW three are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum;
- Loss of Hollow-bearing Trees. It is inevitable that hollow-bearing trees would be lost during clearing for this project. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and as many retained as is possible; and
- Removal of dead wood and dead trees. Some stag trees may be removed during construction of this proposal. Consequently, the final survey line for the pipeline route should take into consideration the importance of stag trees as potential denning sites for these species and hence the need for their retention.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging habitat would be relatively minimal given the substantial resources available in the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved and that as many hollow-bearing trees as possible are retained.

Ground-dwelling Mammals

Species information: DEC 2005a (Threatened Species Profiles)

Parma Wallaby (*Macropus parma*) is listed as Vulnerable under the TSC Act. It prefers moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest. It was once widespread in southern NSW but now it is confined to the coast and ranges of central and northern NSW. This species was not recorded during the survey but three previous records exist from the 5 km of the project area (AECOM 2009).

Long-nosed Potoroo (*Potorous tridactylus tridactylus*) is listed as Vulnerable under the TSC Act. This potoroo inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of Tea-trees or *Melaleucas*. A sandy loam soil is also a common feature. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

Brush-tailed Phascogale (*Phascogale tapoatafa*) is listed as Vulnerable under the TSC Act. It prefers dry sclerophyll open forest with sparse groundcover but is also found in heath, swamps, rainforest and wet sclerophyll forest. This species was not recorded during the survey but 30 previous records exist from the 5 km of the project area (AECOM 2009).

Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) is listed as Vulnerable under the TSC Act. It has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. This species was not recorded during the survey but 39 previous records exist from the 5 km of the project area (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 25 - 30 m wide strip of Eucalypt woodland would be cleared as a part of this proposal and this could potentially provide foraging and nesting habitat for these species. Removal of this amount of potential habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- **I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

- **I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The removal of up to 4.78 ha of woodland, which may form foraging habitat for these species, may slightly reduce the amount of foraging habitat available. However, this is unlikely to substantially impact foraging resources for these species as significant resources occur nearby.

It is unlikely that habitat connectivity for any of these arboreal mammals would be disturbed as these species are mobile and construction for the ROW would only require removal of 25 - 30 m of vegetation, the majority of which is introduced grasslands. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites. .

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A recovery plan has not been prepared for the Long-nosed Potoroo. There are 19 PAS actions that have been identified to help recover this species (DEC 2005a). Of particular importance is the clearing of dense understorey as this provides preferred habitat. Habitat along the amended pipeline route is marginal for this species especially given the larger tracts of native vegetation within the locality. Protection and retention of vegetation along creeklines is a priority of this proposal and hence any potential habitat would be protected.

A recovery plan has not been prepared for the Brush-tailed Phascogale. However, there are seven PAS that have been identified to help recover this species (DEC 2005a). Of particular importance is the control of feral animals within this species habitat. Whilst the construction of another easement through this area is likely to marginally increase the ability of the European Red Fox to move through the landscape, the Construction Environmental Management Plan for this project would set out stringent management measures to ensure that the European Red Fox is not attracted to the construction sites to scrounge for food scraps.

A recovery plan has not been prepared for the Spotted-tailed Quoll. However, there are 32 PAS that have been identified to help recover this species (DEC 2005a). Provided that vegetation clearance is kept to a minimum the proposal would not be inconsistent with any of the priority action statements.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW two are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum; and
- Removal of dead wood and dead trees. Dead wood may be temporarily displaced during construction of the amended pipeline route. After backfilling and fallen timber would be replaced haphazardly.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging habitat would be relatively minimal given the substantial resources available in the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved and that as many hollow-bearing trees as possible are retained.

Microchiropteran Bats

Species information: DEC 2005a (Threatened Species Profiles)

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is listed as Vulnerable under the TSC Act. It prefers moist habitats with trees larger than 20 m. It roosts in hollows in trees or under bark or in buildings. This species was not recorded during the survey and no previous records exist within 5 km of the project site (AECOM 2009).

Little Bentwing-bat (*Miniopterus australis)* is listed as Vulnerable under the TSC Act. It is found in well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. It is known to roost in caves. This species was not recorded during the survey but 14 previous records exist from the 5 km of the project area (AECOM 2009).

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) is listed as Vulnerable under the TSC Act. It roosts in caves, derelict mines, stormwater tunnels and buildings and is known to forage in forested areas. This species was not recorded during the survey but 14 previous records exist from the 5 km of the project area (AECOM 2009).

Eastern Freetail-bat (*Mormopterus norfolkensis*) is listed as Vulnerable under the TSC Act. It forages in dry sclerophyll forest and woodland and roosts in hollows and under bark or man-made structures. This species was not recorded during the survey but 10 previous records exist from the 5 km of the project area (AECOM 2009).

Large-footed Myotis (*Myotis macropus*) is listed as Vulnerable under the TSC Act. They generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. It forages over streams and pools catching insects and small fish by raking their feet across the water surface. This species was not recorded during the survey but 10 previous records exist from the 5 km of the project area (AECOM 2009).

Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) is listed as Vulnerable under the TSC Act. It roosts singly or in groups of up to six, in hollow-bearing trees and buildings but will use mammal burrows. It forages in most habitats across areas with and without trees and appears to defend an aerial territory. This species was not recorded during the survey but two previous records exist from the 5 km of the project area (AECOM 2009).

Greater Broad-nosed Bat (*Scoteanax rueppellii)* is listed as Vulnerable under the TSC Act. It occurs in woodland, moist and dry eucalypt forest and rainforest but prefers tall wet forest. It roosts in tree hollows but also buildings. This species was not recorded during the survey but seven previous records exist from the 5 km of the project area (AECOM 2009).

Large-eared Pied Bat (*Chalinolobus dwyeri)* is listed as Vulnerable under the TSC Act. It roosts near the entrance of caves, crevices in cliffs, derelict mines and in the disused, bottle-shaped mud nests of the Fairy Martin frequenting low to mid-elevation dry open forest and woodland close to these features. This species was not recorded during the survey but one previous record exists from the 5 km of the project area (AECOM 2009).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 25 - 30 m wide strip of Eucalypt woodland would be cleared as a part of this proposal and this could potentially provide foraging and some roosting habitat for these species. Removal of this amount of potential habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) In relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The removal of up to 4.78 ha of woodland, which may form foraging habitat for these species, may slightly reduce the amount of foraging habitat available for this species. However, this is unlikely to substantially impact foraging resources for these species as significant resources occur nearby. It is unlikely that habitat connectivity for any of species of microchiropteran bats would be disturbed as these species are highly mobile and construction for the ROW would only require removal of 25 - 30 m of vegetation, the majority of which is introduced grasslands. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites. .

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for any of these species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There are currently no recovery plans or threat abatements plans which have been prepared for any of these microchiropteran bat species. However, PAS have been issued to help recover these species (DEC 2005a). Of importance for all species is the requirement to ensure the largest hollow-bearing trees, including dead trees and paddock trees are given highest priority for retention during land assessments. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and the need for their retention.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW three are of relevance and these are:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum;
- Loss of Hollow-bearing Trees. It is inevitable that hollow-bearing trees would be lost during clearing for this project. Consequently, the final survey line for the pipeline route should take into consideration the importance of hollow-bearing trees and the need for their retention; and
- Removal of dead wood and dead trees. Some stag trees may be removed during construction of this proposal. Consequently, the final survey line for the pipeline route should take into consideration the importance of stag trees as nesting and roosting sites for some bat species and hence the need for their retention.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on these species as disturbance to any potential foraging and / or roosting habitat would be relatively minimal given the substantial resources available in the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved.

Megachiropteran Bat

The Grey-headed Flying-fox (GHFF, *Pteropus poliocephalus*) is listed as vulnerable under the TSC Act and EPBC Act. It roosts in camps generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. This species feeds on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines in areas supporting subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops (DEC 2005a).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Around 4.78 ha in a 25 - 30 m wide strip of eucalypt woodland would be cleared as a part of this proposal and this could potentially provide foraging and nesting habitat for these species. Removal of this amount of potential habitat on the edge of cleared and disturbed habitat is unlikely to result in a viable local population of any of these species being placed at risk of extinction as this is a relatively small amount of habitat compared to that available in nearby areas to the east and west of the amended pipeline route.

The amended pipeline route and the Stage 1 GFDA extension provides potential foraging habitat for the Grey-headed Flying-fox but does not contain a camp site and consequently it is unlikely that this proposal would adversely affect the life cycle of this species as no breeding habitat would be removed or modified. The area of vegetation to be removed is relatively small and furthermore, foraging habitat of equal quality is located nearby. Consequently it is unlikely that the proposed vegetation clearance would result in isolation of habitat as the GHFF is highly mobile. Therefore it is unlikely that the proposal would place a local population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Although the amended pipeline route and the Stage 1 GFDA extension are likely to provide foraging habitat from time to time, the removal of some of this habitat would not substantially further fragment or isolate habitat for this species as habitat is already patchily distributed. Furthermore the site does not provide breeding habitat for this species and therefore removal of some habitat is unlikely to interfere with the long-term survival of this species especially as habitat of equal quality is provided in neighbouring areas. Furthermore, current disturbance regimes are not likely to be substantially altered from existing levels as the Stage 1 GFDA extension and amended pipeline route traverse agricultural land, powerline easements and mine sites.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Critical habitat has not been declared for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

DECC has not prepared a recovery plan or threat abatement plan for this species. However, 10 PAS have been developed (DEC 2005a). Of particular relevance to this proposal is the retention of foraging resources over the species range. Whilst this proposal would remove a small amount of foraging habitat it is unlikely to significantly impact the recovery of this species due to the higher quality resources available in the locality. Consequently, this proposal is unlikely to impede the implementation of any of these priority actions.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 31 key threatening processes identified in NSW one is of relevance:

- Clearing of Native Vegetation. Around 4.78 ha of woodland habitat along the 26 km of amended pipeline route would be removed for this project. To minimise potential impacts clearing of native vegetation should be kept to a minimum.

Conclusion

This proposal would not impact on any known breeding habitat for this species and it is unlikely to have a significant impact on foraging resources given that resources of equal or higher quality are available within the locality. The implementation of stringent environmental management measures during construction and operation would ensure that remaining vegetation and creeklines are protected and conserved and that as many hollow-bearing trees as possible are retained.

APPENDIX D

SITE PHOTOGRAPHS

Plate 1 Gas Field Development Area – typical view

Plate 2 Typical view of paddock habitat (KP 18.5)

Plate 3 Pipeline route through *Corymbia maculata* and *Eucalyptus crebra* at KP 19

Plate 4 Cattle camp at KP 24.2

Plate 5 Powerline easement at KP 71.5 and 73.8

Plate 6 Hunter Lowland Redgum Forest (EEC) at KP 76.

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Contents

1.0	**INTRODUCTION**		**1**
	1.1	Project Description	1
	1.1.1	Overview	1
	1.1.2	Gas Field Development Area	2
	1.1.3	Central Processing Facility	2
	1.1.4	Pipeline Corridor	4
2.0	**POTENTIAL AIR EMISSIONS FROM THE FACILITY**		**7**
	2.1	Construction Emissions	7
	2.2	Operational Emissions	7
	2.3	Pollutants of Concern	8
	2.3.1	Nitrogen Dioxide	8
	2.3.2	Carbon Monoxide	8
	2.3.3	Particulate Matter	9
	2.3.4	Volatile Organic Compounds (VOCs)	9
	2.3.5	Formaldehyde	9
	2.3.6	Odour	9
	2.4	Impact Assessment Criteria	9
3.0	**EXISTING AIR QUALITY**		**11**
4.0	**ATMOSPHERIC DISPERSION MODELLING**		**13**
	4.1	Dispersion Model	13
	4.2	Modelling Scenarios	13
	4.3	Meteorological Data	14
	4.4	Emissions Inventory	14
	4.4.1	Stack Characteristics	14
	4.4.2	Pollutant Emission Rates	16
	4.5	Terrain Data and Receptors	17
	4.6	Building Wake Effects	17
5.0	**ASSESSMENT OF POTENTIAL AIR QUALITY IMPACTS**		**19**
	5.1	Construction Emissions	19
	5.2	Operational Emissions	19
	5.2.1	CPF Emissions	19
	5.2.2	Gas Flare Emissions	22
6.0	**ENVIRONMENTAL SAFEGUARDS**		**25**
	6.1	Stage 1 GFDA	25
	6.2	CPF	26
7.0	**GREENHOUSE GAS ASSESSMENT**		**27**
	7.1	Methodology	27
	7.2	GHG Source Description	27
	7.3	Results and Assessment	27
8.0	**PLUME RISE ASSESSMENT**		**29**
	8.1	Background	29
	8.2	Project Description	29
	8.3	CASA Requirements	29

8.3.1 Background 29
8.3.2 The Use of Different Plume Models 30
8.4 Assessment Methodology 30
8.5 Modelling Results 32
8.6 Plume Rise Findings 32
9.0 CONCLUSIONS 33

List of Tables

Body Report

Table 1: DECCW Impact Assessment Criteria 10
Table 2: Wallsend Ambient Monitoring Data Summaries 11
Table 3: Meteorological Input Parameters 14
Table 4: Summary of Stack Parameters 15
Table 5: Stack Locations 15
Table 6: Hexham Stack Location 16
Table 7: Pollutant Emission Rates 16
Table 8: Well Flare Emission Source Characteristics 17
Table 9: WBH Maximum Ground level Concentrations ($\mu g/m^3$) 19
Table 10: Maximum Predicted Ground Level Pollutant Concentrations ($\mu g/m^3$) – CPF Site 1 20
Table 11: Predicted Ground Level Pollutant Concentrations ($\mu g/m^3$) – CPF Site 7 21
Table 12: Maximum Predicted Ground Level Concentrations - Well Flaring 22
Table 13: Well Separation Distance Modelling Scenarios 23
Table 14: Well Separation Modelling Results 23
Table 15: Greenhouse Gas Emission Estimates 28
Table 16: TAPM Parameters 30
Table 17: Summary of Stack Parameters 31
Table 18: Stack Locations 31
Table 19: TAPM Modelling Results 32
Table 20: Critical Plume Extents – Central Processing Facility 32

List of Figures

Figures Section

Figure 1: Locality Plan
Figure 2: Site Layout – CPF1
Figure 3: Site Layout – CPF7
Figure 4: Discrete Receptors
Figure 5: Modelled Well Cluster Configurations
Figure 6: Approximate CPF Locations and Gloucester Airfield Location

List of Appendices

Appendix A: TAPM Wind Roses
Appendix B: Meteorological Data Analyses
Appendix C: Manufacturers' Specifications
Appendix D: Example AUSPLUME Input File

1.0 Introduction

The Gloucester Gas Project (GGP, or the Project) is a proposal to extract Coal Seam Gas (CSG) from the Gloucester Basin for use as an energy source for customers in NSW. The Project was originally developed by a joint venture between Lucas Energy Pty Ltd and Molopo (Gloucester) NL, who provided much of the information used in this assessment. The Project was subsequently acquired by AGL Gloucester L E Pty Ltd (AGL).

AECOM Australia Pty Ltd (AECOM) was commissioned by AGL to undertake an Environmental Assessment (EA) for the Project. This report addresses the potential effects of the Project on local air quality.

The Director-General's Environmental Assessment Requirements issued for the proposed Project (ref: S08/00826) specified that:

> *The EA must include a justified and tiered assessment of the risk of fugitive dust, odour and flare impacts during the construction and operation of the part projects and identify measures to mitigate impacts*.

Supplementary assessment requirements (issued on 25 August 2009) also required:

> *a comprehensive air quality impact assessment prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005), with particular focus on nitrogen oxides and particulates. The assessment must consider worst-case operating scenarios and meteorological conditions and potential cumulative impacts from surrounding mining operations and for the ancillary power station component of the project.*

Fugitive dust was considered to be a potential issue during the construction phase of the Project, while issues associated with odour and flaring could potentially occur during the operational phase. Additionally, the potential air quality effects associated with emissions of combustion products from the operation of the proposed plant were also considered.

1.1 Project Description

1.1.1 Overview

The Project involves three primary components:

- Gas-producing wells and associated infrastructure;
- A gas compression and treatment facility (two alternate locations), known as the Central Processing Facility (CPF);
- A high-pressure gas pipeline from Stratford to Hexham; and
- A delivery station at Hexham.

The proposed gas wells and CPF would be located near the town of Stratford, approximately 90 km north of Newcastle and 11 km south of Gloucester. The location of the proposed facilities is within Petroleum Exploration Licence (PEL) 285, issued under the *Petroleum (Onshore) Act 1991*. The project location and the area covered by PEL 285 are shown in **Figure 1**.

1.1.2 Gas Field Development Area

The development of well sites and associated infrastructure in the Gas Field Development Area (GFDA) to produce CSG would incorporate the following components:

- Development of well site locations, including drilling, construction, operation and post development activities;
- Development of a gas and water gathering system to collect gas and water produced at well sites and to transport them to the CPF; and
- Construction and operation of the CPF (detailed in **Section 1.1.3**).

The exact location of well sites and associated infrastructure has not been determined. The wells would, however, be located in a notional grid pattern, spaced approximately 600 m apart. Well sites would be interconnected in 'pod' arrangements via the gas gathering system, which would transport extracted gas to the CPF via a main trunk line.

1.1.3 Central Processing Facility

The Project involves the construction and operation of the CPF to treat and compress gas extracted from the wells to render it suitable for high pressure transport via the proposed gas pipeline. Two locations for the CPF are currently proposed, designated as CPF Site 1 and CPF Site 7 as shown in **Figures 2** and **3** respectively.

The CPF would have a capacity of up to approximately 30 PJ per year, and was designed to accommodate treatment of gas from an extended area. The CPF would compress the gas in stages from pressures of less than 300 kPa up to a maximum of 15.3 MPa. The CPF would also process the gas to remove impurities such as coal fines and free water. The processes undertaken at the CPF are described in further detail below.

CPF Operational Process Description

The CPF may include the following components:

- Up to eight compressor units and associated plant for the compression and dehydration of gas;
- Gas dehydration equipment;
- A water treatment facility for the desalination of produced water;
- Gas filtration, regulation, metering and analysis equipment;
- Filtration, regulation and metering equipment;
- A water treatment facility for the removal of oil-in-water emulsion from the process water caused by the compression process;
- A flaring system;
- A network of storage and evaporation ponds;
- Small scale ancillary power generation with a capacity of up to 15 MW;
- Administration and accommodation facilities;
- A plant control room; and
- Lay down areas for the storage of pipe and equipment.

A process description of each of the CPF process unit operations is provided below. A schematic flow diagram depicting the treatment and compression process has been included in the main AEA document..

Gas Compression Plant

The CPF would be connected to the four main trunk lines of the gas gathering system via a subsurface suction header at the inlet to the gas compression plant within the CPF. Gas would enter at a relatively low pressure via an inlet filter vessel, which would remove coal fines and free water from the gas.

Gas would then enter the compression plant, consisting of a reciprocating multistage compressor powered by a gas engine equipped with fan coolers. Gas would undergo up to four stages of compression. Gas would be heated and compressed at each stage, and then cooled and treated by a gas scrubber before the next stage of compression. Dewatering of the gas would occur (inter-stage dewatering) during the compression process. Water would be transferred to the separation system, discussed below. Compressed gas would be transferred to the dehydration system. The gas engine exhaust would be fitted with catalytic converters to reduce pollutant emissions by up to 90% (depending on the pollutant).

Dehydration System

Following compression, gas would be dehydrated using Triethylene Glycol (TEG). The TEG dehydration system would use TEG to absorb moisture from the compressed gas stream in accordance with the required pipeline specifications. Compressed gas would be counter-flowed with dry hot glycol in a contactor column; water vapour would be removed from the gas and absorbed by the glycol.

The wet glycol, referred to as wet rich glycol, would be regenerated in a tube heater through boiling off the absorbed water vapour. The glycol would be reinjected into the contactor vessel for re-use once the water vapour was removed.

Process Water Treatment System

Water captured during the processes described above may become mixed with oil from the plant and equipment used in each of the processes. The separation system would separate the oil and water; the oil would be stored for off-site transport to a recycling facility, and the water would be transferred to the water processing facility for treatment. The inlet filter vessel, inter-stage scrubbers (compression process), and the discharge filter from the dehydration system would be connected to the separation system.

The separation system would include:

- Distribution pipe work for connecting the vessels to the separator;
- A separator vessel designed for oil water separation;
- Connection of the clean water to the water processing facility; and
- Connection of the separated oil to oil storage tanks for off-site transport and recycling.

Should severe emulsions be generated, a specialised waste water treatment facility would be installed that would break down oil-water emulsions by utilising a chemical successfully trialled at other AGL operations that, when activated, binds oil and flocculates, generating treated water suitable for disposal. The waste chemical-oil residue would be suitable for disposal at a landfill facility.

Flare System

The CPF would be connected to a flare system, which would connect the compressor station suction and discharge pipe work and the compressor blowdown. The flare system would allow gas in the gathering system and CPF to be burned (flared) in the event of an emergency that requires the evacuation of gas from the system.

During normal operation, a small pilot flare will be continuously in operation for provision of emergencies as well as for routine depressurisation of process elements and compression unit for maintenance. The frequency of the maintenance flaring is expected to be once per year after commissioning and is not expected to present a significant additional source requiring modelling.

As the flare is intended as an emergency measure only, emergency flaring emissions were not included in the impact assessment.

Small-Scale Ancillary Power Generation Facility

A small scale ancillary power generation facility is proposed within the CPF footprint. The ancillary power generation facility would comprise up to five 3 MW power generator units, with a total capacity of up to 15 MW. The power generator units would be gas-fired generators that would be driven by gas produced by the Stage 1 GFDA.

The ancillary power generation facility would be used for the purpose of providing power to plant such as the water treatment facility at the CPF site. Where possible, gas produced during the commissioning of well sites would be transported to the power generation facility and used for the generation of electricity rather than being flared for a short period at well sites. Any surplus power generated could be fed into the national electricity grid. The proposed generators would be fitted with catalytic converters, which would reduce pollutant emissions by up to 90% (depending on the pollutant).

Control Room

A control room would be located on the CPF site containing the Supervisory Control and Data Acquisition (SCADA) interface for field, pipeline and compressor station telemetry. Field telemetry would comprise equipment monitoring gas flow, water flow and downhole pressure. This information would be transmitted via a radio link back to the CPF control room to allow for the monitoring of well behaviour, assist with production optimisation and enable improved operational response in the event of an emergency. Various data from the CPF and Transmission Pipeline would be captured by the SCADA system to allow safe operation of the facilities.

Operation

The compressor station would operate 24 hours per day. During typical operation, approximately 30 AGL staff and contractors would be on site between 7 am and 5 pm. Personnel may be required to be on site 24 hours per day for short periods during operational shutdowns for maintenance or other purposes.

1.1.4 Pipeline Corridor

The proposed pipeline would be constructed within a 100 m corridor of land extending approximately 96 km from Stratford to Hexham. The pipeline would transfer the gas to Hexham, from where it would be fed into the Sydney - Newcastle trunk pipeline for distribution to consumers. An odorant will be added to the gas stream at the Hexham transfer point.

Works within the pipeline corridor would include:

- Clearing and site preparation;
- Excavation and earth works;
- Trenching of the pipeline route;
- Laying of pipeline;
- Hydrostatic testing; and
- Backfilling and rehabilitation.

The gas pipeline does not present a risk to air quality under normal operating conditions as any leaks would be quickly rectified to minimise the risk of explosion, which would mitigate any risk to the environment. Emissions from the construction of the pipeline itself would be handled by typical construction management procedures as discussed in **Section 6.0**.

There will be no risks to Air Quality during pipeline operations due to leaks however routine pipeline inspections will detect small leaks consistent with good industry practice and Australian Standards AS2884.5 and AS2885.3.

The Hexham Delivery Station consists of a Gate Station into which the CSG extracted from the Field Area would be fed. This is a continuously operating pipeline junction system which is not expected to significantly contribute to air quality in the Hexham area. However as there is a small natural gas fired water bath heater operating at the site, this source has been included in this assessment.

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2.0 Potential Air Emissions from the Facility

2.1 Construction Emissions

During the construction phase of the project, dust may be generated from construction works, both at the site, within the pipeline corridor and at the well sites (site preparation and drilling of the extraction wells). Products of fuel combustion from vehicles and equipment used in construction activities are also potential air emissions. These emissions, however, can be minimised and managed through standard dust mitigation measures and vehicle selection and maintenance procedures. As such, no detailed investigation of the impacts of these emissions was undertaken.

While the GFDA would be constructed in approximately 18 months, the construction timeframe may be longer depending on the development scenarios (refer to **Section 5.4.13** in EA). Details provided below assume construction will occur within the 18 month timeframe, as this represents the most intense construction period and, therefore, the worst case scenario.

Construction of the CPF would be undertaken over a period of approximately 12 months, with works typically occurring between 7 am and 6 pm, Monday to Saturday with a construction activities also occurring on Sundays for non-sensitive areas.

Construction of the pipeline would be undertaken over a period of approximately 12 months. This period may be extended if poor weather conditions are experienced.

For the CPF, construction plant and equipment would be delivered to the site at the commencement of construction works, and would typically include the following:

- Grading machinery;
- 25T excavators;
- Tip trucks for transporting imported fill and base course material;
- Welding machinery;
- Electric generators;
- Cranes for heavy lifts;
- Cranes for small lifts;
- Franners for pipe spool placement; and
- Forklifts.

The plant components of the CPF would be delivered as prefabricated units and assembled on the site.

2.2 Operational Emissions

Air emissions resulting from operation of the proposed facility include emissions from the CPF plant/equipment and emissions from the flaring of the gas wells during commissioning (for a period of four weeks). Emissions from the wells (once capped), the gas pipeline and the transfer station are expected to be minimal, and would not be expected to affect local air quality either at Stratford or along the length of the pipeline between Stratford and Hexham.

The CPF pollution sources would be:

- 5 x 3 MW power generators (G1 – G5);
- 8 compressors (C1 – C8);
- Alternator (ALT);
- Triethylene regeneration skid (TEG1A); and
- Triethylene glycol re-boiler (TEG1B).

The Hexham delivery system contains a small water bath heater which has been included in the dispersion modelling assessment.

As part of the Hexham delivery system, odourant injection will occur. Odorant injection is however not considered likely to present a source of odorous emissions during normal operations.

As part of the dewatering process at each of the wells, a 45 kW diesel or natural gas generators would be located at each of the wells to provide electricity for each site. It is expected that this would last for between 6 – 8 months and there may be up to 20 separate generators operating around the well field. Due to their size, expected spacing and short period of operation i.e. only during commissioning, these generators are not expected to constitute a significant source and have not been included in the impact assessment.

2.3 Pollutants of Concern

Pollutants emitted from the facilities would primarily be combustion products formed during the compression, cleaning, and flaring of the gas, and burning of natural gas fuel by the proposed plant to generate electricity. The pollutants of concern in this assessment were considered to be:

- Nitrogen dioxide (NO_2);
- Carbon monoxide (CO);
- Particulate matter (PM_{10});
- Volatile organic compounds (VOCs);
- Formaldehyde; and
- Odour.

2.3.1 Nitrogen Dioxide

The combustion of fossil fuels generates oxides of nitrogen (NO_X), primarily nitrogen oxide (NO) and smaller amounts of NO_2. The NO, which has little health effects, reacts with ozone in the atmosphere to form more NO_2, which can significantly affect human health, primarily causing respiratory problems.

2.3.2 Carbon Monoxide

Carbon monoxide is an odourless, tasteless gas formed during the combustion of natural gas. As the gas can cause significant harmful health effects, it is considered to be a criteria pollutant by Australian federal and state governments. Levels of carbon monoxide in most areas of Australia outside the major cities are below levels considered to be hazardous to human health.

2.3.3 Particulate Matter

Particulate matter can be emitted from natural sources, and is also formed during the combustion of fossil fuels. Airborne particles are commonly differentiated according to their equivalent aerodynamic diameter. Particles with a diameter of less than or equal to 50 micrometres (μm) are collectively referred to as total suspended particulates (TSP). TSP primarily cause aesthetic impacts associated with settling on surfaces, which can cause soiling and discolouration. Particles with diameters less than or equal to 10 μm (known as PM_{10} or fine particulates) tend to remain suspended in the air for longer periods than larger particles, and can penetrate into human lungs. Particulate matter affects environmental conditions by enhancing chemical reactions in the atmosphere; reducing visibility; increasing the possibility of precipitation, fog and clouds; and reducing solar radiation.

2.3.4 Volatile Organic Compounds (VOCs)

VOCs are a group of organic chemical compounds that are produced by a wide range of industrial processes, and emitted from organic fuels. These pollutants can cause a wide range of health and environmental effects. While the National Pollutant Inventory (NPI) frequently refers to VOCs collectively, there is no impact assessment criterion for collective VOCs in NSW. As such, the VOC with the lowest criterion, benzene, is typically used to provide a conservative assessment of the potential effects of collective VOCs on sensitive receptors.

2.3.5 Formaldehyde

Formaldehyde, a VOC, is an intermediate product formed during the oxidation or combustion of methane. The pollutant, specifically detailed as an emitted pollutant in the compressor specifications (refer to **Appendix C**), is classified by the Department of Environment, Climate Change and Water (DECCW) as a principal air toxic (IARC Group 2B carcinogen, possible human carcinogen). As such, formaldehyde was assessed separately in this assessment. The power generators and compressors would be fitted with catalytic converters capable of removing 90 % of formaldehyde emissions (relative to published emission factors) from exhaust gases to minimise emissions of this pollutant. Due to the relatively small nature of the gas or diesel generators at the well heads, emissions from these sources are expected to be negligible.

2.3.6 Odour

Natural gas/methane is odourless and tasteless. The odour traditionally associated with natural gas is created by small amounts of sulphur compounds, which are added so leaks can be detected. AGL does not propose to add an odorant to the gas at the CPF, and none of the other activities to be undertaken at the site are significant sources of odour. The Project is, therefore, considered unlikely to generate offensive odours; as such, odour was not considered further in this assessment.

2.4 Impact Assessment Criteria

In order to determine the potential effects of a proposed development on air quality, the predicted ground level concentrations of pollutants resulting from the development need to be compared to relevant impact assessment criteria. In NSW, the criteria are specified by the DECCW in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Approved Methods; 2005), and represent maximum allowable pollution levels at the boundary of the premises or at the nearest sensitive receptor. **Table 1** outlines the DECCW impact assessment criteria for the pollutants assessed for the Project.

Table 1: DECCW Impact Assessment Criteria

Pollutant	Averaging Period	Concentration (μg/m^3)
Nitrogen dioxide (NO_2)	1 hour	246
	Annual	62
Carbon monoxide (CO)	15 minutes	100,000
	1 hour	30,000
	8 hours	10,000
Particulate matter less than 10 microns (PM_{10})	24 hours	50
	Annual	30
Volatile organic compounds (VOC) (benzene)	1 hour	29
Formaldehyde	1 hour	20

3.0 Existing Air Quality

The main sources of air pollution in the Gloucester basin are coal mining operations. Vehicle traffic along the main roadway (The Buckets Way) and wood smoke during the colder months would also contribute to pollutant levels.

No publicly available air quality monitoring data were identified for the Stratford region. A review of the NPI was undertaken of the local area (postcode 2422) in order to assess the local air quality. The Stratford Coal Mine, situated 1.5 km to the southeast of Stratford, is the only facility in the Stratford postcode area (which includes Gloucester) required to report to the NPI. The pollutant emissions from this facility are all ranked as low compared to other facilities and pollutant sources.

The DECCW operates a network of air quality monitoring station at various locations around the state. The closest, most representative station to the proposed Project is located at Wallsend. [The Beresfield station, which is a similar distance from the Project site, was not considered representative as it is located close to ongoing significant road works (Weakley's Drive overpass) and a major arterial road (Pacific Highway)]. The Wallsend station monitors NO_2 and PM_{10} particulate levels; a summary of the recorded data is shown in **Table 2**. Likely background pollutant concentrations at the Project site are expected to be lower than these monitored results due to the relative lack of pollutant sources in the Gloucester area. All other background pollutant concentrations are assumed to be negligible.

Table 2: Wallsend Ambient Monitoring Data Summaries

Year	NO_2 ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)	
	Max. 1 Hr Average	Annual Average	Max. 24 Hr Average[1]	Annual Average
2001	82.7	34.8	34.0	17.2
2002	80.8	34.7	39.0	20.6
2003	94.0	33.1	34.0	16.4
2004	77.1	33.4	43.0	17.1
2005	71.4	33.1	36.0	18.3
2006	69.6	34.3	44.0	18.6
Maxima	94.0	34.8	44.0	20.6

[1] Data recorded during bushfire periods were removed

Based on the data presented above, this assessment assumed the following background pollutant concentrations:

- NO_2 1 hour average – 94.0 $\mu g/m^3$
- NO_2 annual average – 34.8 $\mu g/m^3$
- PM_{10} 24 hour average – 44.0 $\mu g/m^3$
- PM_{10} annual average – 20.6 $\mu g/m^3$

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4.0 Atmospheric Dispersion Modelling

Construction emissions are typically considered to be a management issue due to the transient nature and variability of the emissions. As such, they are not appropriately assessed by dispersion modelling. Potential construction emission sources and mitigation practices were identified, and are discussed in **Section 5.1**. This section, therefore, relates to the Project's operational emissions only.

4.1 Dispersion Model

Operational emissions from the CPF (at each of two proposed locations), the Hexham delivery station and flaring of the gas wells were assessed by dispersion modelling using AUSPLUME v6.0. AUSPLUME is a Gaussian plume dispersion model with algorithms based on the Industrial Source Complex – Short Term (ISCST3) model approved by the US EPA for use in regulatory assessments undertaken within the United States.

AUSPLUME was developed by the Victorian EPA to enhance the ISCST3 model and make it applicable to Australian conditions. AUSPLUME is approved by the DECCW for use in regulatory assessments undertaken in NSW. The model uses the Gaussian dispersion model equation to simulate the dispersion of a plume from point, area or volume sources. Mechanisms for determining the effect of terrain on plume dispersion are also included. AUSPLUME operates on an hourly time step, and, therefore, requires hourly dispersion parameter data, including wind speed and wind direction. The dispersion of each pollutant plume is determined for each hour using conventional Gaussian model assumptions. Gaussian models are best used to identify pollutant concentrations at receptor locations close to emissions sources, as they can overestimate concentrations at longer distances.

Dispersion modelling was undertaken in accordance with the guidelines in the DECCW's Approved Methods. This document prescribes calculation modes for accounting for terrain effects, building wake effects, horizontal and vertical dispersion curves, buoyancy effects, surface roughness, plume rise, wind speed categories and wind profile exponents.

4.2 Modelling Scenarios

The modelling investigated the pollutant levels resulting from the operation of the CPF located at two proposed locations: CPF Site 1 and CPF Site 7 (refer to **Figures 2** and **3**). The CPF was assumed to operate continuously 24 hours a day, 7 days a week for a full year for the purpose of this assessment.

Emissions from the Water Bath Heater (WBH) at the Hexham delivery station are assumed to be continuous, emitting low level pollutants 24 hours a day, 7 days a week for a full year for the purpose of this assessment.

Emissions from the gas well flares were also assessed. Although each well would be flared for a maximum of four weeks, impacts were assessed through modelling a single well assuming continuous flaring for an entire year to ensure worst case meteorological conditions were captured. Only short-term, near-field pollutant concentrations were, however, assessed against the DECCW criteria for this aspect of operations.

Construction emissions are not appropriately assessed through dispersion modelling, as emissions will be highly dependent on works undertaken and the specifically meteorological conditions at the time. As stated in **Section 2.1**, construction emissions can be minimised and managed through standard dust mitigation measures and vehicle selection and maintenance procedures. As such, no dispersion modelling of these emissions was undertaken. Instead, methods to manage construction emissions are discussed in **Section 6.0**.

4.3 Meteorological Data

Meteorology in the area surrounding the Project is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at a small scale, while factors such as synoptic scale winds and complex valley drainage flows that develop during night hours, affect wind speed and direction on a larger scale. As the proposed Project is to be located in a valley setting, wind would be channelled along the axis of the valley.

Meteorological data required by AUSPLUME includes wind speed, wind direction, temperature and an estimation of the stability class and mixing height for the area surrounding the subject site. Preferably, meteorological data are sourced from on-site dedicated meteorological stations that have recorded data over a number of years. For the two sites investigated by this assessment, the meteorological data used was as follows:

- Meteorological data for the Hexham Delivery Station was obtained from the NSW DECCW monitoring location at Beresfield (approximately 4 km to the north of the Delivery Station). 12 months worth of continuous data was used from this location to examine the delivery stations potential impacts.
- No on-site data were available for the Gloucester Gas CPF sites and the Bureau of Meteorology does not operate any weather stations in the area. Meteorological data were, therefore, generated using The Air Pollution Model (TAPM), developed by CSIRO, for the year 2007. TAPM was run using the parameters shown in **Table 3**.

Table 3: Meteorological Input Parameters

Parameter	Input
TAPM v3.0.7	
No. of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 0.3 km)
No. of grid points	25 x 25 x 25
No. of vertical levels	25
Year of analysis	January 2007 to December 2007
Centre of analysis	32°6.5,151°57

Default TAPM parameters were used for land use and terrain data (9 second DEM). Wind rose plots from the TAPM-generated data are provided in **Appendix A**. Statistics relating to the meteorological data is provided in **Appendix B**.

4.4 Emissions Inventory

4.4.1 Stack Characteristics

In the absence of site specific emissions data, stack exhaust conditions and the discharge rate used in the dispersion modelling for the Project were derived from a combination of manufacturers' specifications (refer to **Appendix C**) and other information provided by AGL and their equipment suppliers (Clarke Energy). **Table 4** summarises the stack parameters used in the modelling. The source names represent the plant described in **Section 2.2**.

Table 4: Summary of Stack Parameters

Source Name	Stack Height (m)	Stack Temperature (°C)	Diameter (m)	Stack Area (m^2)	Stack Tip Velocity (m/s)
WBH Stack[1]	4.5	200	0.2	0.031	3.7
G1 – G5	10	375.0	0.60	0.28	32.4
C1 – C8	12.0	447.8	0.98	0.76	15.0
ALT	12.0	447.8	0.69	0.38	15.0
TEG1	8.0	250.0	0.20	0.03	15.0
TEG2	12.0	250.0	0.20	0.03	15.0

[1] WBH Stack is situated at the Hexham deliver station. All other stacks are to be situated at either CPF1 or CPF7 (depending on which site is selected).

The modelled locations of the stacks are shown in **Table 5**.

Table 5: Stack Locations

Source Name	CPF1		CPF7	
	Easting (m)	Northing (m)	Easting (m)	Northing (m)
G1	402211	6449176	400391	6443696
G2	402212	6449185	400389	6443684
G3	402213	6449193	400387	6443673
G4	402215	6449202	400386	6443661
G5	402216	6449211	400383	6443649
C1	402290	6449197	400286	6443667
C2	402291	6449204	400284	6443658
C3	402292	6449212	400283	6443647
C4	402293	6449219	400282	6443638
C5	402294	6449227	400280	6443627
C6	402295	6449234	400278	6443619
C7	402297	6449243	400278	6443607
C8	402298	6449249	400276	6443598
ALT	402351	6449177	400205	6443693
TEG1	402345	6449178	400213	6443692
TEG2	402339	6449180	400221	6443690
Ground elevation	115		140	

Table 6: Hexham Stack Location

Source Name	Easting (m)	Northing (m)	Elevation (m)
WBH	377070	6366955	NA[1]

[1] Elevation not considered at Hexham due to the flat nature of terrain surrounding the Hexham Delivery Station.

4.4.2 Pollutant Emission Rates

Pollutant emissions from the CPF were estimated based on a combination of manufacturers' specifications (refer to **Appendix C**), NPI emission factors and gas usage rates provided by Clarke Energy. Emissions rates for the WBH were obtained from expected gas usage rates and emissions factors from the National Pollutant Inventory (NPI). **Table 7** summarises the pollutant emission rates used in the modelling; data indicate emissions per unit.

Table 7: Pollutant Emission Rates

Source	Emission Rate (g/s)				
	NO_X	CO	PM_{10}	VOCs	Formaldehyde
WBH#	0.0236	0.00721	0.000634	0.00047	N/A
Generators	0.0015*	0.0032*	0.0003**	0.41**	0.016**
Compressors	0.51^	0.29^	0.033**	0.66^	0.039^
Alternator ⅄	0.26	0.14	0.017**	0.33	0.02^
TEG Re-boiler#	0.0073	0.0094	0.00071	0.00053	0.00053
TEG Regeneration skid#	0.013	0.016	0.00124	0.00093	0.00093
Well flare	0.143	0.827	0.01141	1.426	0.00011

* Modelling is based on the generator engine specification for the GE Jenbacher JGS 620 (refer to **Appendix C**). An engine with the same or better emissions specifications will be utilised for the CPF's.

** NPI Emissions Estimation Technique Manual, Combustion Engines, v3.0, 2008, assuming the installation of catalytic converters with a 90% removal efficiency for formaldehyde

^ Modelling of proposed formaldehyde mitigation measures conducted by Exterran; provided by AGL.

⅄ Caterpillar Engine Specification (refer to **Appendix C**).

NPI Emissions Estimation Technique Manual, Combustion in Boilers v3.1, 2008. All VOCs were assumed to be formaldehyde for the TEG plant

Short-term emissions will be released from the well flares during the commissioning of individual wells. As only one well is expected to be flared at any one time, a single well flare was modelled in this investigation. The vertical velocity of the flare was not known; as such, the representative well flare was modelled as a volume source in order to provide a conservative assessment of pollutant impacts (the flare would be expected to have significant vertical plume buoyancy that would assist plume dispersion, which volume sources do not have). The characteristics and pollutant concentrations for the flare are shown in **Table 8**.

Table 8: Well Flare Emission Source Characteristics

Source Name		Units	Well Flare
Flare release height		(m)	5
Initial plume dimensions	Horizontal spread	(m)	0.5
	Vertical spread	(m)	2
Pollutant emission rates[1]	NO_X as NO_2	g/s	0.143
	CO	g/s	0.827
	PM_{10}	g/s	0.0114
	VOCs as benzene	g/s	0.0000032
	Formaldehyde	g/s	0.00011

[1] Sourced from Table 57 NPI Emissions Estimation Technique Manual for Combustion Engines, version 3.0 June 2008

4.5 Terrain Data and Receptors

Digital terrain data were obtained for each of the two proposed CPF locations from a topographical map covering an area of 4 km x 4 km with a grid spacing of 0.2 km, roughly centred on each alternate Project site. The proposed Project sites are located on a relatively flat plain within the Gloucester basin.

Sensitive receptors typically include locations where people work, reside or congregate, such as houses, schools, sports fields, hospitals, nursing homes, child care facilities and some recreational facilities. Coordinates of specific sensitive receptors were provided by Lucas Energy and incorporated into the dispersion modelling, which predicted pollutant concentrations at each location. These locations are shown on **Figure 4**.

4.6 Building Wake Effects

The configuration of the CPF and the locations of the emission sources on site are not expected to give rise to building wake effects. The dispersion modelling did not, therefore, include building wake effects.

Emissions from the WBH at the Hexham Delivery Station are expected to be influenced by building wakes. Building dimensions have been entered into the model and wake effects calculated by the BPIP function in Ausplume.

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5.0 Assessment of Potential Air Quality Impacts

5.1 Construction Emissions

The primary potential sources of pollutant emissions during the construction phase of the Project are dust emissions from soil excavation and handling activities, well drilling and other construction works. Other sources include exhaust emissions (products of combustion) from construction equipment. The access road to the CPF site would be sealed prior to construction works commencing; as such, dust emissions from vehicle traffic accessing the site are expected to be minimal. Emissions from construction works are expected to be managed through standard dust mitigation and management measures as discussed in **Section 6.0**.

5.2 Operational Emissions

Dispersion modelling was conducted for pollutant emissions from the CPF at the two proposed locations (CPF Site 1 and CPF Site 7), the WBH at Hexham and from the flaring of gas wells using AUSPLUME as described in **Section 4.0**. Emissions from the CPF and the WBH consider all pollutant sources listed in **Section 2.2** and **Table 7**, including the power generators. An example AUSPLUME input file is provided in **Appendix D**.

5.2.1 CPF Emissions

Maximum ground level concentrations (GLCs) of all pollutants predicted by the dispersion modelling are shown in **Table 9** (Hexham Delivery Station), **Table 10** (CPF Site 1) and **Table 11** (CPF Site 7) for each of the sensitive receptor locations, as well as the maximum predicted concentrations at any point within the modelling domain.

All oxides of nitrogen emitted from the stacks were assumed to be converted to NO_2 to provide a conservative assessment. As noted in **Section 2.3.4**, benzene was chosen as an indicator pollutant for VOCs, as it has the lowest criterion of all the individual VOC species. The amount of benzene in VOCs released from the proposed plant was estimated from the benzene to VOCs ratio listed in the NPI Emissions Estimation Technique Manual for Combustion Engines, Version 3.0; benzene was, therefore, assumed to comprise 5 % of the total VOCs. As the background pollutant concentrations were assumed to be negligible, the modelled GLCs were taken to be representative of cumulative pollutant concentrations.

Table 9: WBH Maximum Ground level Concentrations ($\mu g/m^3$)

Pollutant	Averaging Period	Concentration	Criteria
NO_2	1 hour	96.5 (190.5)	246
	Annual	7.2 (42.0)	62
CO	15 min	29.8	100,000
	1 hour	29.5	30,000
	8 hour	22.0	10,000
PM_{10}	24 hour	1.7 (45.7)	50
	Annual	0.19 (20.8)	30
Benzene[1]	1 hour	0.14	29

[1] All VOC assumed to present as Benzene

Table 10: Maximum Predicted Ground Level Pollutant Concentrations (μg/m³) – CPF Site 1

Receptor Number	X	Y	NO_2		CO			PM_{10}		1 hour Formaldehyde	1 hour Benzene
			1 hour	Annual	15 min	1 hour	8 hour	24 hour	Annual		
1	401181	6450985	18 (112)	0.5 (35.3)	10	10.2	6.3	0.6 (44.6)	0.03 (20.63)	1.7	1.6
2	402744	6450767	27 (121)	0.3 (35.1)	11.6	15.5	7.6	0.5 (44.5)	0.02 (20.62)	3	2.8
3	401074	6450498	31 (125)	0.6 (35.4)	16.5	18	7.5	0.6 (44.6)	0.04 (20.64)	3	2.7
4	403698	6450518	49 (143)	0.3 (35.1)	15.6	28.5	8.3	0.6 (44.6)	0.02 (20.62)	5.1	4.8
5	402847	6450249	34 (128)	0.3 (35.1)	12.3	19.4	7.4	0.6 (44.6)	0.02 (20.62)	3.2	2.8
6	402911	6450039	22 (116)	0.5 (35.3)	10.9	12.6	11.9	0.7 (44.7)	0.03 (20.63)	2.1	1.9
7	404027	6450015	39 (133)	0.4 (35.2)	12.1	22.9	7.3	0.4 (44.4)	0.03 (20.63)	3.9	3.6
8	400809	6449726	27 (121)	0.5 (35.3)	14.1	15.2	8.6	0.6 (44.6)	0.03 (20.63)	2.5	2.3
9	403496	6449750	33 (127)	0.6 (35.4)	14	19.4	9.4	0.5 (44.5)	0.04 (20.64)	3.3	3
10	400271	6449421	39 (133)	0.4 (35.2)	18.1	22.5	9.1	0.5 (44.5)	0.02 (20.62)	3.8	3.6
11	403817	6449350	34 (128)	1.2 (36)	14.9	19.9	11.3	0.8 (44.8)	0.08 (20.68)	3.5	3.2
12	400374	6448270	39 (133)	0.5 (35.3)	18.5	22.7	7.1	0.7 (44.7)	0.04 (20.64)	3.9	3.6
13	401569	6447708	32 (126)	0.4 (35.2)	12.8	18.8	5.7	0.3 (44.3)	0.03 (20.63)	3.1	2.7
14	402420	6447680	36 (130)	0.6 (35.4)	15.9	20.5	6.9	0.4 (44.4)	0.05 (20.65)	3.3	2.9
15	402384	6447708	37 (131)	0.6 (35.4)	16.5	21.2	7.1	0.4 (44.4)	0.05 (20.65)	3.5	3.1
16	403552	6447169	49 (143)	0.8 (35.6)	19.3	27.9	11.6	0.6 (44.6)	0.06 (20.66)	4.6	4.1
17	400670	6447059	25 (119)	0.4 (35.2)	12.9	14.5	5.6	0.4 (44.4)	0.03 (20.63)	2.5	2.3
18	400845	6447027	30 (124)	0.4 (35.2)	13.3	17.5	4.5	0.3 (44.3)	0.03 (20.63)	3.1	2.9
All modelled locations			100 (194)	3.2 (38)	36.5	57.9	28.1	2.2 (46.2)	0.19 (20.79)	9.6	8.8
Criteria			*246*	*62*	*100000*	*30000*	*10000*	*50*	*30*	*20*	*29*

Table 11: Predicted Ground Level Pollutant Concentrations ($\mu g/m^3$) – CPF Site 7

Receptor Number	X	Y	NO_2		CO			PM_{10}		1 hour Formaldehyde	1 hour Benzene
			1 hour	Annual	15 min	1 hour	8 hour	24 hour	Annual		
1	400085	6445061	27 (121)	0.4 (35.2)	14.4	15.7	7.7	0.7 (44.7)	0.03 (20.63)	1.8	2.4
2	401471	6445045	22 (116)	0.3 (35.1)	8.9	12.5	8.2	0.5 (45)	0.02 (20.62)	2	1.8
3	400052	6444843	29 (126)	0.5 (35.3)	15.7	16.9	7.4	0.6 (45)	0.03 (20.63)	1.8	2.4
4	400023	6444786	29 (126)	0.5 (35.3)	15.8	16.8	6.7	0.6 (45)	0.04 (20.64)	1.7	2.4
5	400019	6444736	30 (126)	0.5 (35.3)	16.2	17.1	6.7	0.6 (45)	0.04 (20.64)	1.8	2.4
6	399982	6444699	29 (123)	0.6 (35.4)	15.9	16.6	6.9	0.6 (45)	0.04 (20.64)	2	2.3
7	399945	6444629	26 (120)	0.6 (35.4)	14.7	14.9	8.1	0.6 (45)	0.04 (20.64)	2.3	2.2
8	399970	6444621	27 (121)	0.6 (35.4)	15	15.3	7.7	0.5 (45)	0.04 (20.64)	2.2	2.1
9	400019	6444613	31 (125)	0.6 (35.4)	17	17.7	6.8	0.6 (45)	0.04 (20.64)	2	2.4
10	399768	6444526	33 (128)	0.8 (35.6)	18.5	19.1	10.7	1 (45)	0.05 (20.65)	1.9	2.9
11	399805	6444489	32 (127)	0.8 (35.6)	18.1	18.6	10.9	0.9 (45)	0.05 (20.65)	2.1	2.9
12	399797	6444432	37 (131)	0.8 (35.6)	20.4	21	11.5	1 (45)	0.06 (20.66)	2	3.1
13	399073	6444452	31 (126)	0.6 (35.4)	16.5	17.9	9.2	0.9 (45)	0.04 (20.64)	2.6	2.6
14	399797	6444403	38 (133)	0.8 (35.6)	21	21.7	11.7	1 (45)	0.06 (20.66)	2	3.2
15	399994	6443626	39 (135)	0.9 (35.7)	17.5	22.5	16.9	0.9 (45)	0.06 (20.66)	3.2	3.3
16	398740	6443243	28 (123)	0.5 (35.3)	14.5	16.3	8.4	0.5 (45)	0.04 (20.64)	2.1	2.6
17	399427	6443161	31 (126)	0.9 (35.7)	16.5	18	9.5	0.7 (45)	0.06 (20.66)	2.3	2.7
18	399616	6442482	36 (131)	0.6 (35.4)	15	20.6	7.2	0.4 (44)	0.04 (20.64)	2.8	3.3
19	400912	6441199	44 (141)	0.6 (35.4)	17.8	25.4	6.3	0.5 (45)	0.05 (20.65)	3.5	3.6
All modelled locations			97 (202)	3 (37.8)	47.8	55	33.4	2.1 (46)	0.18 (20.78)	5.5	6.6
Criteria			***246***	***62***	***100000***	***30000***	***10000***	***50***	***30***	***20***	***29***

As shown in **Tables 9** to **11**, the dispersion modelling predicted that there would be essentially no increase in background pollutant levels for annual NO_2 and annual and 24 hour PM_{10}. All pollutant concentrations were predicted to be well below the guideline criteria at all locations assessed.

5.2.2 Gas Flare Emissions

Each gas well would be flared for approximately four weeks during commissioning. The location of each well would vary, but the highest ground level pollutant concentrations would be expected to be relatively close to the sources; as such, an arbitrary well location was chosen for the dispersion modelling with terrain effects omitted (as terrain effects are not expected to be significant in the distances modelled). Due to the short emission timeframe of each well, only short-term averaging periods were considered in the assessment. The well flare emissions were modelled independently of other emission sources associated with the facility - as the CPF would not be operating at maximum capacity during most of the well commissioning activities, cumulative modelling of the CPF and well flares would likely lead to significant overestimates of pollutant concentrations. Terrain data and specific sensitive receptors were not included as these data would vary for each well location.

The initial assessment of NO_2 concentrations conservatively assumed that 100 % of the NO_X would be converted to NO_2; this led to predicted exceedances of the DECCW criterion. As such, a more specific assessment was undertaken using the DECCW's ozone limiting method. Maximum background ozone and NO_2 concentrations were assumed to be the same as those recorded at the DECCW's air quality monitoring station at Wallsend (approximately 90 km from the site) for 2007 for the purpose of the conversion. Background pollutant concentrations at the site are expected to be lower than those recorded at Wallsend, due to the site's relative isolation from pollution sources; as such, the NO_2 concentration reported represents a conservative estimate.

The maximum predicted GLCs are shown in **Table 12**.

Table 12: Maximum Predicted Ground Level Concentrations - Well Flaring

Pollutant	Averaging Period	Maximum GLC ($\mu g/m^3$)	Criteria ($\mu g/m^3$)
NO_2[1]	1 hour	113.9 (207.9)	246
CO	15 minute	3,982	10,000
	1 hour	3,180	30,000
	8 hour	1,730	10,000
PM_{10}	24 hour	10.8 (**54.8**)	50
VOCs (as benzene)[2]	1 hour	0.0123	29
Formaldehyde	1 hour	0.422	20

Bold entries denote exceedance of criteria; values in parentheses indicate cumulative concentrations

[1] NO to NO_2 conversion limited by ambient ozone concentration (DECCW Method 2, Level 1 Assessment; Approved Methods, 2005)

[2] Benzene concentrations calculated using predicted total VOCs concentration and the benzene to VOCs ratio listed in the NPI Emissions Estimation Technique Manual for Combustion Engines, Version 3.0 (benzene is predicted to comprise approximately 5% of the total VOCs).

All predicted ground level pollutant concentrations were well below the impact assessment criteria with the exception of cumulative concentrations of PM_{10}. It should be noted that the maximum concentration of PM_{10} occurs very close to the source with concentrations decreasing rapidly as they move away from the well. Within 150m of the wells, the PM_{10} concentration would be expected to decrease from its maximum, worst case concentration to a level below the assessment criteria (when considered cumulatively. It should also be noted, that the background concentrations from Wallsend are considered to be conservative estimates of actual background pollutant concentrations at the Project site. Actual concentrations would be expected to be lower at the Stratford area than in the Lower Hunter Valley.

It is understood that the flaring of the wells during commissioning may occur for up to four weeks per well on average, resulting in the likelihood that multiple wells would be flaring simultaneously.

Spacing of simultaneously flaring wells need to be examined to ensure that cumulative impacts do not occur. At present the order of commissioning and the spacing of the wells have not been finalized. To ensure that air quality impacts of the flares has been addressed, the pollutant which is emitted at the concentration resulting in the potential exceedences i.e. NO_2 has been used to try and define a minimum separation distance for simultaneous flaring.

The locations and configuration of the various wells and associated flares is not known. As a result, AECOM have investigated two well grouping configurations to try and establish generic separation distances between wells in a close cluster (refer **Figure 5**). The two cluster configurations examined were:

- Wells positioned in a straight line; and
- Wells configured on a triangular grid.

An initial separation distance between concurrently flaring wells was estimated based on the results of the modelling of a single flare. These separation distances were then refined using Ausplume for each of the scenarios above with a variable number of wells. Scenarios examined are shown in **Table 13**.

Table 13: Well Separation Distance Modelling Scenarios

Scenario	Well Sources Modelled
Scenario 1	3 Sources, triangular grid, 800m well separation distance
Scenario 2	3 Sources, spaced in a line, 500m well separation distance
Scenario 3	3 Sources, triangular grid, 700m well separation distance
Scenario 4	4 Sources, spaced in a line, 500m well separation distance
Scenario 5	4 Sources, triangular grid, 800m well separation distance
Scenario 6	5 Sources, spaced in a line, 500m well separation distance

Modelled results were examined and the results expressed in terms of the maximum predicted cumulative NO_2 concentration (with the aim of compliance with the 1 hour average criteria of 246 $\mu g/m^3$). Results of the modelling activities are shown in **Table 14**.

Table 14: Well Separation Modelling Results

Analysis Statistic	Modelled Scenario					
	1	2	3	4	5	6
Max[1] ($\mu g/m^3$)	206	243	**265**	243	206	243
Average[1] ($\mu g/m^3$)	120	120	121	123	125	126

Bold entries denote exceedence of assessment criteria.

[1] A background value of 92 $\mu g/m^3$ has been assumed for the modelling.

As shown in the modelled results, the well separation distances to ensure compliance are as follows:

- 800m for wells positioned in a triangular grid; and
- 500m for wells positioned in a straight line.

In addition to the spacing of individual wells within a cluster (either in a grid or straight line), spacing of well clusters was considered. When the well cluster NO_2 concentration contours were examined, it was noted for both the triangular grid and straight line scenarios that the NO_2 concentrations dropped off rapidly as you move away from the well cluster. Generally, once the plume had extended 1.5km – 2km from one of the wells on the edge of the cluster, the concentration reduced to within approximately 20-40 $\mu g/m^3$ of background (~115 – 135 $\mu g/m^3$). Hence if another cluster were commissioned at a spacing of 4km between the closest wells, the maximum concentration that would be expected to be approximately 174 $\mu g/m^3$ (background (94 $\mu g/m^3$) + well cluster 1 contribution (40 $\mu g/m^3$) + well cluster 2 contribution 40 $\mu g/m^3$) which is below the criteria of 246 $\mu g/m^3$.

The cluster spacing's are a general observation for the wells modelled and the clusters were not modelled together. As a result, a conservative cluster spacing of 4km is recommended to minimize the potential for cumulative impacts.

It needs to be noted that the modelling undertaken above was performed assuming a gas consumption rate of 0.1639 m^3/s (500,000 standard cubic feet per day, scfd). This gas flow rate is expected to comprise the upper limit of the expected flow rate and to ensure the modelling is conservative the upper limit of the gas consumption has been used in the modelling predictions. However, advice from AGL has indicated that the flow rate is expected to be lower than the upper limit and is expected to be closer to 0.0983m^3/s (300,000 scfd) to 0.0328 m^3/s (100,000 scfd), which would result in 40% - 80% reduction in NO_X emissions and a decrease in both the well minimum separation distances and the cluster spacing.

Based on modelling assumptions and assuming the minimum gas emission rate of 100,000 scfd, the well separation distance could be reduced from 800m (at 500,000scfd gas usage) to a 300m well spacing for wells in a triangular grid formation and a spacing of 100m for wells configured in a straight line (reduced from 500m). In addition the well cluster spacing would be expected to be able to be reduced significantly (estimated value of 1km would be expected to provide a significant degree of protection to prevent cumulative impacts from flaring well clusters.

6.0 Environmental Safeguards

6.1 Stage 1 GFDA

Construction

The construction safeguards recommended for the Stage 1 GFDA consist of the development and implementation of an Air Quality Management Plan (AQMP) as part of the broader CEMP for the Project which would outline activities required to minimise dust and vehicle emissions during the construction phase of the Project including:

- Control of access via gravelled roadways.
- Vehicle speed limits on site.
- Monitoring of wind speed and direction to manage dust-generating activities during undesirable conditions.
- Minimisation of areas of disturbed soils during construction.
- Dust suppression with water sprays or other media during windy periods (as required).
- Stockpiling of soils on site kept to a minimum.
- Conducting excavation works with limited soil free fall.
- Progressive rehabilitation of disturbed areas wherever feasible.
- Construction equipment idling time and engine tuning to minimise exhaust emissions.
- Visual assessment of air emissions on a routine basis.
- Procedures to address any complaints received.
- Use of wet drilling methods or emission capture devices (e.g. baghouses) to reduce dust emissions during well drilling.
- Contingency measures.

The safeguards to minimise potential impacts to air quality from the flaring of wells when commissioning wells are as follows:

- Minimising the time that flares are to be active i.e. minimise the time taken to cap the wells.
- Ensure a separation distance of at least 500 m for wells positioned in a straight line (maximum of five wells simultaneously flaring). To prevent cumulative impacts from flaring emissions.
- Ensure a separation distance of at least 800 m for wells positioned in a triangular grid.

If additional wells are to be flared simultaneously within the Stage 1 GFDA, a spacing of 4 km would be maintained. Provided the 4km spacing is implemented, the same separation distances as detailed above would be applied to ensure compliance.

Chapter 25 of the EA document provides further detail on the CEMP to be prepared for the Project.

Operation

Operation of the Stage 1 GFDA would require the development and implementation of an OEMP, with specific features of the plan aimed at monitoring, assessing and, if required, rectifying any air quality issues associated with the operation of the Stage 1 GFDA. **Chapter 25** of the EA document provides further detail on the OEMP to be prepared for the Project.

6.2 CPF

Construction

The construction safeguards recommended for the CPF consist of the development and implementation of an AQMP as part of the broader CEMP for the Project which would outline activities required to minimise dust and vehicle emissions during the construction of the CPF.

Operation

There are no predicted exceedences of the impact assessment criteria for pollutants of concern in relation to the operation of the CPF at either Site 1 or Site 7, provided that catalytic converters are installed on the generators and compressors with at least a 90% reduction efficiency for formaldehyde emissions.

The operational safeguards recommended for the CPF would require the development and implementation of an OEMP, with specific measures to monitor, assess and, if required, rectify any air quality issues associated with the operation of the CPF. These measures may include:

- Emissions testing to confirm post commissioning emissions for generator units and compressors.
- Regular emissions monitoring to ensure efficient operation of generator units and compressors.
- Provision for ambient monitoring of pollutants for a period of time post commissioning to demonstrate that impacts are not occurring.
- Provision of a contact number for local residents to report environmental concerns.

The OEMP would have an air emissions monitoring regime comprising the following:

- Level 1: Year 1 to 2: air emissions testing conducted quarterly.
- Level 2: Year 3 to 4: air emissions testing conducted semi-annually.
- Level 3: Year 5 onwards: air emissions testing conducted annually, if required.
- If there are any deviations on air emissions the testing regime would regress to a former level for two periods.
- If additional units are installed that are identical to ones previously installed then these new units would adhere to the older unit testing regime.

7.0 Greenhouse Gas Assessment

7.1 Methodology

The assessment of the greenhouse gas emissions associated with the Project was conducted using the methods and emission factors specified by the National Greenhouse Accounts (NGA) Factors (Department of Climate Change, November 2008). The NGA Factors provide three types of assessment categories:

- Scope 1 - direct emissions from sources within the boundary of an organisation such as fuel combustion and manufacturing processes.
- Scope 2 - indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.
- Scope 3 - all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation; that is, emissions from off site waste disposal, emissions associated with the production of fuels, and emissions from the generation of purchased electricity.

Due to the information available, this assessment was constrained to emissions resulting from the operational phase of the Project.

7.2 GHG Source Description

Sources or activities likely to generate greenhouse gas emissions from the proposed Project are:

- Fuel consumption (Scope 1) by CPF plant and equipment, i.e. the:
  - Generators;
  - Compressors;
  - Alternator;
  - TEG facility (re-boiler and regeneration skid); and
  - Water Bath Heater (Hexham Delivery Station)
- Natural gas pipeline transmission (Scope 3);
- Electricity used to run plant operations (Scope 2); and
- End use of natural gas produced at the facility (Scope 3).

The CPF will supply a total of approximately 30,000,000 GJ (30 PJ) of natural gas to end users per year. The workbook defines large users as those with an annual usage of greater than 100,000 GJ. As such, the CPF facility is considered to be a Scope 3 large user.

Note that the emissions from the temporary well generators have not been included as they represent small scale emissions over a very limited period of time and are not considered significant sources for this assessment.

7.3 Results and Assessment

Consumption details and greenhouse gas estimates resulting from operation of the Project are summarised in **Table 15**. Greenhouse gas emissions were converted to carbon dioxide equivalent units (CO_2-e) in accordance with the NGA Factors.

Table 15: Greenhouse Gas Emission Estimates

GHG Source	Number	Total Consumption		Total GHG	
				kg CO_2-e	t CO_2-e
WBH	1	7300	(GJ/year)	374,709	375
Generators	5	1,115,729	(GJ/year)	57,270,395	57,270
Compressors	8	4,302	(GJ/year)	220,820	221
Alternator	1	269	(GJ/year)	13,801	14
TEG re-boiler	1	6	(GJ/year)	283	0.3
TEG regeneration skid	1	10	(GJ/year)	495	0.5
Flares (gas well commissioning)*	52	2989	(t/year)	-	8460.2
Electricity usage	-	2,000	(kWh/year)	1,780	2
Pipeline transmission (indirect)	98 km	-		-	855
End user (large user)	-	30,000,000	(GJ/year)	426,000,000	426,000
				Total	**492,343**

* each flare would be flared continuously for 1 week; assumed all flares are flared in the same year

Total greenhouse gas emissions resulting from operation of the Project were estimated to be approximately 492,000 t CO_2-e per year. This represents approximately 0.32 % of the total greenhouse gas emissions from NSW in 2007 (151.6 Mt CO_2-e) and 0.42% of the NSW emissions from the energy sector (117.2 Mt CO_2-e).

The beneficial aspects of the Project should be considered. If the power to be supplied by the Project was generated by coal-fired power stations, the associated greenhouse gas emissions would be approximately double. Methane is a powerful greenhouse gas, with a potency of around 25 times that of carbon dioxide; removing this methane from the coal seams for use as a power source not only reduces the amount of coal needed to be extracted to provide power, but prevents the release of the methane to atmosphere, reducing net greenhouse gas emissions (burning of natural gas emits primarily CO_2 emissions which has a greenhouse gas potency 25 times lower than Methane).

8.0 Plume Rise Assessment

8.1 Background

The Gloucester Gas Project (the Project) is a proposal to extract Coal Seam Methane (CSM) gas from the Gloucester Basin for use as an energy source for customers in NSW. The Project was originally developed by a joint venture between Lucas Energy Pty Ltd and Molopo (Gloucester) NL, who provided much of the information used in this assessment. The Project was subsequently acquired by AGL Energy Limited (AGL).

AECOM Australia Pty Ltd (hereafter referred to as AECOM) was commissioned by AGL to undertake an Environmental Assessment (EA) for the Project. The potential effects of the Project on local air quality have been addressed as part of the EA (AECOM, 2009).

Plume emitting stacks within 15 km of an airport require the authorisation of the Civil Aviation Safety Authority (CASA) to assess compliance with civil aviation requirements for air space safety. The proposed gas compression and treatment facility for the Project, known as the Central Processing Facility (CPF), is located approximately 4.5 km from an active airfield and AGL is therefore required to submit an Impact Assessment Report that provides the data upon which CASA will base its hazard assessment, and determine whether the plume should be classified as a ‘hazardous object’ under Civil Aviation Safety Regulation (CASR) Part 139.

This report provides the assessment prepared in accordance with the Guidelines for Conducting Plume Rise Assessments (June 2004) issued by CASA, with data generated using the plume rise assessment module of The Air Pollution Model (TAPM).

8.2 Project Description

8.2.1.1 Location

The proposed CPF would be located at one of two proposed locations near the town of Stratford, approximately 90 km north of Newcastle and 11 km south of Gloucester. The location of the proposed CPF is within Petroleum Exploration Licence (PEL) 285, issued under the *Petroleum (Onshore) Act 1991*. The project location including the two potential CPF locations (designated CPF1 and CPF7) are shown in **Figure 6**.

8.2.1.2 Nearby Airfield

As discussed above, there is a small airfield in the general area as shown in **Figure 6**.

8.3 CASA Requirements

8.3.1 Background

Guidelines for conducting plume rise assessments are recommended in the Advisory Circular (AC) 139-05(0). The level of assessment depends on the type of source and proximity to an aerodrome and it should be noted that Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the regulations. This section summarises the guidelines relevant to this assessment.

The purpose of the AC is to provide guidance to aerodrome operators and persons involved in the design, construction and operation of the facilities with exhaust plumes about the information required to assess the potential hazard from a plume rise to aircraft operations. CASA has identified that there is a need to assess the potential hazards to aviation because the vertical velocity from gas efflux may cause airframe damage and/or affect the handling characteristics of an aircraft in flight.

Aviation authorities have established that an exhaust plume with a vertical gust in excess of 4.3 m/s may cause damage to an aircraft airframe, or upset an aircraft when flying at low levels. As a result, CASA requires the proponent of a facility with an exhaust plume, which has an average vertical velocity exceeding the limiting value (4.3 m/s at the aerodrome Obstacle Limiting Surface (OLS) or at 110 m above ground level anywhere else) to be assessed for the potential hazard to aircraft operations.

8.3.2 The Use of Different Plume Models

The Air Pollution Model (TAPM) is a combined predicted meteorological module, and plume dispersion module, which provides for realistic estimates of plume rise and lateral dispersion/displacement. This combination provides a three dimensional grid type simulation model which is most suited in estimating frequencies of occurrences. TAPM, run in meteorology mode, reliably simulates the complex three dimensional behaviour of the atmosphere and predicts site-specific hourly-averaged meteorological data. In the plume rise mode, TAPM analyses plume behaviour in the meteorological conditions which are likely to be experienced at the site.

CASA considers that TAPM provides the ability for realistic plume modelling where there is no reliable meteorological data available from measurements/observations.

Attachment A of the AC recommends the input parameters and data analysis and presentation requirements for the modelling assessment.

8.4 Assessment Methodology

Prediction of the plume rise statistics as required by the CASA AC has been undertaken using the TAPM prognostic dispersion model. Stack parameters along with expected plume merging parameters were used to predict the plume velocity and plume extent for every hour over a 5 year time period. The vertical velocity targeted by this investigation was 4.3 m/s and the modelling parameters used are summarised in this section.

Modelling data used in this plume rise assessment incorporates the same time period as used in the Air Quality Impact Assessment previously prepared for the Project to ensure consistency.

The TAPM model inputs and settings were based on the requirements outlined in the CASA AC “Guidelines for Conducting Plume Rise Assessment”. Aspects of the assessment and their relative compliance with the CASA circular have been listed in **Table 16**. The latest version of TAPM (v4) was used for this assessment.

Table 16: TAPM Parameters

Parameter	Model Data	Compliant with CASA Guidelines (Y/N)
Modelling period	1 Jan 2003 – 31 Dec 2007	Y
Grid centre coordinates	-32.1083°,151.95°	Y
Local values	400396 m, 6447077 m	N/A
Grid points	25 x 25	Y
Outer grid spacing	30 km x 30 km	Y
Vertical levels	25	Y
Domains	30 km, 10 km, 3 km	Y
Terrain	AUSLIG 9 second DEM	Y

The source parameters for each of the proposed stacks are shown in **Table 17.** The plumes from the three groups of stacks (i.e. G1 to G5, C1 to C8, and ALT, TEG1 and TEG2) would be expected to merge due to their proximity to each other, which may increase the buoyancy of the plume, and was accounted for in the dispersion modelling through the application of a buoyancy enhancement factors to the emissions from each gas stack. The value for the buoyancy enhancement factors was obtained from Manins, Carras and Williams (1992) and entered into the TAPM model.

As both CPF1 and CPF7 are to be constructed to a similar footprint, modelling the two locations separately was not deemed necessary. The results for the plume rise were applied to both locations and the impacts assessed in this context.

Table 17: Summary of Stack Parameters

Source Name	Stack Height (m)	Stack Temperature (°C)	Diameter (m)	Stack Tip Velocity (m/s)	Buoyancy Emission Factor
G1 – G5	10	375.0	0.60	32.4	2.91
C1 – C8	12	447.8	0.98	15.0	3.34
ALT	12	447.8	0.69	15.0	2.34
TEG1	8	250.0	0.20	15.0	2.34
TEG2	12	250.0	0.20	15.0	2.34

The modelled locations of the stacks are shown in **Table 18**.

Table 18: Stack Locations

Source Name	CPF1	
	Easting (m)	Northing (m)
G1	402210.8	6449176.3
G2	402212.2	6449184.5
G3	402213.3	6449193.1
G4	402214.6	6449201.8
G5	402216.0	6449211.1
C1	402289.7	6449197.2
C2	402290.9	6449203.8
C3	402292.0	6449212.0
C4	402293.1	6449218.6
C5	402294.3	6449227.0
C6	402295.2	6449233.7
C7	402296.6	6449242.7
C8	402297.7	6449249.3
ALT	402351.2	6449177.4
TEG1	402345.2	6449178.2
TEG2	402338.7	6449179.7

8.5 Modelling Results

The objective of the analysis of the data obtained from the TAPM model is to establish the critical height at which the plume vertical velocity is below the 4.3 m/s threshold. Data analysis was performed to calculate the critical vertical velocity profile in accordance with CASA (2004). For each of the five years assessed, the maximum vertical velocity and corresponding plume rise height was extracted from the TAPM output files and is shown below in **Table 19**.

Table 19: TAPM Modelling Results

Year	Maximum Plume Height at Critical Velocity (m)
2003	43
2004	48
2005	38
2006	48
2007	43

A summary of the plume characteristics for the CPF for all five years is provided in **Table 20**, which shows the maximum, minimum and average heights below which the plume vertical velocity exceeded 4.3 m/s (critical height). Plume characteristics shown in addition to the plume height include the maximum, minimum and average spreads of the plume in the horizontal and vertical directions.

Table 20: Critical Plume Extents – Central Processing Facility

Statistic	Critical Height (m)	Horizontal Plume Spread (m)	Vertical Plume Spread (m)	Horizontal Plume Displacement (m)[1]	
				X	Y
Maximum	48	5	3	9	7
Minimum	16	2	1	0	0
Average	18	3	2	1.3	1.3

[1] Note that the plume displacement value does not indicate direction, merely the degree to which the plume moved away from the source.

The results of the TAPM modelling found the plume height where the plume velocity was 4.3 m/s was 48 m. The maximum horizontal displacement away from the source location is estimated to be 9 m. As the closest proposed CPF is located approximately 4.5 km from the airfield, impacts from the plume on the airfield are not expected to occur (and by inference the more distant CPF to the south would also not result in impacts on the airfield). Furthermore, it was decided no further analysis was necessary as the plume height where the maximum plume vertical velocity occurred was well below 110 m.

8.6 Plume Rise Findings

Investigations into plume rise dynamics of the two potential CFP locations were conducted in accordance with CASA (2004). TAPM results were analysed to assess the height at which a vertical plume velocity of 4.3 m/s was exceeded and whether the subsequent plume height exceeded 110 m (CASA criteria). The results indicate that the plume characteristics from the proposed CFP are predicted to be in compliance with CASA (2004) requirements.

Plate 7 View of SEPP 14 Wetland from caravan Park

AH
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9.0 Conclusions

AGL proposes to develop a CSG extraction project at Stratford, approximately 90 km from Newcastle, NSW. The proposed activities include the extraction and purification of CSG from a number of gas wells at a Central Processing Facility (CPF), and transport of the gas via pipeline to Hexham, where it will be connected to the Sydney - Newcastle gas pipeline.

Air quality emissions from the proposed CPF facility and gas wells include emissions of dust during construction, and emissions of combustion products during operation of the CPF and flaring of the gas wells during commissioning. Odour was not considered likely to be an issue for the Project as natural gas is odourless, and odorant would not be added to the gas at the CPF. As such, odour modelling was not undertaken for the Project.

The CPF sources assessed were five 3 MW small scale ancillary power generators, eight compressors, an alternator, and a triethylene glycol re-boiler and regeneration skid. Construction emissions were not assessed quantitatively; rather, this assessment recommends the development and implementation of a Construction Environmental Management Plan.

The effects of the CPF, WBH and gas flare emissions on local air quality were assessed through dispersion modelling using AUSPLUME, together with meteorological data either sourced locally or generated by TAPM. Due to the inherent variability and relatively low likely emissions levels, fugitive emissions were not taken into account in the modelling.

Pollutants investigated were products of the combustion of natural gas; i.e.:

- Nitrogen dioxide (NO_2);
- Carbon monoxide (CO);
- Fine particulates (PM_{10});
- Volatile organic compounds (VOCs); and
- Formaldehyde.

The CPF emissions were assessed at two proposed locations – CPF Site 1 and CPF Site 7 – assuming operation for 24 hours per day, 365 days per year. The gas wells were modelled by assuming continuous flaring of a single well for a year, at an indicative location. Information used to determine emission rates and stack parameters were obtained from AGL, manufacturers' specifications, and National Pollutant Inventory emission factors. Catalytic converters were assumed to be fitted to all power generators and compressors to reduce pollutant emissions by up to 90% (relative to the NPI emission factors). Ground level pollutant concentrations predicted by the dispersion modelling were compared to DECCW criteria. Ambient pollutant concentrations were expected to be negligible due to the lack of pollutant sources near the site; as such, the model predictions were taken to be representative of cumulative pollutant concentrations.

The dispersion modelling predicted that all ground level pollutant concentrations resulting from operation of the proposed facilities would be below the relevant DECCW criteria for both proposed CPF sites at all modelled locations within the modelling domain (including both gridded and sensitive receptors).

Additionally, emissions resulting from the flaring of the wells during commissioning were also predicted to be below the DECCW criteria, with the exception of PM_{10}, where exceedances of cumulative pollutant concentrations were predicted for the area immediately surrounding the wells. Given that the PM_{10} concentrations fall to levels below the assessment criteria within 150 m of the wells and that the background pollutant concentrations assumed for this assessment are expected to be higher than those actually occurring at the site, no adverse impacts are expected to result from the Project.

The results of the dispersion modelling suggest that the proposed facilities should operate within acceptable air quality guidelines, provided that proposed mitigation measures are implemented, particularly the installation of catalytic converters on the generators and compressors with up to 90% reduction efficiency for air pollutant emissions.

All concentrations from the WBH are predicted to fall below the assessment criteria for all pollutants modelled. It should be noted that even with all the NO_X assumed to be NO_2 predicted levels are less than the assessment criteria. On this basis the Hexham Delivery Station is not expected to detrimentally impact on local air quality.

During the flaring of the wells (during commissioning) emissions of NO_X and PM_{10} have the potential to cumulatively impact on the environment. Provided well separation distances are maintained at 500m for wells constructed in a line or 800m for wells constructed in a grid pattern, impacts are not expected.

A plume rise assessment undertaken for the proposed CPF operation has demonstrated that the plume characteristics from the proposed CFP are predicted to be in compliance with CASA (2004) requirements.

Overall, the Gloucester Gas project is not expected to result in air quality emissions that will have detrimental impacts on the environment surrounding the CPF, Stage 1 GFDA, the pipeline or the Hexham delivery station.

Figures

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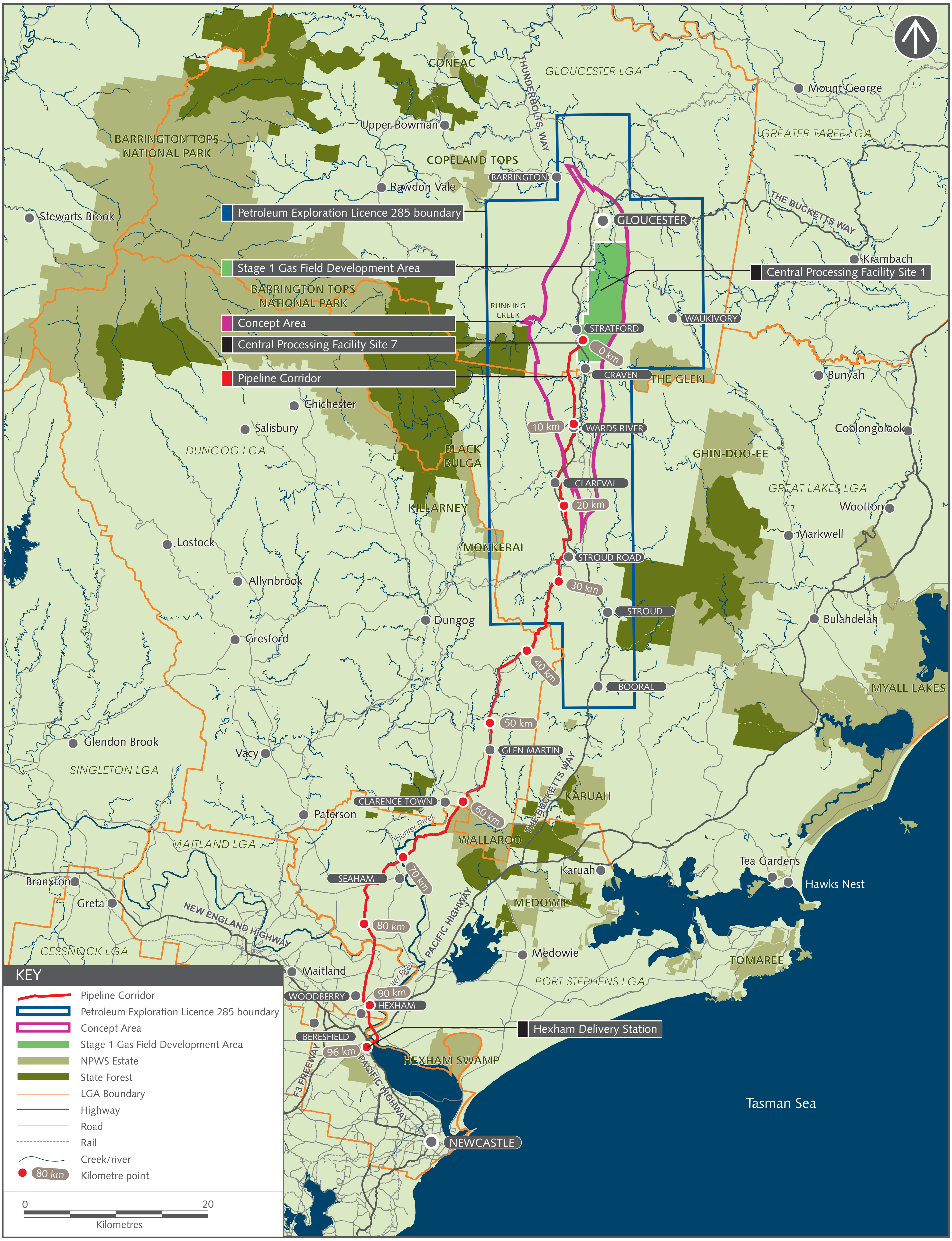

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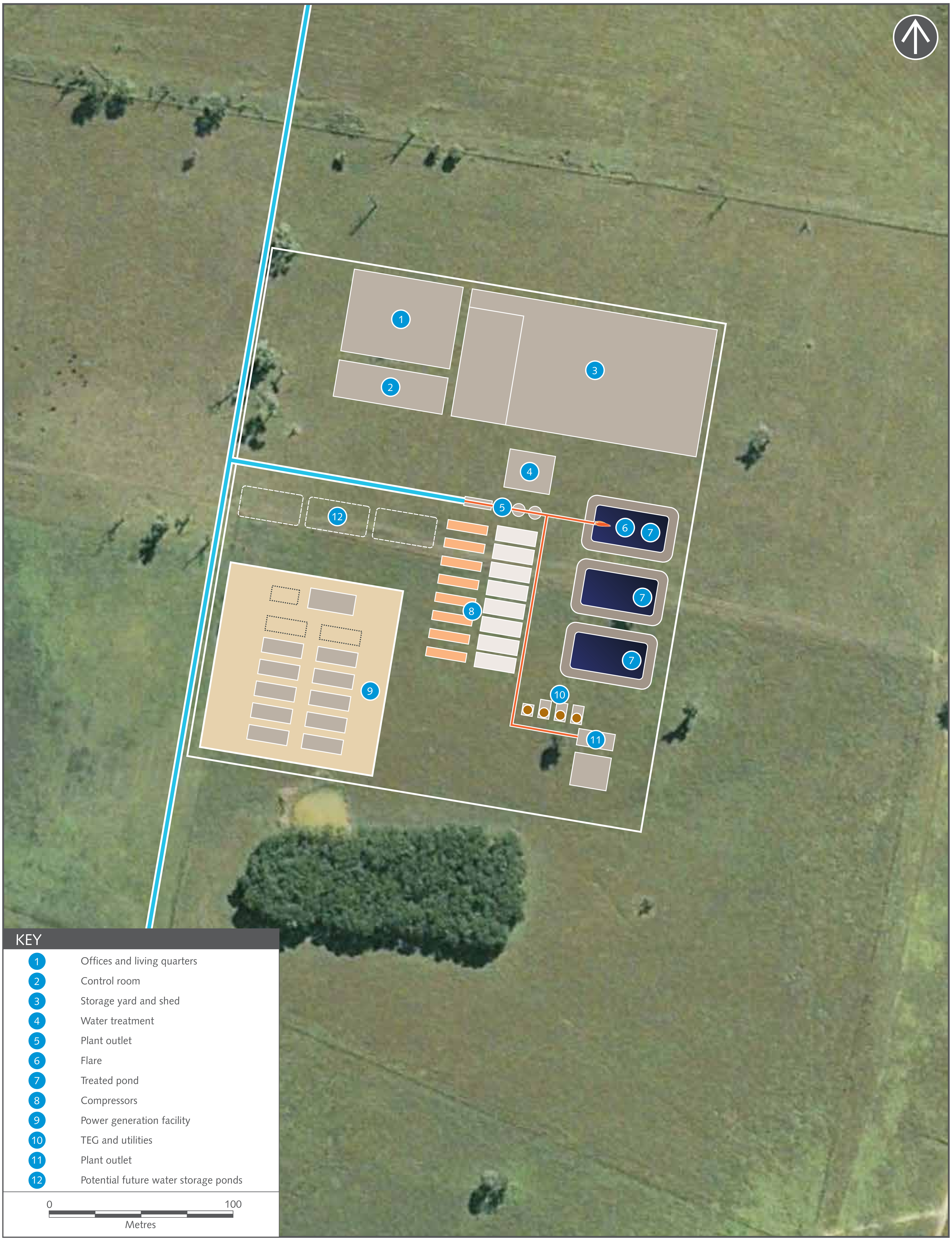
GLOUCESTER COAL SEAM METHANE GAS PROJECT LOCATION AND PEL 285 BOUNDARY

FIGURE 1



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CPF CONCEPTUAL SITE LAYOUT - SITE 1

FIGURE 2

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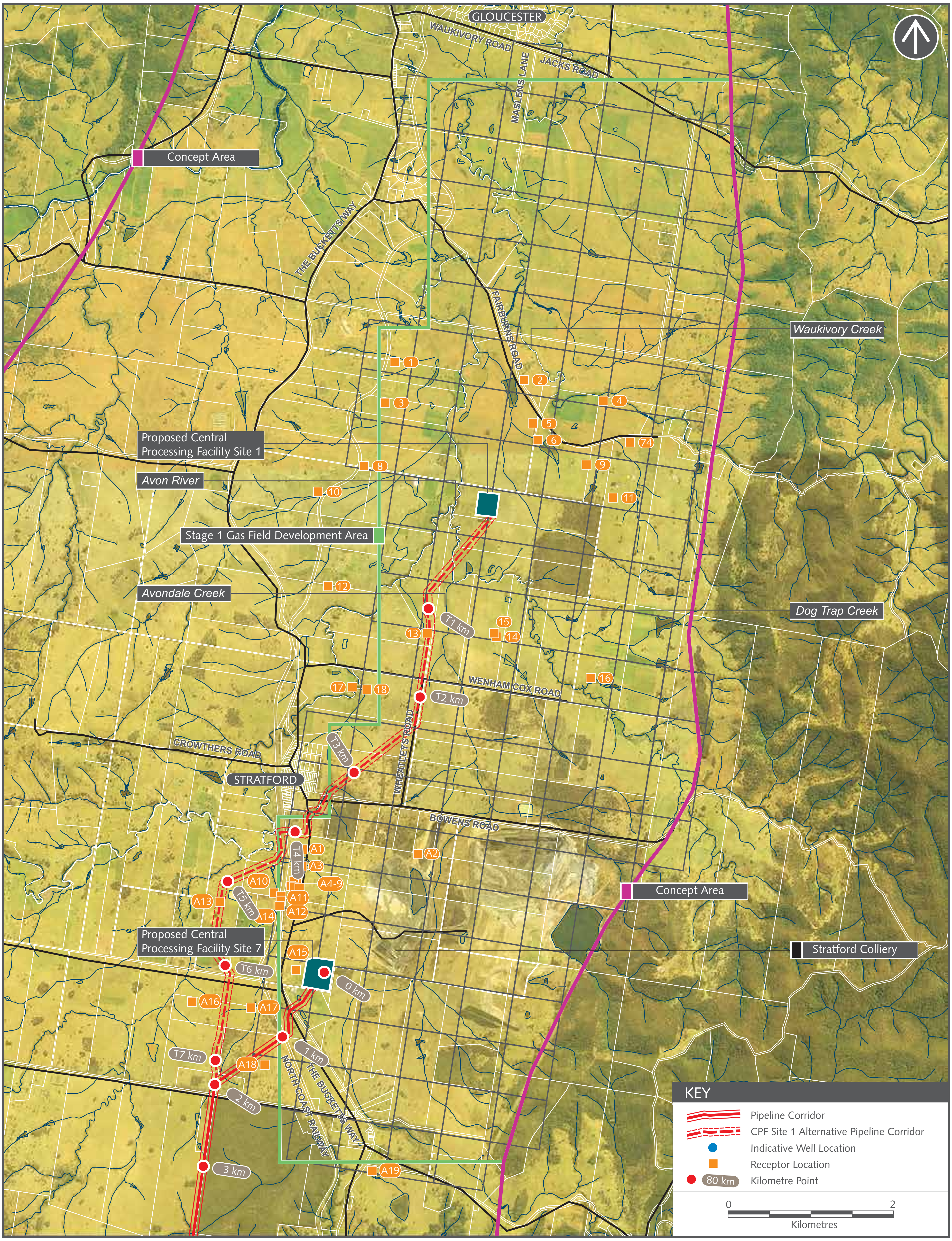
CPF CONCEPTUAL SITE LAYOUT - SITE 7

FIGURE 3



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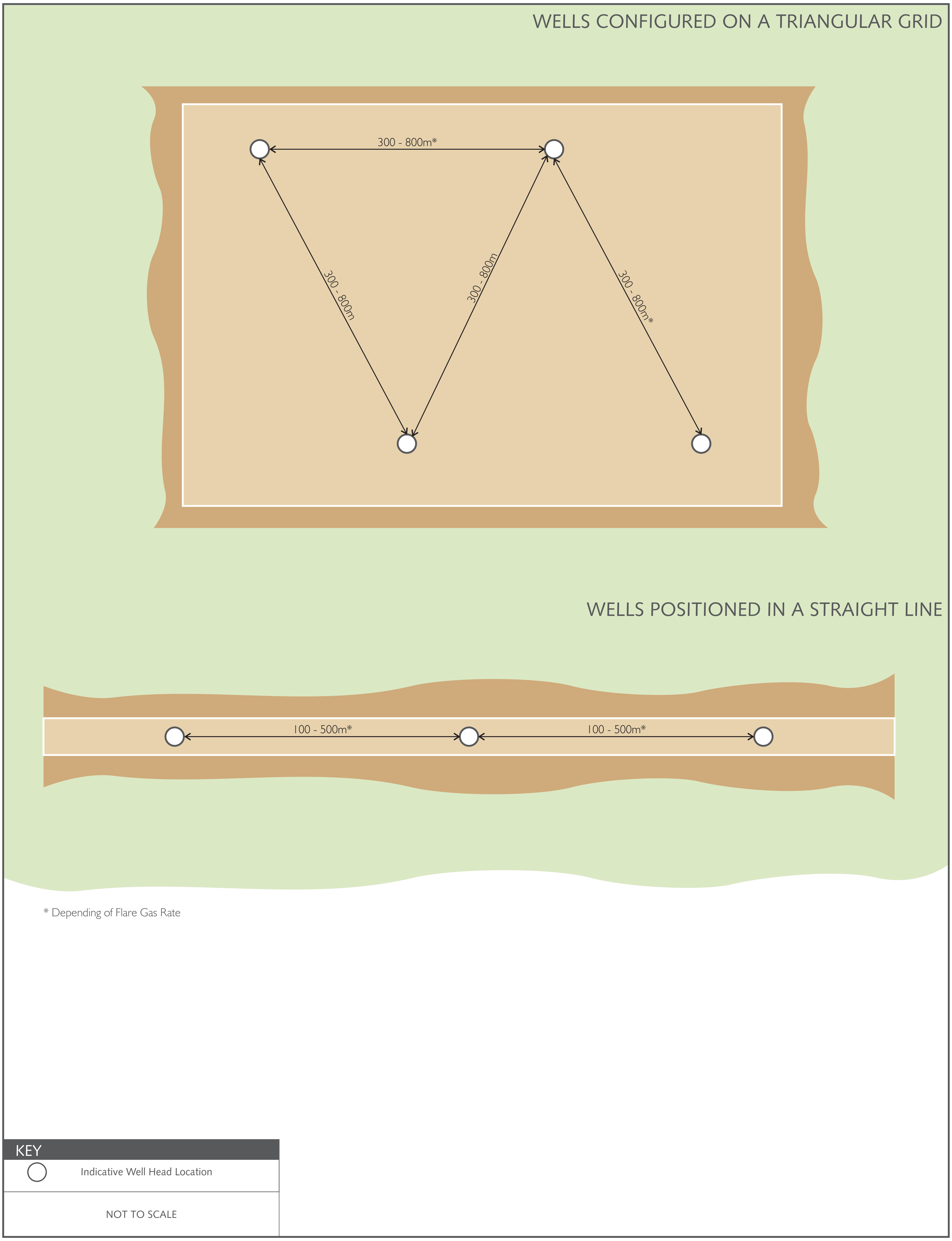
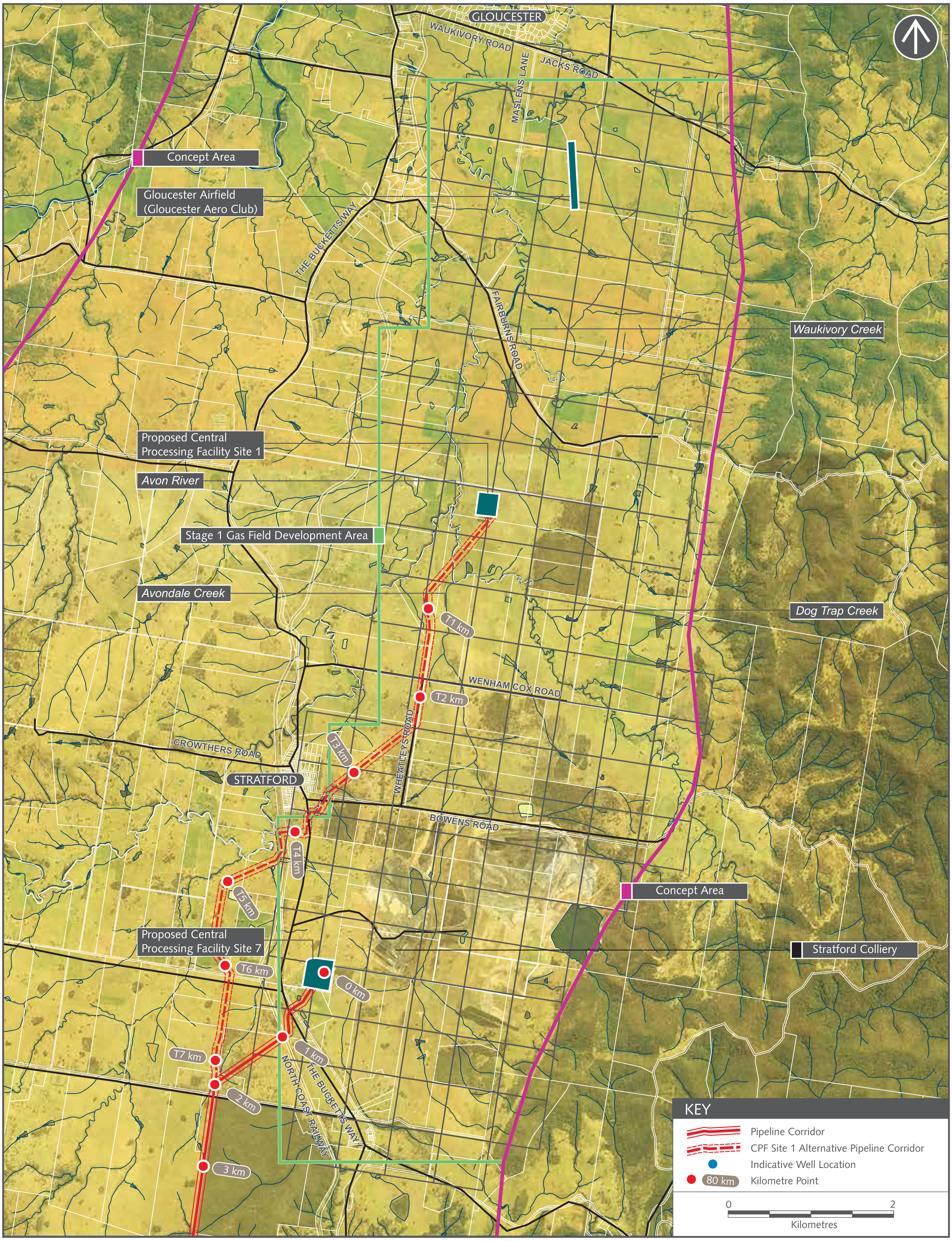
AIR QUALITY ASSESSMENT RECEPTOR LOCATIONS

FIGURE 4



AECOM MODELLED WELL CLUSTER CONFIGURATIONS

FIGURE 5



AECOM

CPF LOCATIONS AND LOCATION OF GLOUCESTER AIRFIELD

FIGURE 6

Appendix A: TAPM Wind Roses

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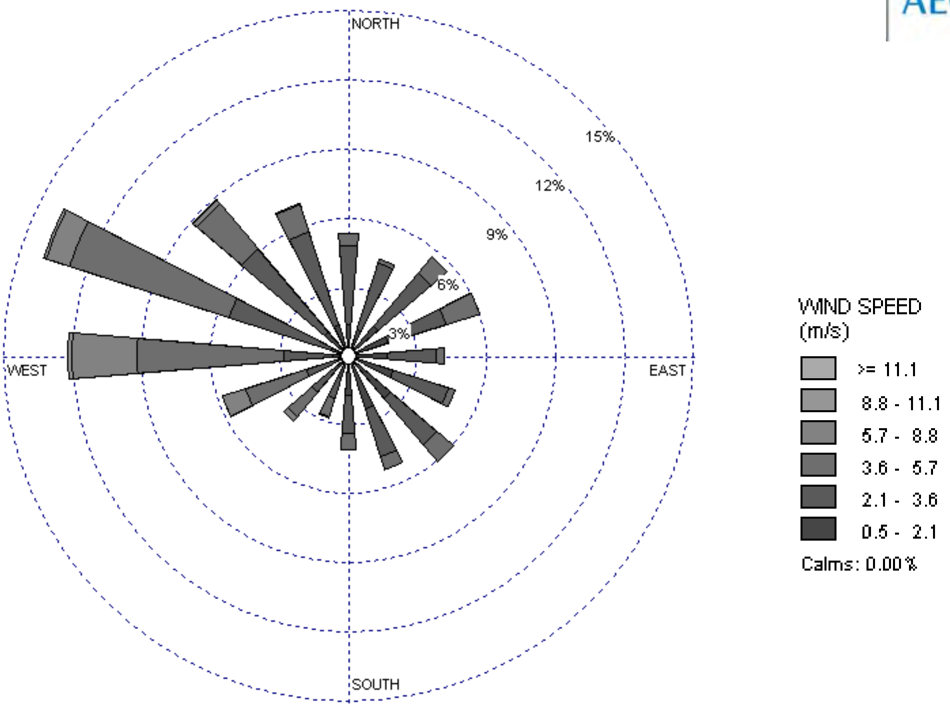
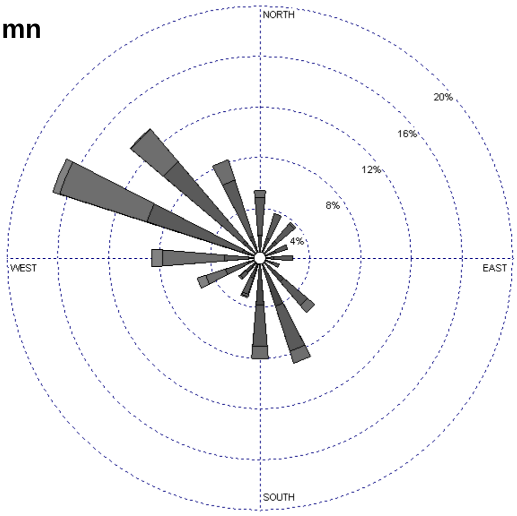
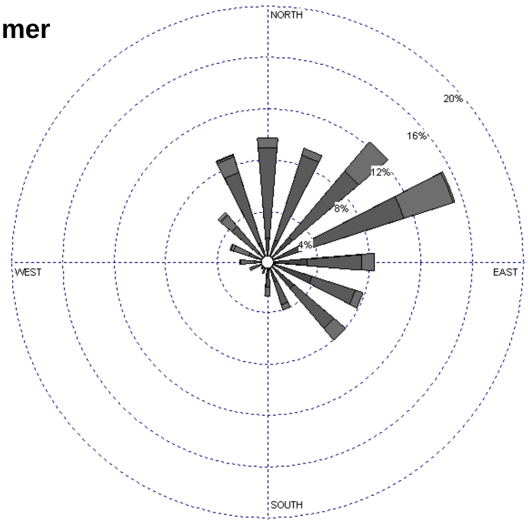
Annual



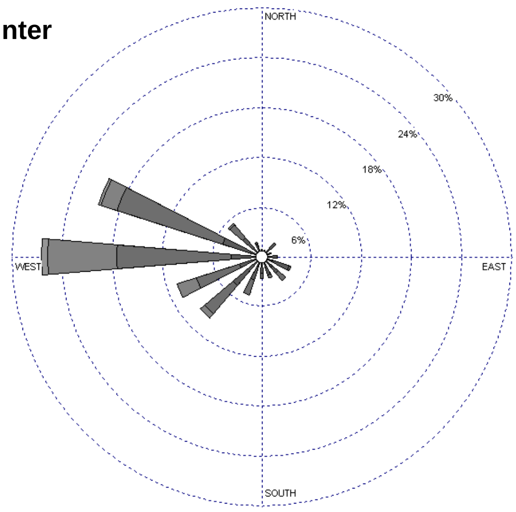
Autumn



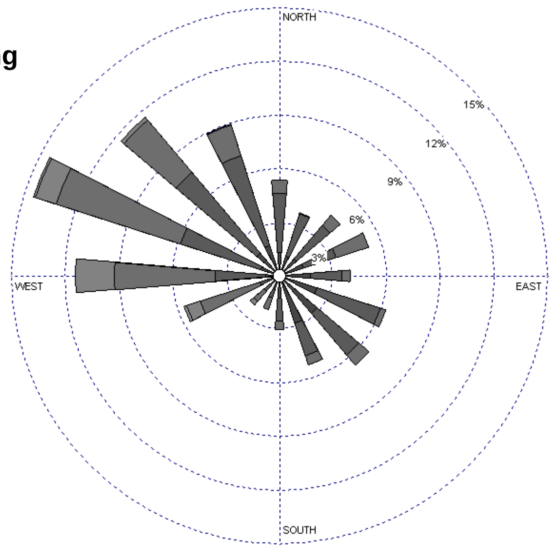
Summer



Winter



Spring



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Appendix B: Meteorological Data Analyses

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Stability Class

An important aspect of plume dispersion is the atmospheric turbulence level in the region of the plume. Turbulence acts to increase the cross-sectional area of the plume due to random motions, thus diluting or diffusing a plume. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe atmospheric conditions and, thus, dispersion.

The most well-known stability classification is the Pasquill-Gifford scheme, which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions, plumes can remain relatively undiluted for considerable distances downwind. Intermediate stability classes range from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is low.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds. The frequency distribution of estimated stability classes in the meteorological file are shown below.

Frequency of Occurrence - Stability Classes

Stability Class	Frequency of Occurrence (%)
A	1.0
B	4.0
C	7.7
D	16.2
E	43.8
F	22.0

Stability Class by Hour of Day

Hour	Stability Class Counts					
	A	B	C	D	E	F
1	0	0	0	130	175	60
2	0	0	0	137	171	57
3	0	0	0	137	171	57
4	0	0	0	141	173	51
5	0	0	0	143	177	45
6	0	0	0	261	85	19
7	0	0	7	336	18	4
8	0	0	103	262	0	0
9	0	30	171	164	0	0
10	0	92	172	101	0	0
11	3	123	160	79	0	0
12	22	115	145	83	0	0
13	32	91	152	90	0	0
14	33	66	151	115	0	0
15	28	68	127	142	0	0
16	3	67	99	196	0	0
17	0	19	100	246	0	0
18	0	0	36	282	33	14
19	0	0	0	220	97	48
20	0	0	0	99	161	105
21	0	0	0	108	167	90
22	0	0	0	116	166	83
23	0	0	0	121	167	77
24	0	0	0	129	162	74

Mixing Height

Mixing height is the depth of the atmospheric surface layer beneath an elevated temperature inversion. It is an important parameter within air pollution meteorology. Vertical diffusion or mixing of a plume is generally considered to be limited by the mixing height, as the air above this layer tends to be stable, with restricted vertical motions.

Stability Class by Mixing Height

Mixing Height (m)	Stability Class					
	A	B	C	D	E	F
< = 500	1	210	821	3204	1909	784
< = 1000	46	327	459	532	14	0
< = 1500	66	107	111	79	0	0
< = 2000	5	24	31	17	0	0
< = 3000	3	3	1	6	0	0
> 3000	0	0	0	0	0	0

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Appendix C: Manufacturers' Specifications

Technical Description

Genset

JGS 620 GS-S.L

Gloucester

Electrical output **3041 kW el.**

Emission values
NOx < 500 mg/Nm³ (5% O_2)

0.01 Technical Data (at genset) 4
Main dimensions and weights (at genset) 5
Connections 5
0.02 Technical data of engine 6
Thermal energy balance 6
Exhaust gas data 6
Combustion air data 6
Output / fuel consumption 7
Sound pressure level 7
Sound power level 7
0.03 Technical data of generator 8
Reactance and time constants 8
connection variant 1K 9
0.05 Cooling water circuit 10
Oil - heat (Engine jacket water cooling circuit) 10
Engine jacket water - heat (Engine jacket water cooling circuit) 10
Mixture Intercooler (1st stage) (Engine jacket water cooling circuit) 10
Mixture Intercooler (2nd stage) (Low temperature circuit) 10
10 Technical parameters 11
1.00 Scope of supply - Genset 12
1.01 Spark ignited gas engine 12
1.01.01 Engine design 12
1.01.02 Engine accessories 13
1.01.03 Standard tools (1/plant) 14
1.02 Generator-medium voltage 15
1.03 Module accessories 15
1.03.01 Engine jacket water system 17
1.03.02 Automatic lube oil replenishing system 17
1.05 Gas train 17
1.07 Painting 18
1.11 Engine generator control panel – DIA.NE XT 18
1.11.03 Remote Data-Transfer with DIA.NE XT - HERMES 22
1.20.01 Starting system 24
1.20.03 Electric jacket water preheating 25
1.20.04 Flexible connections 25
2.00 Electrical equipment 25
4.00 Delivery, installation and commissioning 26

4.01 Carriage **26**
4.02 Unloading **26**
4.03 Assembly and installation **26**
4.04 Storage **26**
4.05 Start-up and commissioning **26**

5.01 Limits of delivery - Genset **26**

5.02 Factory tests and inspections **27**
5.02.01 Engine tests **27**
5.02.02 Generator tests **27**
5.02.03 Module tests **27**

0.01 Technical Data (at genset)

Data at:				**Full load**	**Part Load**	
Fuel gas LHV		kWh/Nm³		9,5		
				100%	75%	50%
Energy input		kW	[2]	7.076	5.468	3.860
Gas volume		Nm³/h	*)	745	576	406
Mechanical output		kW	[1]	3.119	2.339	1.559
Electrical output		kW el.	[4]	3.041	2.276	1.504
Heat to be dissipated			[5]			
~ Intercooler 1st stage (Engine jacket water cooling circuit)		kW		492		
~ Intercooler 2nd stage (Low temperature circuit)		kW		221		
~ Lube oil (Engine jacket water cooling circuit)		kW		326		
~ Jacket water		kW		538		
~ Surface heat	ca.	kW	[7]	266		
~ Balance heat		kW		71		
Spec. fuel consumption of engine		kWh/kWh	[2]	2,27	2,34	2,48
Lube oil consumption	ca.	kg/h	[3]	0,94	~	~
Electrical efficiency		%		43,0%	41,6%	39,0%

*) approximate value for pipework dimensioning
[_] Explanations: see 0.10 - Technical parameters

All heat data is based on standard conditions according to attachment 0.10. Deviations from the standard conditions can result in a change of values within the heat balance, and must be taken into consideration in the layout of the cooling circuit/equipment (intercooler; emergency cooling; ...). In the specifications in addition to the general tolerance of +/- 8% on the thermal output a further reserve of 10% is recommended for the dimensioning of the cooling requirements.

Main dimensions and weights (at genset)

Length	mm	~ 8.900
Width	mm	~ 2.200
Height	mm	~ 2.800
Weight empty	kg	~ 29.400
Weight filled	kg	~ 30.400

Connections

Jacket water inlet and outlet	DN/PN	100/10
Exhaust gas outlet	DN/PN	600/10
Fuel gas (at gas train)	DN/PN	100/16
Fuel Gas (at genset)	DN/PN	100/10
Water drain ISO 228	G	½"
Condensate drain	mm	18
Safety valve - jacket water ISO 228	DN/PN	2x1½"/2,5
Lube oil replenishing (pipe)	mm	28
Lube oil drain (pipe)	mm	28
Jacket water - filling (flex pipe)	mm	13
Intercooler water-Inlet/Outlet 1st stage	DN/PN	100/10
Intercooler water-Inlet/Outlet 2nd stage	DN/PN	65/10

0.02 Technical data of engine

Manufacturer		GE Jenbacher
Engine type		J 620 GS-E01
Working principle		4-Stroke
Configuration		V 60°
No. of cylinders		20
Bore	mm	190
Stroke	mm	220
Piston displacement	lit	124,75
Nominal speed	rpm	1.500
Mean piston speed	m/s	11,00
Filling capacity lube oil	lit	670
Filling capacity water	lit	330
Length	mm	5.542
Width	mm	1.900
Height	mm	2.540
Weight dry	kg	12.000
Weight filled	kg	13.000
Moment of inertia	kgm^2	69,21
Direction of rotation (from flywheel view)		left
Flywheel connection		SAE 24"
Radio interference level to VDE 0875		N
Starter motor output	kW	30
Starter motor voltage	V	24

Thermal energy balance

Energy input	kW	7.076
Intercooler	kW	713
Lube oil	kW	326
Jacket water	kW	538
Exhaust gas total	kW	2.119
Exhaust gas cooled to 180 °C	kW	1.320
Exhaust gas cooled to 100 °C	kW	1.735
Surface heat	kW	188
Balance heat	kW	71

Exhaust gas data

Exhaust gas temperature at full load	°C [8]	425
Exhaust gas mass flow rate, wet	kg/h	17.325
Exhaust gas mass flow rate, dry	kg/h	16.181
Exhaust gas volume, wet	Nm^3/h	13.666
Exhaust gas volume, dry	Nm^3/h	12.293
Max.admissible exhaust back pressure after engine	mbar	60

Combustion air data

Combustion air mass flow rate	kg/h	16.816
Combustion air volume	Nm^3/h	13.008
Max. admissible pressure drop in front of intake-air filter	mbar	10

basis for exhaust gas data: natural gas: 100% CH_4; biogas 65% CH_4, 35% CO_2

Output / fuel consumption

ISO standard fuel stop power ICFN	kW	3.119
Mean effe. press. at stand. power and nom. speed	bar	20,00
Fuel gas type		Coal Seam Methane
Based on methane number|Min. methane number	MZ d)	94|80
Compression ratio	Epsilon	11,00
Min. fuel gas pressure for the pre chamber	bar	3,0-4,0
Min./Max. fuel gas pressure at inlet to gas train	mbar	120 - 200 c)
Allowed Fluctuation of fuel gas pressure	%	± 10
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	40
Spec. fuel consumption of engine	kWh/kWh	2,27
Specific lube oil consumption	g/kWh	0,30
Max. Oil temperature	°C	80
Jacket-water temperature max.	°C	95

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.1

Sound pressure level

Aggregate b)	dB(A) re 20µPa	101
31,5 Hz	dB	88
63 Hz	dB	95
125 Hz	dB	101
250 Hz	dB	99
500 Hz	dB	94
1000 Hz	dB	93
2000 Hz	dB	92
4000 Hz	dB	94
8000 Hz	dB	95
Exhaust gas a)	dB(A) re 20µPa	123
31,5 Hz	dB	112
63 Hz	dB	121
125 Hz	dB	131
250 Hz	dB	119
500 Hz	dB	117
1000 Hz	dB	118
2000 Hz	dB	117
4000 Hz	dB	112
8000 Hz	dB	98

Sound power level

Aggregate	dB(A) re 1pW	122
Measurement surface	m²	144
Exhaust gas	dB(A) re 1pW	131
Measurement surface	m²	6,28

a) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635, precision class 2.
b) average sound pressure level on measurement surface in a distance of 1m (converted to free field) according to DIN 45635, precision class 3.
Operation with 1200 rpm see upper values, operation with 1800 rpm add 3 dB to upper values.
Engine tolerance ± 3 dB

0.03 Technical data of generator

Manufacturer		AVK e)
Type		DIG 140 k/4 e)
Type rating	kVA	4.000
Driving power	kW	3.119
Ratings at p.f. = 1,0	kW	3.041
Ratings at p.f. = 0,8	kW	3.013
Rated output at p.f. = 0,8	kVA	3.766
Rated current at p.f. = 0,8	A	198
Frequency	Hz	50
Voltage	kV	11
Speed	rpm	1.500
Permissible overspeed	rpm	2.250
Power factor lagging		0,8 - 1,0
Efficiency at p.f. = 1,0	%	97,5%
Efficiency at p.f. = 0,8	%	96,6%
Moment of inertia	kgm²	190,00
Mass	kg	10.000
Radio interference level to VDE 0875		N
Construction		IMB 24
Protection Class		IP 23
Insulation class		F
Temperature (rise at driving power)		F
Maximum ambient temperature	°C	40
Total harmonic distortion	%	5,0

Reactance and time constants

xd direct axis synchronous reactance	p.u.	2,07
xd' direct axis transient reactance	p.u.	0,26
xd'' direct axis sub transient reactance	p.u.	0,16
Td'' sub transient reactance time constant	ms	40
Ta Time constant direct-current	ms	80
Tdo' open circuit field time constant	s	3,80

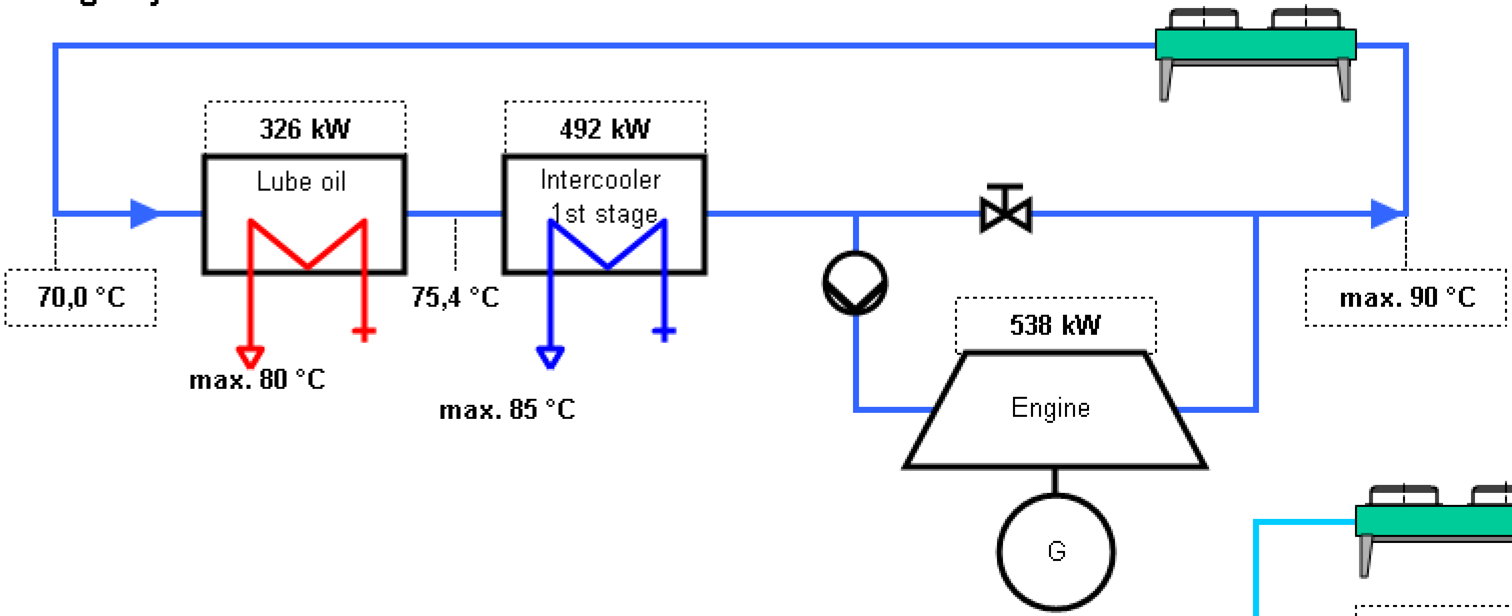
e) GE Jenbacher reserves the right to change the generator supplier and the generator type. The contractual data of the generator may thereby change slightly. The contractual produced electrical power will not change.

GLOUCESTER J620 E01

Engine jacket water cooling circuit (calculated with Glykol 37%)

Heat to be dissipated = 1.356 kW (+20/-8%)

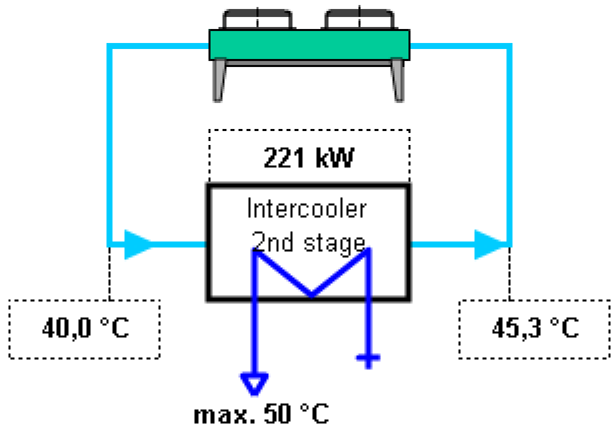
Engine jacket water flow rate = 58,2 m³/h



Low temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 221 kW (+20/-8%)

Cooling water flow rate = 40,0 m³/h



0.05 Cooling water circuit

Oil - heat (Engine jacket water cooling circuit)

Nominal output	kW	326
Max. Oil temperature	°C	80
Nominal pressure of engine jacket water	bar	10
Loss of nominal pressure of engine jacket water	bar	0,40
Safety valve - max press. set point	bar	2,50

Engine jacket water - heat (Engine jacket water cooling circuit)

Nominal output	kW	538
Max. engine jacket water temperature (outlet engine)	°C	90
Engine jacket water flow rate	m³/h	58,2
Safety valve - max press. set point	bar	2,50

Mixture Intercooler (1st stage) (Engine jacket water cooling circuit)

Nominal output	kW	492
Max. inlet cooling water temp. (intercooler)	°C	75,4
Nominal pressure of cooling water	bar	10
Loss of nominal pressure of engine jacket water	bar	0,50
Safety valve - max press. set point	bar	2,50

Mixture Intercooler (2nd stage) (Low temperature circuit)

Nominal output	kW	221
Max. inlet cooling water temp. (intercooler)	°C	40
Aftercooler water flow rate	m³/h	40,0
Nominal pressure of cooling water	bar	10
Intercooler water pressure drop	bar	0,60
Safety valve - max press. set point	bar	2,50

10 Technical parameters

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures and the methane number and subject to technical development and modifications.

All pressure indications are to be measured and read with pressure gauges (psi.g.).

(1) At nominal speed and standard reference conditions ICFN according to DIN-ISO 3046 and DIN 6271, respectively
(2) According to DIN-ISO 3046 and DIN 6271, respectively, with a tolerance of + 5 %
(3) Average value between oil change intervals according to maintenance schedule, without oil change amount
(4) At p. f. = 1.0 according to VDE 0530 REM / IEC 34.1 with relative tolerances
(5) Total output with a tolerance of +/- 8 %
(6) According to above parameters (1) through (5)
(7) Only valid for engine and generator; module and peripheral equipment not considered
(8) Exhaust temperature with a tolerance of +/- 5 %

Radio interference level
The ignition system of the gas engines complies the radio interference levels of CISPR 12 and EN 55011 class B, (30-75 MHz, 75-400 MHz, 400-1000 MHz) and (30-230 MHz, 230-1000 MHz), respectively.

Definition of output
- ISO-ICFN continuous rated power:
  Net break power that the engine manufacturer declares an engine is capable of delivering continuously, at stated speed, between the normal maintenance intervals and overhauls as required by the manufacturer. Power determined under the operating conditions of the manufacturer's test bench and adjusted to the standard reference conditions.
- Standard reference conditions:

Barometric pressure:	1000 mbar (14.5 psi) or 100 m (328 ft) above sea level
Air temperature:	25°C (77°F) or 298 K
Relative humidity:	30 %

- Volume values at standard conditions (fuel gas, combustion air, exhaust gas)

Pressure:	1013 mbar (14.7 psi)
Temperature:	0°C (32°F) or 273 K

Output adjustment for turbo charged engines
Based on an elevation of 260masl, full load is possible up to 35°C air intake temperature, a deration of 1,2°C per each 1°C is applicable between 35 and 40°C, 2% per each 1°C is applicable above 40°C.

If the actual methane number is lower than the specified, the knock control responds. First the ignition timing is changed at full rated power. Secondly the rated power is reduced. These functions are carried out by the engine management system.

Parameters for the operation of GE Jenbacher gas engines
The following "Technical Instruction of GE JENBACHER" forms an integral part of a contract and must be strictly observed: **TI 1100-0110 – TI 1100-0112**

Appendix D: Example AUSPLUME Input File

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AGL Dispersion Modelling - Location CP1

Concentration or deposition	Concentration
Emission rate units	grams/second
Concentration units	microgram/m3
Units conversion factor	1.00E+06
Constant background concentration	0.00E+00
Terrain effects	Egan method
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.400m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise? Yes

Stack-tip downwash included? Yes

Building downwash algorithm: PRIME method.

Entrainment coeff. for neutral & stable lapse rates 0.60,0.60

Partial penetration of elevated inversions? No

Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients

given by the hourly met. file, a value from the following table

(in K/m) is used:

Wind Speed	Stability Class					
Category	A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES

Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES

1 hour

AGL Dispersion Modelling - Location CP1

SOURCE CHARACTERISTICS

STACK SOURCE: G1

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402211	6449177	115m	10m	0.60m	375C	32.4m/s

No building wake effects.

(Constant) emission rate = 1.60E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: G2

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402212	6449185	115m	10m	0.60m	375C	32.4m/s

No building wake effects.

(Constant) emission rate = 1.60E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: G3

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402213	6449193	115m	10m	0.60m	375C	32.4m/s

No building wake effects.

(Constant) emission rate = 1.60E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: G4

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402215	6449202	115m	10m	0.60m	375C	32.4m/s

No building wake effects.

(Constant) emission rate = 1.60E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: G5

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402216	6449211	115m	10m	0.60m	375C	32.4m/s

No building wake effects.

(Constant) emission rate = 1.60E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C1

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402290	6449197	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C2

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402291	6449204	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C3

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402292	6449212	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C4

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402293	6449219	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C5

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402294	6449227	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C6

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402295	6449234	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C7

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402297	6449243	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: C8

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402298	6449250	115m	12m	0.98m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 4.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: ALT

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402351	6449178	115m	12m	0.69m	448C	15.0m/s

No building wake effects.

(Constant) emission rate = 2.00E-02 grams/second

No gravitational settling or scavenging.

STACK SOURCE: TEG1

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402345	6449178	115m	8m	0.20m	250C	15.0m/s

No building wake effects.

(Constant) emission rate = 5.30E-04 grams/second

No gravitational settling or scavenging.

STACK SOURCE: TEG2

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
402339	6449180	115m	12m	0.20m	250C	15.0m/s

No building wake effects.

(Constant) emission rate = 9.30E-04 grams/second

No gravitational settling or scavenging.

AGL Dispersion Modelling - Location CP1

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

400095.m 400295.m 400495.m 400695.m 400895.m 401095.m 401295.m

401495.m 401695.m 401895.m 402095.m 402295.m 402495.m 402695.m

402895.m 403095.m 403295.m 403495.m 403695.m 403895.m 404095.m

and these y-values (or northings):

6447034.m 6447234.m 6447434.m 6447634.m 6447834.m 6448034.m 6448234.m

6448434.m 6448634.m 6448834.m 6449034.m 6449234.m 6449434.m 6449634.m

6449834.m 6450034.m 6450234.m 6450434.m 6450634.m 6450834.m 6451034.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	401181	6450985	110.0	0.0	10	400271	6449421	124.0	0.0
2	402744	6450767	110.0	0.0	11	403817	6449350	120.0	0.0
3	401074	6450498	120.0	0.0	12	400374	6448270	129.0	0.0
4	403698	6450518	120.0	0.0	13	401569	6447708	111.0	0.0
5	402847	6450249	110.0	0.0	14	402420	6447680	120.0	0.0
6	402911	6450039	112.0	0.0	15	402384	6447708	121.0	0.0
7	404027	6450015	110.0	0.0	16	403552	6447169	132.0	0.0
8	400809	6449726	112.0	0.0	17	400670	6447059	120.0	0.0
9	403496	6449750	110.0	0.0	18	400845	6447027	120.0	0.0

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Worldwide Locations

Australia	+61-2-8484-8999
Azerbaijan	+994 12 4975881
Belgium	+32-3-540-95-86
Bolivia	+591-3-354-8564
Brazil	+55-21-3526-8160
China	+86-20-8130-3737
England	+44 1928-726006
France	+33(0)1 48 42 59 53
Germany	+49-631-341-13-62
Ireland	+353 1631 9356
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Japan	+813-3541 5926
Malaysia	+603-7725-0380
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Philippines	+632 910 6226
Scotland	+44 (0) 1224-624624
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Turkey	+90-312-428-3667
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Venezuela	+58-212-762-63 39

Australian Locations

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Newcastle
Perth
Sydney
Singleton

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Appendix G Ecological Assessment

Ecological Assessment Explanatory Note – Appendix G

An Ecological Assessment was prepared by AECOM Australia Pty Ltd (AECOM 2009) for the Gloucester Gas Project (the Project). This Ecological Assessment assessed the ecological values and potential impacts of the pipeline alignment known as Revision C, and shown in the Figures provided in AECOM (2009) in this Appendix.

Several project components have been altered since the original Ecological Assessment was prepared and as such, an Ecological Addendum has been prepared by Alison Hunt & Associates Pty Ltd (AHA 2009) to assess potential ecological impacts associated with the components of the Project which have been altered.

As such Appendix G contains two reports:

- **AECOM 2009**. Gloucester Gas Project Ecological Assessment. Gloucester to Hexham. Report prepared for AGL Gloucester LE Pty Ltd.
- **AHA 2009**. Gloucester Gas Project Gloucester to Hexham Amended Section. Addendum Ecological Report. Prepared for AGL Gloucester LE Pty Ltd.

These two reports should be read in conjunction with each other and Chapter 10 of the Environmental Assessment (Volume 1 of this EA).

The amended components of the project are listed below. Kilometre Point (KP) references were based on a previous pipeline alignment (known as Revision C) (refer to figures in AECOM (2009)).

- Expansion of the Stage 1 GFDA to encompass a total of 110 well site locations;
- Amended pipeline alignment totalling approximately 26 km between the following Kilometre Points (KPs) (refer to the Ecological Assessment prepared by AECOM (2009)):
  - KP 17 – 25: the pipeline route was realigned between these KPs to avoid a number of crossings of the Karuah River and associated riparian communities which are representative of Endangered Ecological Communities (EEC) *Lowland Rainforest on Floodplain of the NSW North and Sydney Bio-Regions*. Three crossings of the Karuah River and approximately 240 m of these EECs have been avoided by this re-alignment;
  - KP 27.5: Ramstation Creek crossing;
  - KP 71 – 82.8;
  - KP 89.5 – 95; and

Changes to the pipeline alignment are shown on **Figure 1** of the Ecological Addendum (AHA 2009). KP references in the Ecological Addendum (AHA 2009) are based on the updated pipeline alignment (Revision E), which is the revised version of the alignment proposed as part of the Project.

A KP conversion table is provided in **Table 1** which includes reference points for items discussed in the original Ecological Assessment against the revised pipeline route as discussed in the Ecological Addendum.

Figures 10.1 to **10.20** in Volume 4 of the EA reflect the revised pipeline alignment.

Table 1: Conversion Table for Kilometre Points (KPs) along Pipeline

Relevant Assessment Report	Original Route (Revision C)	Revised Route (Revision E)
AECOM 2009	0	-
AECOM 2009	0.2	0
AECOM 2009	1	0.9
AECOM 2009	16.2	16
AECOM 2009	17	16.7
AHA 2009	18	-
AHA 2009	19	-
AHA 2009	20	-
AHA 2009	21	-
AHA 2009	22	-
AHA 2009	23	-
AECOM 2009	24	24.8
AECOM 2009	26.2	27
AECOM 2009	27	27.9
AECOM 2009	28	-
AECOM 2009	28.2	29
AECOM 2009	29	29.9
AECOM 2009	30	30.9
AECOM 2009	61.2	62
AECOM 2009	63	64.1
AECOM 2009	64.1	65
AECOM 2009	65	65.9
AECOM 2009	70.1	71
AHA 2009	71	-
AHA 2009	72	-
AHA 2009	73	-
AHA 2009	74	-
AHA 2009	75	-
AHA 2009	76	-
AHA 2009	77	-
AHA 2009	78	-
AHA 2009	79	-

Relevant Assessment Report	Original Route (Revision C)	Revised Route (Revision E)
AECOM 2009	80	82.9
AECOM 2009	83	85.9
AECOM 2009	80	82.9
AECOM 2009	83	85.9
AECOM 2009	83.1	86
AHA 2009	84	-
AHA 2009	85	-
AECOM 2009	86	88.9
AECOM 2009	86.1	89
AHA 2009	87	-
AHA 2009	88	-
AHA 2009	89	-
AHA 2009	90	-
AHA 2009	91	-
AHA 2009	92	-
AHA 2009	-	95
AHA 2009		

Table 2 details the vegetation to be removed along the revised pipeline route and incorporates findings and recommendations from both AECOM (2009) and AHA (2009) reports, utilising the KPs for the proposed pipeline route as detailed in the Environmental Assessment.

Table 2: Lengths of Remnant Vegetation Transected and Potential Areas to be Cleared along Proposed Pipeline

KP start	KP end	Length (km)	Area to be Cleared (ha)			Location Notes	Vegetation	Landform
			30m ROW	20 m ROW	15m ROW			
3.8	**3.86**	0.06			0.06		Dry foothills Spotted Gum	Plain
8.16	**8.19**	0.03		0.06		Bull Creek	Riparian	Stream
14.4	**15.05**	0.65	0.795				South Coast Shrubby Grey Gum	Hillslope / Plain
18.55	**18.7**	0.15	0.3				Spotted Gum / Ironbark Forest	Hillslope / Plain
19.3	**19.4**	0.1	0.15				Spotted Gum / Ironbark Forest	Hillslope
19.64	**20**	0.36	0.38				Spotted Gum / Ironbark Forest	Hillslope
23	**23.15**	0.15			0.225		Spotted Gum / Ironbark Forest	Hillslope
24.2	**24.35**	0.15	0.45				Spotted Gum / Ironbark Forest	Hillslope
27.49	**27.57**	0.08		0.08			Riparian	Stream
28.54	**28.54 2**	0.02		0.04			Riparian	Stream
28.84	**28.86**	0.02		0.04			Riparian	Stream
29.47	**29.65**	0.18		0.36			Ironbark	Plain
30.5	**30.9**	0.4		0.08			Ironbark	Plain
31.88	**31.92**	0.04		0.4			Ironbark	Stream
32.24	**37.27**	5.03		7.545			Dry foothills Spotted Gum	Hillslope
37.27	**37.68**	0.41		0.615			South Coast Shrubby Grey Gum	Hillslope

37.68	**37.75**	0.07		0.105		Black Camp Creek	Rainforest	Hillslope / Stream
37.75	**38.81**	1.06		1.59			Dry foothills Spotted Gum	Hillslope
39.04	**39.07**	0.03		0.06			Rainforest	Stream
41.01	**41.08**	0.07		0.07		Cedar Tree Creek	Rainforest	Stream
46.6	**46.7**	0.1		0.1		Little Black Camp Creek	Redgum / apple	Stream
46.8	**47**	0.2	0.2				Ironbark	Plain
50.45	**50.85**	0.04		0.04			Rainforest	Stream
59	**60.37**	1.37	1.37				Ironbark	Hillslope / Plain
65.25	**65.34**	0.09	0.18			Roadside Environment Area	Ironbark	Plain
71.5	**71.7**	0.2		0.4			Grey Gum / Stringybark / Bloodwood Forest	Hillslope
71.8	**72.5**	0.7	1.4				Grey Gum / Stringybark / Bloodwood Forest	Hillslope
72.6	**73.44**	0.84	0.84				Grey Gum / Stringybark / Bloodwood Forest	Hillslope
75.74	**76.18**	0.46		0.23			Forest Red Gum / Spotted Gum Woodland	Plain
Total		**13.17**	**6.065**	**11.815**	**0.285**		**Total to be Cleared**	**18.17**

AECOM

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Gloucester Gas Project

Gloucester to Hexham

Final

AECOM
2 November 2009
Document No.: S7003802_Appendix G_Ecology_3Nov09

Environment

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Contents

GLOSSARY OF TERMS .... **V**
EXECUTIVE SUMMARY **1**
1.0 INTRODUCTION **1**
1.1 Project description 1
1.1.1 Field Development Area and Central Processing Facilities 2
1.1.2 Pipeline 2
1.2 Scope of Works 2
2.0 ASSESSMENT METHODS **5**
2.1 Desktop Assessment 5
2.1.1 Determination of Significance Level 6
2.2 Field Survey 6
2.3 Analysis of Results 7
2.4 Assumptions and limitations 7
3.0 EXISTING ENVIRONMENT **9**
3.1 Description of Survey Areas 9
3.2 Protected Areas 9
3.2.1 RAMSAR Wetlands 9
3.2.2 State Protected Areas 10
3.2.3 Significant Roadside Environment Areas 10
3.3 Critical Habitat 10
3.4 Flora 11
3.4.1 Threatened Ecological Communities under the EPBC Act 11
3.4.2 Threatened Ecological Communities under the TSC Act 12
3.4.3 Ecological Communities Protected under the FM Act 14
3.4.4 Other Remnant Vegetation 15
3.4.5 Endangered Populations 15
3.4.6 Threatened Flora Species 15
3.4.7 Declared Weeds 17
3.5 Fauna 17
3.5.1 Fauna Habitats 17
3.5.2 Endangered Populations 18
3.5.3 Threatened Fauna 19
3.5.4 Migratory and Marine Protected Birds 19
3.5.5 Koalas in the Port Stephens LGA. 19
3.5.6 Introduced Species 20
4.0 POTENTIAL IMPACTS **21**
4.1 Introduction 21
4.2 Removal of Native Vegetation 21
4.2.1 Protected Areas 23
4.2.2 Threatened Vegetation Communities 24
4.2.3 Other Remnant Vegetation 26
4.3 Loss of Hollow-Bearing Trees 27
4.4 Removal of Dead and Fallen Timber 28

	4.5	Removal of Rock	28
	4.6	Creation of Edge Effects	28
	4.7	Spread of Environmental Weeds	29
	4.8	Maintenance of the Easement	29
	4.9	Excavation Works	30
	4.10	Soil Compaction	31
	4.11	Barrier Effects to Wildlife Movement	31
	4.12	Alterations to Hydrology	31
	4.13	Wild Fire	32
	4.14	Construction Waste	32
	4.15	Erosion, Sedimentation and Dust Emissions	32
	4.16	Spread of the plant pathogen *Phytophthora cinnamomi*	33
	4.17	Spread of the amphibian pathogen 'Chytrid fungus'	34
5.0	**MITIGATION MEASURES**		**35**
	5.1	Pre- Construction Phase	35
	5.2	Construction Phase	38
	5.3	Operation Phase	47
6.0	**CONCLUSION**		**49**
7.0	**REFERENCES**		**53**

List of Tables

Body Report

Table 1: Summary of Residual impacts 49

Tables Section

Table T1: Significant Roadside Environment Areas Transected or Adjacent to the Proposed Pipeline
Table T2: Vegetation Recorded at Detailed Flora Assessment Sites
Table T3: Vegetation Transected by the Proposed Pipeline
Table T4: Endangered Populations under the TSC Act Potentially Occurring in the Wider Study Area.
TableT5: Threatened Ecological Communities under the TSC Act as Potentially Occurring in the Wider Study Area
Table T6: Flora Species Listed under Commonwealth and / or State Legislation and Identified from database Searches as Previously Recorded from the Wider Study Area, or with Geographical Ranges that Overlap the Wider Study Area with Preferred Habitat.
Table T7: Declared Weeds Recorded During Field Surveys
Table T8: Fauna Habitats Recorded along Proposed Pipeline
Table T9: Threatened Fauna Species Previously Recorded from the Wider Study Area, with Potential Habitat in the Project Site.
Table T10: Threatened Fauna Species and Previously Recorded from the Wider Study Area, but without Potential Habitat in the Project Site.
Table T11: Assessment of migratory species listed under the EPBC Act
Table T12: Lengths of Remnant Vegetation Transected and Potential Areas to be Cleared along Proposed Pipeline
Table T13: Summary of Potential Areas of Remnant Vegetation to be Cleared along Proposed Pipeline

Table T14: Protected Environmental Values and Likelihood of Identified Potential Impacts Without Mitigation
Table T15: Assessment of flora species listed under the EPBC Act
Table T16: Assessment of fauna species listed under the EPBC Act

List of Figures

Figures Section

Figure F1: Stage 1 Gas Field Development Area
Figure F2: Kilometre Point 0-5km - Sheet 1 of 18
Figure F3: Kilometre Point 5-10km - Sheet 2 of 18
Figure F4: Kilometre Point 10-15km - Sheet 3 of 18
Figure F5: Kilometre Point 15-20km - Sheet 4 of 18
Figure F6: Kilometre Point 20-25km - Sheet 5 of 18
Figure F7: Kilometre Point 25-30km - Sheet 6 of 18
Figure F8: Kilometre Point 30-35km - Sheet 7 of 18
Figure F9: Kilometre Point 35-40km - Sheet 8 of 18
Figure F10: Kilometre Point 40-45km - Sheet 9 of 18
Figure F11: Kilometre Point 45-50km - Sheet 10 of 18
Figure F12: Kilometre Point 50-55km - Sheet 11 of 18
Figure F13: Kilometre Point 55-60km - Sheet 12 of 18
Figure F14: Kilometre Point 60-65km - Sheet 13 of 18
Figure F15: Kilometre Point 65-70km - Sheet 14 of 18
Figure F16: Kilometre Point 70-75km - Sheet 15 of 18
Figure F17: Kilometre Point 75-80km - Sheet 16 of 18
Figure F18: Kilometre Point 80-85km - Sheet 17 of 18
Figure F19: Kilometre Point 85-90km - Sheet 18 of 18
Figure F20: Kilometre Point 60-65km - Sheet 1 of 6
Figure F21: Kilometre Point 65-70km - Sheet 2 of 6
Figure F22: Kilometre Point 70-75km - Sheet 3 of 6
Figure F23: Kilometre Point 75-80km - Sheet 4 of 6
Figure F24: Kilometre Point 80-85km - Sheet 5 of 6
Figure F25: Kilometre Point 85-92km - Sheet 6 of 6

List of Plates

Plates Section

Plate P1: Cleared Powerline Easement through Wallaroo National Park at KP 61.9
Plate P2: Freshwater Wetland Transected by the Proposed Pipeline at KP 67.9
Plate P3: Swamp Oak Forest Adjacent to the Proposed Pipeline at KP 86
Plate P4: Swamp Sclerophyll Forest Adjacent to the Proposed Pipeline at KP 68.8
Plate P5: Swamp Scerophyll Forest Transected by the Proposed Pipeline at KP 68.9
Plate P6: Redgum Forest Transected by the Proposed Pipeline at KP 45.6
Plate P7: Tidal Channel with Mangroves the Proposed Pipeline at KP 89.8
Plate P8: Riparian Rainforest Transected by the Pipeline on the Karuah River at KP 19.2
Plate P9: Flowers and Leaves of *Grevillea parviflora* subsp*. parviflora* at KP 58.9

List of Appendices

Appendix A Vegetation Assessment Data Sheets
Appendix B Habitat Assessment Data Sheets
Appendix C Fauna Observations from the Field Investigation
Appendix D Legislation Relevant to Ecological Aspects of the Proposed Development
Appendix E TSC Act Section 5a Assessment (Seven-part Tests) for Threatened Ecological Communities and Species

Glossary of Terms

ASL	Above Sea Level
CPF	Central Processing Facilities
CRA	Comprehensive Regional Assessment
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DEWHA	Department of the Environment, Water, Heritage and the Arts
DPI	Department of Primary Industries
EEC	Endangered Ecological Community
EMP	Environmental Management Plan
EP&A Act	*Environmental Planning and Assessment Act* 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
FM Act	*Fisheries Management Act* 1994
GFDA	Gas Field Development Area
GIS	Geographic Information System
GPS	Global Positioning System
HDD	Horizontal Directional Drilling
KP	Kilometre Point
LGA	Local Government Area
LHCC	Lower Hunter and Central Coast
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy
NPW Act	*National Parks and Wildlife Act* 1974
NPWS	New South Wales National Parks and Wildlife Service
NRP	National Recovery Plan
NSW REC	New South Wales Roadside Environment Committee
NV Act	*Native Vegetation Act* 2003
NW Act	*Noxious Weeds Act 1993*
PASS	Potential Acid Sulfate Soils
PO Act	*Petroleum (Onshore) Act* 1991
ROW	Right of Way
SPRAT	Species Profile and Threats Database, maintained by DEWHA
TSC Act	*Threatened Species Conservation Act* 1995
VCA	Voluntary Conservation Agreement

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Executive Summary

AGL Gloucester Pty Ltd (AGL) proposes to develop a coal seam gas (CSG) extraction and transport system from Gloucester to Hexham. The project consists of a Gas Field Development Area (GFDA) within Petroleum Exploration Lease 285, principally comprising approximately 110 wells and gathering lines, Central Processing Facilities (CPF) including gas and water treatment and compression at Stratford, and a Gas Transmission Pipeline (pipeline).

AECOM Australia Pty Ltd (AECOM) has been commissioned by AGL to undertake this ecological assessment to:

- identify key ecological constraints associated with the production licence area, GFDA and CPF sites, and the proposed pipeline route
- meet the Key Assessment Requirements identified by the Director-General in relation to ecological impacts
- pursuant to the referral decision made by the Environment Assessment Branch on 25 September 2008 that the proposed action is a controlled action under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), address the potential impacts to matters of national environmental significance.

This report acts as a full technical Appendix to the main Environmental Assessment (EA) in Volume 1. This report was undertaken on the basis of relevant State and Commonwealth legislation and in accordance with the Environmental Assessment Requirements (EARs) provided by Department of Planning specifically for this project.

This assessment was undertaken using:

- Desktop reviews of available information (including reviews of previous studies, DECC and DPI database searches, Commonwealth Protected Matters database search) to identify protected areas, species, populations and communities potentially occurring within the proposed development and surrounding areas and allow field surveys to target specific areas of concern.
- Targeted field surveys to:
  - describe vegetation communities, wetlands and fauna habitats
  - assess potential habitat for listed threatened species (under the TSC Act and the EPBC Act) and listed Migratory and / or Marine Protected Species (under the EPBC Act)
  - search for listed threatened flora species in suitable habitat using the random meander technique
  - search for listed threatened fauna species in suitable habitat (including indirect signs such as scats, tracks, diggings, scratches, etc), to a limited extent.
- Analyses conducted of information collected in the desktop and field studies to:
  - assess the potential for direct and indirect impacts of the proposed development on the ecological values of the study area
  - develop appropriate measures to avoid, mitigate or offset identified potential impacts

- identify uncertainties in the current assessment that may require further investigation
- where appropriate, recommend locations for infrastructure such as gas wells, CPF and pipelines.

A series of recommendations were formulated on the basis of this assessment. Provided that the recommended mitigation measures outlined in **Section 5.0** are implemented effectively, impacts are anticipated to be limited to:

- Clearing of between 16.72 and 25 ha of native vegetation.
- Impacts on one population of Small-flower Grevillea, which would not lead to any net loss in the total number of populations or area of extent.
- Little or no disturbance of native vegetation within Wallaroo National Park.
- Little or no disturbance of native vegetation in the proposed nature refuge at Lot 68 DP753176
- Little or no impacts on any Endangered Ecological Communities.
- Little or no impacts on other threatened flora and fauna species listed at both State and Commonwealth levels.
- No indirect or downstream effects on threatened flora and fauna species or wetland areas.

1.0 Introduction

AGL Gloucester L E Pty Ltd (AGL) proposes to develop a coal seam gas (CSG) extraction and transport system from Gloucester to Hexham. The project consists of a Gas Field Development Area (GFDA) within Petroleum Exploration Licence 285 (PEL 285), principally comprising approximately 110 wells and gathering lines, Central Processing Facilities (CPF) including gas and water treatment and compression at Stratford, and a Gas Transmission Pipeline (Pipeline). The Minister for Planning has declared the project under Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) and some preliminary work has already been undertaken, including:

- approvals strategy
- permissibility assessment
- stakeholder management strategy
- preliminary environmental review / scoping report.

AECOM Australia Pty Ltd (AECOM) has been commissioned by AGL to undertake this ecological assessment to:

- identify key ecological constraints associated with the GFDA, CPF site and Pipeline.
- meet the Key Assessment Requirements identified by the Director-General in relation to ecological impacts.
- pursuant to the referral decision made by the Environment Assessment Branch on 25 September 2008 that the proposed action is a controlled action under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), address the potential impacts to matters of national environmental significance.

This ecological assessment has been developed in accordance with the Department of Environment and Conservation (now Department of Environment and Climate Change - DECC) and Department of Primary Industries (DPI) 'Draft Guidelines for Threatened Species Assessment' (DEC / DPI 2005), which identifies matters of relevance for the assessment of Major Projects under Part 3A of the EP&A Act.

This assessment has specifically considered threatened species, populations and communities listed under both State and Commonwealth legislation that have been recorded on the site and surrounding areas. This assessment identifies potential impacts on threatened species and details measures to avoid or mitigate such impacts. Residual ecological risks associated with the construction and operation of the proposed infrastructure are identified and discussed.

1.1 Project description

The location of the proposed GFDA, CPF and pipeline are shown in **Figure 1.1 in Volume 4 of this EA**. The study area lies north of Newcastle from Gloucester to Hexham. The project area lies within six local government areas (LGAs) - Gloucester, Dungog, Great Lakes, Port Stephens, Maitland and Newcastle. Three main catchments (the Avon, Karuah and Williams / Hunter) are found in the study area and the proposed pipeline route crosses numerous waterways.

1.1.1 Field Development Area and Central Processing Facilities

The GFDA is located east of Gloucester and Stratford, covering an area of approximately 34.5 km^2. The area is used mainly for mining and agriculture, including grazing and cropping with a number of dispersed homesteads. The Avon River flows within the GFDA and contains a few remnant riparian forest patches. An open pit coal mine is located in the southern side of the GFDA. The CPF is proposed to be located within an existing rail loop near the south-east corner of the GFDA.

The infrastructure would consist of a network of approximately 110 wells and associated flowlines. The arrangement of the wells has been loosely identified within the GFDA but detailed locations are to be designed and finalised around the environmental and social constraints identified during the environmental approval process. In accordance with the requirements of the *Petroleum (Onshore) Act* 1991 (PO Act), all wells would be located at least 200 m from existing residences. The required disturbance footprint during well drilling is 65 m x 65 m. The area would be topped with hard stand material (e.g. gravel) to protect the land surface from heavy machinery and avoid bogging of equipment.

Once wells are in production, hard stand materials such as gravel would be removed and a reduced area (15 m x 15 m) would be fenced off. This area would contain the wellhead, as well as a wellhead pump for water lift and control equipment. The reminaing area within the fence would be suitably rehabilitated to reflect the original condition of the land.

Flowlines would transport the gas from the individual wellheads into a main spineline, which would be connected to the CPF. The gas would then be transported to Hexham via an underground pipeline.

1.1.2 Pipeline

The proposed gas transmission pipeline would be approximately 92 km long, running from the CPF near Gloucester to Hexham. It would pass primarily through cleared agricultural land, but would transect a number of remnant vegetation patches. It would cross the Karuah River, the Williams River, the Hunter River and various tributaries of these rivers.

The proposed pipeline would be constructed in accordance with the requirements of the *Pipelines Act* 1967 and would be underground. In already cleared areas without other constraints, the disturbance footprint would be contained within a 30 m right of way (ROW). In sensitive areas (e.g. remnant native vegetation, stream crossings, on steep slopes, etc.), the ROW would be reduced to minimise impacts.

1.2 Scope of Works

The following tasks were undertaken to address ecological components of the requirements made by the Director General and Environment Assessment Branch.

- Desktop reviews were undertaken of available information (including reviews of previous studies, DECC and DPI database searches, Commonwealth Protected Matters database search) to identify protected areas, species, populations and communities potentially occurring within the proposed development and surrounding areas and allow field surveys to target specific areas of concern.
- Targeted field surveys were undertaken to:
  - describe vegetation communities, wetlands and fauna habitats
  - assess potential habitat for listed threatened species (under the TSC Act and the EPBC Act) and listed Migratory and / or Marine Protected Species (under the EPBC Act)
  - search for listed threatened flora species in suitable habitat using the random meander technique

- search for listed threatened fauna species in suitable habitat (including indirect signs such as scats, tracks, diggings, scratches, etc), to a limited extent.

- Analyses were conducted of information collected in the desktop and field studies to:
  - assess the potential for direct and indirect impacts of the proposed development on the ecological values of the study area
  - develop appropriate measures to avoid, mitigate or offset identified potential impacts
  - identify uncertainties in the current assessment that may require further investigation
  - appropriate, recommend locations for infrastructure such as gas wells, CPF and pipelines.

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2.0 Assessment Methods

The methods used in this assessment are in accordance with the 'Draft Guidelines for Threatened Species Assessment' (DEC / DPI 2005) and consider the matters of relevance for the assessment of Major Projects under Part 3A of the EP&A Act.

Threatened species considered in this assessment are those species, populations and ecological communities identified within Schedules 1, 1A and 2 of the NSW *Threatened Species Conservation Act* 1995 (TSC Act), Schedules 4, 4A, 5 and 5A of the NSW *Fisheries Management Act* 1994 (FM Act) and / or under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). A summary of legislation relevant to the assessment of ecological impacts of the proposed development is given in **Appendix D**.

2.1 Desktop Assessment

Desktop searches for significant flora and fauna species and ecological communities were conducted for three geographical blocks that incorporate the proposed GFDA, CPF, pipeline and adjacent areas. These three blocks comprise the broader study area for the purposes of this report. The coordinates for these three blocks are:

- -31.95°S, 152.01°E to -32.32°S, 151.85°E
- -32.32°S, 151.97°E to -32.71°S, 151.75°E
- -32.57°S, 151.75°E to -32.9°S, 151.6°E.

The EPBC Act identifies significant flora and fauna species and ecological communities and other matters of national significance. A Protected Matters Report was generated on 13 August 2008 that identified all EPBC Act listed species and ecological communities potentially occurring within the study area.

The Atlas of NSW Wildlife Database and BioNet Database contain recorded sightings of flora and fauna species within New South Wales and identify their current status under the TSC Act. A report from both the Atlas of NSW Wildlife and BioNet was generated on 14 August 2008 that identified all flora and fauna species known to occur within the study area.

Additionally, data were requested from the Atlas of NSW Wildlife Data Unit on 19 August 2008 to identify all threatened ecological communities under the TSC Act that potentially occur in the region (i.e. Dungog, Bulahdelah and Newcastle map sheets). These data include detailed geographic coordinates for individual records of threatened flora and fauna species.

The FM Act identifies all threatened aquatic species, populations and ecological communities within NSW. A search of the DPI website was undertaken to determine any species, populations or ecological communities that potentially occur in the study area.

Critical Habitats are areas which are considered to be critical to the survival of an endangered species, populations or ecological communities. Critical Habitats are protected under the TSC Act and FM Act. A search of the following websites was undertaken to identify the occurrence of any known Critical Habitats within the study area:

- http://www.environment.nsw.gov.au/criticalhabitat/CriticalHabitatProtectionByDoctype.htm
- http://www.dpi.nsw.gov.au/fisheries/species-protection/species-conservation/what/register-of-critical-habitat

As well as searching the above databases, vegetation and landscape patterns across the site were assessed using:

- Comprehensive Regional Assessment (CRA) forest ecosystem mapping for the upper and lower northeast region (NPWS, 1999) – **Figures 1 to 19**
- Lower Hunter and Central Coast (LHCC) Region vegetation mapping, which covers the southern section of the proposed pipeline from KP 66 to 97.5 (NPWS, 2000) – **Figures 21** to **25**
- NSW native vegetation mapping (Keith, 2002)
- recent aerial imagery.

2.1.1 Determination of Significance Level

Threatened flora species and threatened fauna species are defined as those taxa listed in the EPBC Act and / or the TSC Act as Critically Endangered, Endangered or Vulnerable. Regionally Significant fauna are defined as those taxa that have not been listed as threatened species under the EPBC Act or TSC Act, but have been listed in the relevant Action Plan for their respective taxonomic group as Vulnerable, Rare, Near Threatened, Insufficiently Known or Data Deficient. Migratory and / or Marine Protected Species listed under the EPBC Act are assessed separately from threatened species.

2.2 Field Survey

Initial field surveys were carried out during from 28 August to 5 September 2008. The field surveys were conducted by AECOM flora ecologists Dr Con Lokkers and Jodi Blandthorn and AECOM fauna ecologists Lysanne de Graaf and Dario Rivera. Additional surveys were conducted by Dr Con Lokkers (17 October 2008) and Rachel Manassa (19 November 2008).

The objective of the field surveys was to confirm the presence and / or potential presence of the threatened species and ecological communities identified in the desktop assessment or the presence of their preferred habitat(s). Detailed fauna survey techniques (e.g. trapping) were not undertaken. Incidental fauna observations were recorded and these were supplemented by limited spotlighting, ultrasonic bat detecting and call-playback activities.

Flora field surveys were conducted at 81 sites and fauna ground surveys were conducted at 82 sites, mostly within timbered areas selected through aerial photograph interpretation. Of these, detailed assessments were made at 22 flora sites and 21 fauna sites, while briefer observation records were made at 59 flora sites and 61 fauna sites. The locations of the flora and fauna survey sites are shown in **Figures 1** to **19.**

The detailed flora assessments recorded an inventory of dominant and common woody flora species and dominant ground storey species (including native and exotic flora species), structural characteristics (average height and approximate abundance), landform characteristics and information on condition and sensitivity. The detailed fauna assessments were based upon an analysis of habitat quality and recorded features such as the extent of habitat fragmentation and the presence of key habitat features like hollow bearing trees, fallen logs and water bodies. Detailed sites were established where the characteristics of the site indicated the greatest chance of detecting significant species and other values. Only dominant flora and fauna characteristics were recorded for the observational sites.

Survey sites and vehicular traverses were distributed so as to sample as much environmental variability within the study area as possible, within practical time and accessibility constraints. As well as recording dominant species, the surveys and traverses also focused on locating any potential threatened flora and fauna species.

Fauna surveys were supplemented by night spotlighting and ultrasonic bat detecting activities (using AnaBat equipment). Spotlighting and bat detecting were undertaken at dusk for one hour on 30 August (GFDA) and 1 September (Black Camp Road).

Call-playback surveys of approximately 20 minutes were undertaken for several species in appropriate habitats within the study area. Species surveyed at least once by this method were: *Phascolarctos cinereus, Tyto tennibricosa, Tyto novaehollandiae, Ninox strenua, Ninox connivens, Clayptorhynchus lathami, Lathamus discolour, Litoria booroolongensis, Litoria aurea, Mixophyes balbus* and *Mixophyes iteratus*. In the case of *Phascolarctos cinereus,* the surveys were typically up to 40 minutes in duration.

Scats, bones, feathers and other signs (e.g. scratchings, diggings, etc.) were specifically searched for during the detailed fauna assessments, and on an incidental basis elsewhere. Scats were forwarded to Barbara Triggs (renowned expert and author of *Scats, Tracks and other Traces: A Field Guide to Australian Mammals*) for laboratory identification.

GPS coordinates were taken using hand held GPS with an accuracy of +/- 10 m.

2.3 Analysis of Results

Threatened flora and fauna species, populations and ecological communities that may potentially be impacted by the project were identified from the desktop study, the site habitat assessments and an analysis of the ecology of the species. These assessments drew heavily on information on the threatened species pages of the DECC website, and also included a review of existing Recovery Plans, where these exist, for those threatened species, populations and ecological communities considered to be potentially present. Potential impacts were then identified and categorised. Risk assessments were undertaken for each species (or group of species) that might potentially be impacted by the proposed actions, using the TSC Act Section 5a assessment (also known as the Seven Part Test). Where possible, mitigation measures to avoid or minimise potential impacts were recommended.

2.4 Assumptions and limitations

The presence or otherwise of a particular flora or fauna species within the study area can only be confirmed by detailed targeted field surveys. Where field sampling effort was not adequate for detecting particular threatened flora or fauna species, the precautionary principle has been applied to their potential presence within the study area (i.e. they are assumed to be potentially present).

Whilst a significant proportion of the study area is cleared and is likely to be suitable for locating infrastructure which would be required for the construction and operation of the pipeline, the specific locations for wellhead pumps, gas pipelines, secondary access roads, and other support infrastructure had not been precisely identified at the time of the assessment.

A number of properties could not be accessed during the field survey due to a lack of consent by landholders. In some cases, observations could be made from adjacent roadsides and properties. Otherwise, aerial imagery and available mapping was used to derive likely vegetation and habitat information.

Heavy rainfall before and during the present survey made access to many locations difficult. Some areas were inundated, impairing detection and identification of ground storey flora. These conditions also hindered detection of fauna and signs of fauna such as diggings and scats.

3.0 Existing Environment

3.1 Description of Survey Areas

The GFDA is approximately 3,456 ha and lies in a flat to gently sloping plain. The majority is cleared for cattle pastures and the southern section is further disturbed by an active coal mining operation. Comprehensive Regional Assessment (CRA) mapping indicates only 203 ha of the GFDA (5.9%) contains remnant native vegetation (**Figures 1** to **19**). Aerial imagery and field ground truthing support the mapping data, with most remnant vegetation contained within several blocks in the central and southern portions of the GFDA. Narrow strips of remnant vegetation also occur along the Avon River and tributaries, although these are often heavily disturbed by weeds, such as willows (*Salix* species), Wandering Jew (*Tradescantia fluminensis*), privet (*Ligustrum* species) and Peach (*Prunus persica*).

The CPF is proposed to be located near the south-western corner of the GFDA, in a cleared area within an existing rail loop. However, this exact location was not available at the time of the field assessment.

The proposed gas transmission pipeline would run 91.6 km from the GFDA to Hexham and traverse a variety of landforms, including flat plains, gently to moderately sloping hills, streams of varying sizes, swamps and one small tidal channel. The major streams transected would include the Karuah River, the Williams River and the Hunter River. The majority of the proposed pipeline would pass through cleared pastures, but it would transect or lie adjacent to a number of significant blocks of remnant vegetation. Along the proposed route, the largest areas of remnant vegetation are the eucalypt forests associated with hilly terrain along Black Camp Road and in Wallaroo National Park.

The proposed GFDA and the majority of the proposed pipeline lie within the NSW North Coast biogeographic region. The southern 18 km of the proposed pipeline lies in the Sydney Basin biogeographic region.

3.2 Protected Areas

3.2.1 RAMSAR Wetlands

The southern end of the proposed pipeline lies about 1 km upstream of the Hunter Estuary Wetlands, which is listed as a Ramsar wetland because it contains:

- unique combination of high conservation near-natural wetlands (Melaleuca swamp forest, freshwater reed marsh and coastal estuarine mangrove-lined creek) and artificial wetlands (constructed freshwater lagoons, coastal estuarine Casuarina-lined channel, model farm dam)
- ecologically diverse flora and avifauna communities that represent a significant genetic pool for wetland species in the Sydney Basin biogeographic region
- populations of at least 45 species of migratory birds listed under the EPBC Act, Japan - Australia Migratory Bird Agreement (JAMBA) and China - Australia Migratory Bird Agreement (CAMBA)
- actual or potential habitat for numerous threatened species, including the Green and Golden Bell Frog (*Litoria aurea*), Australasian Bittern (*Botaurus poiciloptilus*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Comb-crested Jacana (*Irediparra gallinacea*) and Magpie Goose (*Anseranas semipalmata*).

- habitat that supports a large number of migratory shorebird species at a critical seasonal stage of their breeding cycle, including 2 to 5% of the East Asian-Australasian Flyway population of Eastern Curlew (*Numenius madagascariensis*) and more than 1 % of the Australian populations of sixteen migratory wading bird species (Smith 1991; Watkins 1993).

3.2.2 State Protected Areas

The proposed pipeline transects Wallaroo National Park for approximately 3.3 km from KP 59.8 to 63.1. The route is on the western edge of the National Park, ranging from 50 to 350 m from the western boundary. The proposed pipeline follows an existing powerline easement that contains a clearing of approximately 25 m width (**Plate 1**).

The southern end of the proposed pipeline lies about 0.8 km east of the Hexham Swamp section of the Hunter Estuary National Park and 1 km southeast of the Kooragang section of the Hunter Estuary National Park.

Two landholders with properties on or adjacent to the proposed pipeline have a Voluntary Conservation Agreement (VCA) or are currently negotiating a VCA. A VCA is a contract between landholders and the Minister for the Environment that aims to conserve the natural, cultural and / or scientific values of a property or portion of a property and restricts land uses likely to compromise these values. These properties include:

- Lot 1 DP1004421 - a property immediately east of the proposed pipeline from KP 2.3 to KP 4 (1.7 km)
- Lot 68 DP753176 - a property transected by the proposed pipeline from KP 54.1 to KP 54.9 (0.8 km).
- No protected tenures were identified within the GFDA and CPF. The western boundary of the Glen Nature Reserve lies approximately 2.5 km east of the south-eastern corner of the GFDA.

3.2.3 Significant Roadside Environment Areas

The New South Wales Roadside Environment Committee (NSW REC) has identified significant roadside environment areas within the study site and adjacent areas. NSW REC has installed signs at the start and finish of these roadside areas. Significant roadside environment areas often represent some of the last remaining native vegetation within mostly cleared landscapes and may provide ecological values such as conservation of biodiversity and cultural / historical significance, corridors for wildlife movement, buffering of adjacent ecosystems, reducing weed spread, improving waterway health, reducing land degradation and improving visual amenity.

A number of roadside areas which contained remnant vegetation within a mostly cleared landscape were observed along or adjacent to the pipeline during the field survey. These areas, listed in **Table T1**, were identified as significant roadside environment areas for the purposes of the present assessment.

3.3 Critical Habitat

No areas or habitats within the project area have been declared as critical habitat for threatened species or ecological communities under either the EPBC or TSC Acts.

3.4 Flora

During the field survey, detailed flora assessments were conducted at 22 sites and briefer flora observations were made at 59 other sites (**Figures 1** to **19**). Completed field sheets for the 22 detailed survey sites are provided in **Appendix A**. Results of the detailed flora assessments are summarised in **Table T2**.

Where possible, vegetation was assigned to existing regional and state vegetation communities, including:

- Lower Hunter and Central Coast (LHCC) Region vegetation mapping, which covers the southern section of the proposed pipeline from KP 60 to KP 91.6 (NPWS, 2000)
- Comprehensive Regional Assessment (CRA) forest ecosystem mapping for the upper and lower northeast region (NPWS, 1999)
- NSW native vegetation mapping (Keith, 2002).

A breakdown of all remnant vegetation and cleared areas along the proposed pipeline with lengths and start / end KPs is given in **Table T3**. The majority of the proposed GFDA and proposed pipeline ROW was cleared, with a dense ground cover of exotic pasture grasses. Most cleared areas had very few trees, but regrowth of native tree species was observed in some areas. Based on field and desktop information, approximately 3,253 ha (94%) of the GFDA was cleared and 81 km (88%) of the proposed pipeline ROW was cleared.

Most remnant vegetation in plain and hillslope landforms was open forest dominated by eucalypts such as Spotted Gum (*Cor. maculata*), Ironbark (*Euc. siderophloia*), Grey Gums (*Euc. punctata* and *Euc. propinqua*), Broad-leaved White Mahogany (*Euc. umbra*) and Grey Box (*Euc. moluccana*). Most sites had a relatively sparse midstorey of shrubs and sapling eucalypts, while the groundstorey was often dense, with a variety of grasses, herbs and rushes.

Most streams within the study site supported a narrow band of riparian vegetation, with cleared pastures on either side. The canopy often contained one to several dominant species, such as Grey Myrtle (*Backhousia myrtifolia*), Lillypillies (*Waterhousia floribunda*, *Syzygium* species), Snow-in-summer (*Melaleuca leariifolia*) and Willow Bottlebrush (*Callistemon salignus*). Riparian vegetation generally supported a higher diversity of canopy species than other communities, while the ground storey was generally sparse. Emergent eucalypts were often present. Some streams (especially the Avon River in the GFDA) were heavily degraded by weeds, including willows (*Salix* species), Wandering Jew (*Tradescantia fluminensis*), Privet (*Ligustrum* species) and Peach (*Prunus persica*).

3.4.1 Threatened Ecological Communities under the EPBC Act

The EPBC Act Protected Matters Report identified one critically endangered ecological community that may potentially occur within the study site and adjacent area:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

Targeted searches were made for this ecological community during the field survey but it was not observed in the areas inspected. Furthermore, the tree species that are recognised as dominant and characteristic of this ecological community were not recorded within the areas inspected.

3.4.2 Threatened Ecological Communities under the TSC Act

The Atlas of NSW Wildlife Data Unit identified that 35 ecological communities listed as threatened under the TSC Act may potentially occur within the study area (**TableT5**). Vegetation with floristic and structural characteristics resembling six of these ecological communities was recorded within or immediately adjacent to areas inspected within the study area. Of these six communities, it is considered that five Endangered Ecological Communities occur within or adjacent to the pipeline. Each observed ecological community is discussed below.

Freshwater Wetlands

Three Endangered wetland communities were recorded along the proposed pipeline corridor:

- Freshwater Wetlands on Coastal Floodplains of New South Wales North Coast, Sydney Basin and South East Corner Bioregions - correspond to Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) map unit 46 (freshwater wetland complex) and NSW map unit 56 (coastal freshwater lagoon)
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner - corresponds to LHCCREMS map unit 41 (Swamp Oak sedge forest), CRA map unit 143 (Swamp Oak) and NSW map unit 50 (coastal floodplain wetland)
- Swamp Sclerophyll Forest of Coastal Floodplains of the New South Wales North Coast, Sydney Basin and the South East Corner- corresponds to LHCCREMS map unit 37 (swamp mahogany paperbark swamp forest), CRA map unit 142 (swamp mahogany) and NSW map unit 50 (coastal floodplain wetland).

Freshwater Wetlands on Coastal Floodplains were recorded within the proposed pipeline corridor at the following locations:

- an ephemeral wetland, which is dominated by sedges such as *Carex apressa* and *Juncus pallidus*, near the Williams River for about 0.9 km at approximately KP 68, including:
  - transecting the wetland for about 0.15 km (**Plate 2**)
  - transecting an artificial drainage channel, which is fringed by sedges for about 5 to 10 m
  - passing through cleared pasture just east of the wetland for 0.7 km
- passing through cleared pasture that lies in a 100 m gap between the Williams River and a sedge-dominated wetland for 0.5 km at approximately KP 66.5 (detailed site assessment at flora site 20)
- passing through cleared pasture just north of the Williams River and just south-east of a narrow strip of wetland with sedges and occasional paperbarks (about 10 m wide at approximately KP 69.2)
- passing to the east of Woodberry Swamp (mapped as a SEPP14 wetland) for about 0.8 km at approximately KP 86
- passing to the east of Tarro Swamp (mapped as a SEPP14 wetland) for about 1.2 km at approximately KP 88.

- Swamp Oak Floodplain Forests were observed along the proposed pipeline corridor at the following locations:
- passing through a 50 m wide cleared strip through an open forest dominated by Swamp Oak (**Plate 3**) for about 300 m at KP 86 (to the east of Woodberry Swamp)
- passing through cleared pasture just south of the Williams River and just south-east of a narrow strip of wetland with an open canopy of Swamp Oaks and a dense ground story of sedges (about 50 m wide at KP 70).

Swamp Sclerophyll Forest of Coastal Floodplains was recorded adjacent to the proposed pipeline for 0.2 km and is transected for about 30 m, just north of the Williams River at approximately KP 69. A detailed assessment of this community was conducted at flora site 21 (**Figures 1** to **19**, **Table T2, Plate 4**). The transected area has been partially cleared for a powerline corridor (**Plate 5**). A 10 m wide strip directly underneath the powerline is totally cleared, while the areas 10 to 20 m on either side contain well-established regenerating paperbark trees characteristic of this community. The majority of this community lies to the south-east of the proposed pipeline, with a small area also extending about 50 to 100 m to the north-west. This wetland (including the section transected by the proposed pipeline) is mapped as a SEPP 14 wetland.

Hunter Lowland Redgum Forest

A small area of Hunter Lowland Redgum Forest was recorded along Little Black Camp Creek at approximately KP 45.5 (**Plate 6**). The proposed pipeline would transect a 100 m wide strip of open forest dominated by Forest Red Gum on alluvial soils. The community was dissected by a 20 m wide clearing associated with Black Camp Creek Road. To the west of the road, the community had been partially cleared with a canopy cover of about 10%, while the eastern side was much denser with a canopy cover up to 40%. The vegetation on the western edge of the road is considered to be regrowth, while the eastern side is remnant. This community most closely resembles LHCCREMS map unit 19 (Hunter lowlands redgum forest), CRA map unit 49 (redgum / apple forest) and NSW map unit 21 (northern hinterland semi-mesic forest).

Lower Hunter Spotted Gum – Ironbark Forest

Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is a community occurring on Permian age sediments and dominated by Spotted Gum (*Cor. maculata*) and Broad-leaved Ironbark (*Euc. fibrosa*). It is very similar to a number of Spotted Gum communities in the region, including Seaham Spotted Gum - Ironbark Forest. LHCCREMS mapping indicates that Spotted Gum - Ironbark forests along the proposed pipeline are Seaham Spotted Gum - Ironbark Forest, rather than the Endangered Lower Hunter Spotted Gum – Ironbark Forest. The present assessment supports this mapping for the following reasons:

- Ironbarks observed in this community were predominantly *Euc. siderophloia*, not *Euc. fibrosa*.
- Under story species composition was more characteristic of Seaham Spotted Gum - Ironbark Forest (e.g. *Pratia purpurascens, Leucopogon juniperensis, Lomandra multiflora*).
- Seaham Spotted Gum - Ironbark Forest occurs primarily on Carboniferous sediments, while Lower Hunter Spotted Gum – Ironbark Forest occurs primarily on Permian sediments.

Lowland Rainforest on Floodplain of the NSW North Coast Bioregion and Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion

Both of these EECs are subtropical rainforest communities that are characterised by closed canopies with high floristic diversity (although disturbed stands may have a broken canopy). Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion occurs in a range of high nutrient lithic substrates on coastal plains, foothills and plateaux, while Lowland Rainforest on Floodplain of the NSW North Coast Bioregion is found on floodplain alluvium.

Narrow bands of riparian forest that contain some rainforest elements are transected by the proposed pipeline in numerous locations (approximately 0.66 km) and also occur in the GFDA. These are primarily associated with the Karuah River (**Plate 8**), the Avon River and tributaries of the Avon, Karuah, Williams and Hunter Rivers. These riparian bands correspond most closely to dry rainforest communities in existing mapping (Hunter Valley dry rainforest - LHCCREMS map unit 3, Rainforest - CRA map unit 168, dry rainforest - NSW map unit 4). As they are forests with some rainforest elements on recent alluvial soils, they also resemble the EEC, Lowland Rainforest on Floodplain of the NSW North Coast Bioregion. No rainforests in the development area resemble the EEC, Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion, as no rainforests occurring on lithic substrates were recorded.

The crossing points of the Karuah River (KP 19.3, 23.5, 24.3; survey sites FL 08, FL 10) support riparian vegetation with a diverse canopy storey. Common canopy species include *Syzygium australe, Waterhousea floribunda, Tristaniopsis laurina, Backhousia myrtifolia, Eucalyptus tereticornis* and *Casuarina cunninghamiana*, The first three species are included in the core species assemblage of the EEC, Lowland Rainforest on Floodplains of the NSW North Coast Bioregion. The riparian communities on the Karuah River are therefore considered to fall within the definition of this EEC. The pipeline transects approximately 240 m of this community.

However, other riparian crossings are not considered to contain Lowland Rainforest on Floodplain of the NSW North Coast Bioregion, as their canopies are dominated by species that are not characteristic of the EEC. The canopy vegetation of creeks from KP 27 to KP 62 (KP 27, KP 36.9, KP 38.3, KP 40.2, KP 49.5, KP 62.1) are dominated by a variety of species, including Paperbark species (e.g. *Melaleuca styphelioides, M. linariifolia*), Eucalypt species (e.g. *E. umbra, C. maculata*) and Grey Myrtle (*Backhousia myrtifolia*). Riparian sites examined on the Avon River and tributaries (GFDA, KP 8.4) have a very broken canopy, with common species including Paperbark species (e.g. *Melaleuca styphelioides, M. linariifolia*), Bottlebrush (*Callistemon salignus*) and Grey Myrtle (*Backhousia myrtifolia*).

3.4.3 Ecological Communities Protected under the FM Act

No specific ecological communities listed in the FM Act are likely to occur in the study area. However, mangroves, seagrasses and other marine vegetation are protected under the FM Act. Under Section 205 of the FM Act, a permit is required from DPI to harm (e.g. cut, remove, damage, destroy, shade) marine vegetation.

The proposed pipeline crosses one small occurrence of marine vegetation associated with a small tidal channel beside Hunter River at KP 90 (**Plate 7**). This channel is about 10 m wide and supports scattered mangroves, including Grey Mangrove (*Avicennia marina*). At the time of survey, landholder permission to access this site had not been granted, so survey was limited to remote observation using binoculars.

3.4.4 Other Remnant Vegetation

Eucalypt forests are the most common community type along the proposed pipeline ROW, transecting approximately 14.5 km (**Table T3).** The largest areas of eucalypt forest occur along Black Camp Road (KP 31.5 to KP 38) and in Wallaroo National Park (KP 59.8 to KP 63). Several blocks of remnant eucalypt forest are also present in the central and southern portions of the GFDA. These forests are classified as Hunter Macleay dry sclerophyll forest (unit 69) and northern hinterland semi-mesic forest (unit 21) in NSW mapping. CRA forest ecosystems that most closely correspond to these forests are ironbark (unit 71), dry foothills Spotted Gum (unit 33) and south coast Shrubby Grey Gum (unit 134). Corresponding LHCCREMS vegetation units include Seaham Spotted Gum Ironbark forest (unit 16) and Hunter Valley moist forest (unit 12).

Narrow bands of riparian forest are transected by the proposed pipeline in numerous locations (approximately 0.42 km) and also occur in the GFDA. This vegetation corresponds most closely to dry rainforest communities in existing mapping (Hunter Valley dry rainforest - LHCCREMS map unit 3, Rainforest - CRA map unit 168, dry rainforest - NSW map unit 4). The riparian communities along the Karuah River (**Plate 8**) are considered to be endangered under the TSC Act (Lowland Rainforest on Floodplain of the NSW North Coast Bioregion) and are discussed in more detail in the previous section.

Wetland communities were observed along 0.2 km of the proposed pipeline. These communities are listed as endangered under the TSC Act and are discussed in more detail in the previous section.

3.4.5 Endangered Populations

The Atlas of NSW Wildlife Data Unit identified seven endangered populations of flora species listed under the TSC Act that may potentially occur within the study site and adjacent regions (**Table T4)**. Five of these have preferred habitat which was identified within the study area during the field survey. These species / populations were targeted during the field survey, but none were observed in the areas inspected. Seven-part tests (pursuant to Section 5a of the TSC Act) for these populations are provided in **Appendix E**. They are not considered likely to occur within the boundaries of the project area and are therefore not evaluated further in this report.

3.4.6 Threatened Flora Species

Nineteen flora species known to occur or potentially occur within the study area and surrounding region are identified as being critically endangered, endangered or vulnerable under the EPBC Act and / or the TSC Act (**Table T6**). Fourteen species are listed under the EPBC Act (six endangered and eight vulnerable) and 19 species are listed under the TSC Act (seven endangered and 12 vulnerable). Of the 19 threatened species identified as potentially occurring within the greater area, 14 have preferred habitat which was identified within the study area. These species were targeted during the field study, but only one species was detected. One population of *Grevillea parviflora* subsp*. parviflora* was recorded at KP 58.9 along the proposed pipeline route.

***Grevillea parviflora* subsp*. parviflora* (Small-flower Grevillea)**

Small-flower Grevillea is listed as vulnerable in Schedule 2 of the TSC Act and vulnerable under the EPBC Act (**Plate 9**). The Wildlife Atlas database contains 46 records of this species from five localities within 20 km of the proposed alignment, all in the southern section. The majority of these records are from a population about 20 km west of the alignment.

The current survey recorded a population of Small-flower Grevillea within a previously cleared 25 m wide powerline corridor at approximately KP 59. The site supported a range of low forbs, shrubs, grasses and sedges, including *Pultenaea villosa, Daviesia ulcifolia, Themeda triandra, Entolasia stricta* and *Lepidospermum laterale*. The population extended approximately 200 m along the corridor and was estimated to contain several hundred to a thousand plants. An accurate population count was not made during the initial survey as its identity was not confirmed until a specimen was sent to the Royal Botanic Gardens, Sydney. It was also difficult to determine the extent of individual plants as they were coppicing extensively under the current regular slashing regime. An individual plant was recorded in remnant open forest approximately 0.5 km north of the main population. It is therefore likely that other populations exist in surrounding remnant vegetation (including the nearby Wallaroo National Park).

The population is regularly slashed during maintenance works for the powerline and is transected by a maintenance track. Plants were relatively prostrate and multi-stemmed, but appeared to be otherwise healthy, with most of them flowering at the time of the survey. Several plants were observed growing between the wheel ruts of the maintenance track. No specific management plan is in place for this population, as it was not previously known to be present in the easement. However, the population appears to be coping effectively with the current management regime.

NPWS (2002) noted that competition and shading from tick bush can limit the spread of this species, so regular slashing may even assist the population by reducing competition. Comparison of population sizes within the easement and surrounding native vegetation might provide circumstantial support for this possibility.

The entire powerline easement in the vicinity of this population was traversed by foot or vehicle and no other populations or individuals of this species were observed. Given the high visibility of this species at the time of survey (most plants were flowering profusely), it is considered unlikely that other significant populations were present in the powerline easement in Wallaroo National Park and nearby areas. However, it is possible that scattered individuals may be present.

Other Threatened Species

Three of the flora species potentially present are relatively large and conspicuous. As none of these species were recorded during the field survey, it is considered highly unlikely that any of these species occurs within the sites investigated. Sixteen of the identified species are smaller and less conspicuous, so are more difficult to detect during a single rapid survey. For example, the Leafless Tongue Orchid (*Cryptostylis hunteriana*) is only visible when flowering from November to February and the Eastern Underground Orchid (*Rhizanthella slateri*) grows almost entirely underground, so is usually discovered only when the soil is disturbed. Although none of these species were observed within the sites investigated during the field survey, because of their inconspicuous nature it is not possible to discount the occurrence of these species within the investigated sites.

Seven part tests for these species are provided in **Appendix E**. As not all parts of the study area could be closely inspected due to time and access limitations, it is not possible to discount the possibility that any of the identified threatened flora species occur within the study area or surrounding regions. However, it is considered unlikely that any of these species occur within the study site, especially in the areas that are heavily impacted through grazing and / or cultivation. Even if they do occur, it is very likely that they would be in very small numbers.

One undescribed orchid, closely related to *Diuris alba*, has recently been discovered in forest near KP 54.5 (Kathleen Tuohy-Main, landholder, pers. comm.). No orchids of this genus were recorded in this area or within other sites inspected during the present field survey.

No threatened or protected flora species under the FM Act are known to occur or potentially occur within the study area or adjacent regions.

3.4.7 Declared Weeds

Eight weed species that are declared under the *Noxious Weeds Act 1993* (NW Act) were recorded within or immediately adjacent to the study area (**Table T7).** Under the NW Act, weed species are classified into 5 categories:

- Classes 1 and 2: The plant must be eradicated from the land and the land kept free of the plant.
- Class 3: The plant must be fully and continuously suppressed and destroyed.
- Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local authority.
- Class 5: The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

Of the eight declared weeds recorded, four species are listed as Class 4 (Mistflower, Water Hyacinth, Small Leaf Privet and Blackberry) and four as Class 5 (Lantana, Onion Grass, Oxalis and Willow).

A weedy *Sporobolus* species, identified as Parramatta Grass (*S. africanus*), was recorded at several locations within the study area **(Table T7**). This species is not declared, but a very similar species, Giant Parramatta Grass (*S. fertilis*) is listed as a Class 3 weed. These two species are very difficult to distinguish, so it is possible that the declared Giant Parramatta Grass was also present at the sites where Parramatta Grass was recorded. I

A weed warning for Alligator Weed (*Alternanthera philoxeroides*) was observed for a section of the proposed pipeline at approximately KP 86. This species is listed as a Class 2 weed. No Alligator Weed was observed during the present survey, but the area had been inundated by recent rains, so young plants would be submerged and therefore not visible.

Some weed species are also recognised by the Commonwealth Government as Weeds of National Significance (WONS) based on their:

- invasiveness and impact characteristics
- potential and current area of spread
- current primary industry, environment and socioeconomic impacts.

WONS that were recorded in the proposed pipeline area included Lantana and Blackberry, but the only WONS recorded in the GFDA was Willow.

3.5 Fauna

3.5.1 Fauna Habitats

Seven vegetation communities were identified from the flora assessments as occurring in the project area (**Table T3)**. Fauna habitats within the project area can be classified more simply on the basis of the preferred habitats types of fauna species found in the project area. In this way, four broad habitat classes can be recognised (**Table T8)**, although these are not necessarily mutually exclusive:

- grasslands and pastures
- riparian and / or closed forests
- sclerophyll woodlands and forests
- open freshwater wetlands.

The most widespread of these four habitats in the project area is grasslands and pastures. About 94% of the proposed GFDA is grazed pasture and about 88% of the proposed gas pipeline passes through cleared pastures, intentionally avoiding all other habitats wherever possible. No threatened species identified as potentially occurring in the project area prefer grassland or pasture habitats.

The proposed gas pipeline crosses streams of varying sizes. Narrow bands of riparian forest are intersected by the proposed pipeline in numerous locations and also occur in the GFDA. These are primarily associated with the Avon River and the Karuah River and tributaries of the Avon, Karuah, Williams and Hunter Rivers. Up to 11 threatened fauna species potentially occur in riparian habitats along the proposed pipeline route, especially at the Karuah River.

The proposed pipeline route passes through or lies adjacent to a number of significant blocks of remnant vegetation. The largest remnant areas are eucalypt forests associated with hilly terrain along Black Camp Road and in Wallaroo National Park. The forests along Black Camp Road are the tallest, most closed and most moist forests on the proposed route. Several semi-mesic and dry forest types dominated by eucalypts occur here. There is potential for several threatened fauna species reliant on mesic forests to occur in these forests (e.g. forest owls, Yellow-Bellied Glider), although being fairly dry the habitat is marginal for such species.

A large number of threatened fauna species identified as potentially occurring in the project area (over 30) prefer to inhabit drier woodlands and open forests. By strict definition, true woodlands were not recorded in the project area, although the distinction between these and open forests is gradual. Open forests in or adjacent to the project area occur along Black Camp Road and in Wallaroo National Park, as well as in small patches scattered along the proposed pipeline route. Single paddock trees (particularly large old-growth trees with numerous hollows) can potentially comprise important habitat for several threatened species (e.g. Barking Owl, micro-bats). A number of roadside areas which contained remnant vegetation within a mostly cleared landscape were observed along or adjacent to the proposed pipeline route during the field survey (**Table T1)**. These areas could potentially provide important habitat, particularly movement corridors for threatened woodland fauna species.

Open freshwater wetlands and timbered freshwater wetlands were recorded along the proposed pipeline route at several locations, generally between KP 66 and KP 89 (**Section 3.4.2**). Several threatened species (water birds and frogs) potentially occur in theses habitats. The Green and Golden Bell Frog, which is listed as endangered and is reliant on open freshwater wetlands, has previously been recorded at 140 locations within 5 km of the project site.

3.5.2 Endangered Populations

The Atlas of NSW Wildlife Data Unit identified two endangered populations of fauna species listed under the TSC Act that may potentially occur within the study site and adjacent regions (**Table T4)**. Seven-part tests (pursuant to Section 5a of the TSC Act) for these populations are provided in **Appendix E**. Neither of these fauna populations has preferred habitat which occurs in the study area and neither was observed during the field surveys. They are not considered likely to occur within the boundaries of the project area and are therefore not evaluated further in this report.

3.5.3 Threatened Fauna

The desktop search revealed 81 threatened fauna species previously recorded from the broader study area surrounding the proposed project footprint (i.e. the three search-area boxes described in **Section 2.1**). As a first stage screening process these species were separated into two groups based on the likelihood of their occurrence in the project area:

- Group 1: Species classed as potentially occurring in the project area because suitable potential habitat was recorded in or adjacent to the proposed project footprint or because previous records exist from within 5 km of the proposed footprint.
- Group 2: Species classed as unlikely to occur in the project area because suitable potential habitat was not recorded in or adjacent to the proposed project footprint and because no previous records were found from within 5 km of the proposed footprint.

Table T9 lists the 47 threatened fauna species from Group 1 (potentially occurring in the project area) along with their legislative status and a brief summary of their distribution, ecology and habitat requirements. A seven-part test pursuant to Section 5a of the TSC Act was undertaken for each of these species (**Appendix E**). All 47 species are listed as either vulnerable or endangered under the TSC Act and 10 species are also listed as either vulnerable or endangered under the EPBC Act (**Table T16)**. This group is comprised of 3 amphibians, 2 reptiles, 24 birds and 18 mammals. Of the birds, 18 are woodland or forest species and six are wetland species. Of the mammals, 9 are bats. Only one threatened species, the Grey-crowned Babbler (*Pomatostomus temporalis*) was recorded during the survey at KP 4, KP 36.9 and KP 39.5.

Table T10 lists the threatened fauna species from Group 2 (unlikely to occur in the project area) along with their legislative status, a brief summary of their distribution, ecology and habitat requirements, and a statement on why they were not assessed in further detail.

3.5.4 Migratory and Marine Protected Birds

A total of 21 bird species listed as Migratory and / or Marine under the EPBC Act were identified as potentially occurring within the project area. It is considered unlikely that the proposed development would have impacts of national significance on any of these species. **Table T11** summarises the distribution, ecology, habitat requirements and assesses the potential impacts for these 21 bird species.

3.5.5 Koalas in the Port Stephens LGA.

The *Port Stephens Council Comprehensive Koala Plan of Management* (Port Stephens Council 2002; CKPoM*)* was prepared under SEPP 44 to establish a management framework for Koalas and their habitat in the Port Stephens LGA. The CKPoM is described in **Appendix D**.

The pipeline transects two Koala Management Units defined in the CKPoM:

- The Balickera Management Unit from KP 59.7 to KP 66.8
- The Western Management Unit, from from KP 66.8 to KP 79.7.

The proposed pipeline avoids all *Preferred* and *Supplementary* Koala habitat mapped in the Balickera Management Unit.

The proposed pipeline skims the edge of narrow slivers of *Preferred* habitat between KP 61.0 and KP 62.5 where it follows the existing pipeline easement through Wallaroo National Park. The easement is mapped as cleared *Buffer* zone habitat.

The pieline will transect a small patch or habitat mapped as *Marginal* for about 50 m at KP 66.3. The pieline will also transect a small patch or habitat mapped as *Marginal* for 50 m at KP 66.7.

From KP 67.7 to KP 68.8 the proposed pipeline follows an existing easement on the north-east side of the Willimas River, traversing cleared habitat mapped as *Buffer*, and skirting habitat mapped as *Preferred*.

The proposed pipeline avoids all *Preferred* and *Supplementary* Koala habitat mapped in the Western Management Unit.

The proposed pipeline skirts riparian habitat mapped as *Preferred* from KP 68.8 to KP 69.5. It transects three very small patches of habitat mapped as *Marginal* between KP 70.1 and KP 71.1. The pipeline threads through a gap in habitat mapped as *Preferred* at KP 73.7. The pipeline route utilises an existing easement to avoid habitat mapped as *Marginal* from KP 73.8 to 76.9.

The CKPoM recognises the threat that bushfires pose to Koalas and Koala habitat and the importance of considering the welfare of Koalas. Both of these issues are considered in detail in **Section 4** and **Section 5** of this report.

3.5.6 Introduced Species

Four introduced mammal species were recorded during the field surveys. European Rabbit (*Oryctolagus cuniculus*) was observed at KP 4 and KP 50.5. Brown Hare (*Lepus capensis*) was observed in remnant eucalypt forest in the GFDA. Scats of Red Fox (*Vulpes vulpes*) were collected in the GFDA and along the proposed pipeline at KP 19 (Karuah River). Most Red Fox scats contained remains of House Mouse (*Mus musculus*).

A number of other introduced mammal and bird species are likely to occur in the project area. The proposed development activities are not likely to lead to any change in the status, abundance or distribution of introduced fauna species in the local area, region, state or country.

4.0 Potential Impacts

4.1 Introduction

The potential impacts discussed here are based on desktop studies of the project area and field investigations of the sections that were considered most at risk of negative impacts from construction and maintenance activities. Legislation and regulations relevant to the assessment of potential ecological impacts of the proposed development are summarised in **Appendix D**. A matrix table of potential impacts and the environmental values (pursuant to the EPBC and TSC Acts) that they potentially could impact on is provided in **Table T14**. Assessments of environmental values (i.e. threatened species and ecological communities) are provided in **Appendix E.**

Potential impacts arising from the proposed development can be classed as those that are reversible and those that are non-reversible. The most wide-spread impact likely to arise from the proposal is the loss of native vegetation (**Section 4.2**, **Table T14**). However, this is largely a reversible impact. Once the proposed pipeline has been constructed, there is potential to allow tree, shrub and ground storey vegetation to naturally re-establish over all but the area immediately over the pipeline and shallow-rooted vegetation directly over the pipeline itself. Keeping a 3 m strip on either side of the proposed pipeline free of trees and shrubs may be all that is necessary to protect the pipe from potential root damage and facilitate ongoing pipeline inspection and necessary maintenance. As such, subject to landholder property management practices, it is expected that over the medium term (typically around 20 years) significant portions of the proposed pipeline construction footprint would naturally regenerate.

The proposed pipeline is likely to be decommissioned within several decades. The impacts associated with clearing for construction and maintenance of the pipeline are considered to be reversible within all vegetation communities within the medium term and potentially within 10 years.

4.2 Removal of Native Vegetation

Native vegetation is made up of plant communities that comprise primarily indigenous species and have a structure resembling that of the undisturbed community. It includes canopy trees (where present), understorey, ground cover and below ground biomass (roots, bulbs and the seed bank). Removal of native vegetation not only affects the plant species removed but also reduces habitat (feeding, breeding, roosting and sheltering resources) for native fauna species. Numerous impacts can result from clearing native vegetation (DECC, 2005), including:

- Destruction of habitat causing a loss of biological diversity, which may result in total extinction of species or loss of local genotypes.
- Fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species.
- Riparian zone degradation, such as bank erosion leading to sedimentation that affects aquatic communities.
- Disturbed habitat which may permit the establishment and spread of exotic species that may displace native species.
- Loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

- There are numerous threatened species, populations and ecological communities adversely affected by the clearing of native vegetation. "*Clearing of native vegetation*" is listed as a key threatening process in Schedule 3 of the TSC Act and "*Land Clearing*" is listed as a key threatening process under the EPBC Act.

Impacts potentially arising from removal of native vegetation have particular relevance in this proposal for a number of protected areas, threatened ecological communities, threatened flora species and threatened fauna species that have been recorded in the study area or wider locality (**Table T14**). More specific details for each environmental value potentially impacted are provided in **Appendix E**.

Approximately 203 ha of the GFDA (5.9%) contains remnant native vegetation. While the exact locations of wells have not been finalised, it is unlikely that any of this remnant vegetation would be cleared or disturbed for construction and operation of wells, with appropriate mitigation as described in **Section 5.0**. Installation of flowlines for transporting gas may require clearing of narrow strips within riparian areas. The area of riparian vegetation impacted by flowlines cannot be accurately determined until locations of wells and associated flowlines are resolved. However, measures recommended in **Section 5.0** will be generally applicable to avoiding, minimising and / or mitigating potential impacts of flowlines on riparian areas within the GFDA.

The following principles would be used to locate gas wells and flowlines:

- not within 200 m of existing residences or as required to meet project noise goals
- minimum of 40 m from a watercourse
- avoiding vegetation and riparian areas
- avoiding Indigenous and European heritage places or items
- located adjacent to existing fence lines and access tracks where possible
- located on relatively flat ground, where possible
- considering visual effects and opportunistic use of natural screening such as vegetation
- considering land use and landowner preferences.

Approximately 16.4 km of remnant native vegetation is transected by the proposed 92 km pipeline route. Clearing may also be required for other construction requirements (e.g. access tracks, batch plants, stockpile and storage areas etc.). While exact locations for these requirements were unknown at the time of reporting, it is anticipated that these would be located in existing cleared areas as far as possible to reduce the total area of vegetation loss.

Clearance figures for each scenario are summarised for each vegetation community in **Table T13**. To help consider the significance of this proposed clearing in a regional context, the table also shows the estimated area of each vegetation community that occurs within a 5 km buffer centred on the proposed pipeline route (i.e. an area extending 5 km either side of the route). Comparisons were made with CRA mapping (NPWS, 1999), which covers the entire route, and with LHCC mapping (NPWS, 2000), which provides higher resolution mapping but covers only the southern third of the route.

A worst case scenario is shown in **Table T13** to illustrate a comparison with the confirmed pipeline clearance requirements. This worst case scenario (Scenario 1 in **Table T13**) is based on a consistent 30 m ROW along the entire length of the pipeline route. However, this will not be the construction approach and has been included for comparison purposes only.

This assessment has identified defined points where a reduced ROW should be employed to reduce or avoid impacts. It also identified areas where an HDD construction technique should be employed to further reduce impacts.

Under scenario 1 (entire 30 m ROW is remnant vegetation and all native vegetation is cleared), a maximum of 49.3 ha of remnant vegetation would be cleared for the proposed pipeline. This represents only 0.13% of the estimated remaining vegetation within the 5 km buffer based on CRA mapping and 0.2% based on LHCC mapping.

However, the following measures have been included in this project:

- Areas of the full 30 m ROW can utilise existing power easements that have already been largely cleared with some regrowth native vegetation (known as free width).
- Reduction to a 20 m wide ROW where specific ecological features have been identified to minimise direct impacts.
- Employment of the HDD construction technique at the Karuah River to avoid any clearing of riparian rainforest communities that are identified as the EEC, Lowland Rainforest on Floodplain of the NSW North Coast Bioregion.
- Alignment of the pipeline through the existing cleared easement within the Wallaroo National Park, utilising a reduced ROW. No additional clearing will be undertaken through this section.

All of these measures have been included in the project where possible. In some areas, however, a reduced 20 m wide ROW may not be able to be achieved due to other physical constraints. In addition, where existing easements are utilised, some minor areas of vegetation regrowth may still need to be cleared. As such, the actual clearance of native vegetation is anticipated to be between 16.72 ha (which is the lowest possible amount of clearing based on achieving the 20 m ROW in all required locations and free width of existing cleared easements) to 25 ha.

The potential impacts on each protected area and vegetation community are considered further in the following sections.

4.2.1 Protected Areas

Wallaroo National Park

The proposed pipeline transects Wallaroo National Park for approximately 3.3 km, following an existing powerline easement that contains a clearing of approximately 25 m width. Construction would be restricted to the existing ROW and no additional clearing would be undertaken within Wallaroo National Park.

Nature Refuge

A proposed Nature Refuge in Lot 68 DP753176 is transected by the proposed pipeline for approximately 0.8 km. The pipeline follows an existing powerline easement of approximately 40 m width. Construction would be restricted to the existing ROW and no additional clearing would be undertaken within the Nature Refuge area.

SEPP 14 wetlands

The pipeline transects one section of Swamp Sclerophyll Forest for about 30 m, which is mapped as a SEPP 14 wetland. This wetland is also an EEC and discussed in more detail in the following Section. If the full 30 m ROW was cleared, a maximum of 0.09 ha of wetland would be removed.

Clearing could be reduced by use of an existing 10 m clearing within the powerline easement and / or by reducing the clearing width in this short section. Dependent on further investigations, it may be possible to avoid any clearing of this community by rerouting of the proposed pipeline about 100 m to the west or by use of HDD beneath this area.

4.2.2 Threatened Vegetation Communities

No communities listed as threatened under the EPBC Act or FM Act were recorded within the proposed GFDA or pipeline route. Five Endangered Ecological Communities listed in the TSC Act were observed in the proposed pipeline route: three wetland communities, one rainforest community and one eucalypt forest. None of these communities was observed in the GFDA.

Freshwater Wetlands on Coastal Floodplains

One small section of Freshwater Wetland on Coastal Floodplains of New South Wales North Coast, Sydney Basin and South East Corner Bioregions was transected by the proposed pipeline near the Williams River at approximately KP 68. If the full 30 m ROW is cleared, a maximum of 0.45 ha of wetland would be removed (**Table T13**). This represents about 2% of the entire wetland patch at this site, which is approximately 24 ha in extent. Based on LHCCREMS mapping (which only covers the southern third of the study area), 2970 ha of freshwater wetland complex remains within the 5 km buffer area). The maximum clearing proposed by this development therefore represents only 0.02% of the estimated total extent in the buffer area. Therefore, this impact would not be considered significant.

Several other areas of Freshwater Wetlands on Coastal Floodplains lie adjacent to the proposed pipeline, so they could be disturbed by indirect impacts such as altered hydrology, movement of sediments, nutrients and pollutants, disturbance of wildlife during construction and introduction and spread of wetland weeds.

Table T14 lists environmental values that could be affected by these potential impacts. These values include wetland areas listed under Ramsar and SEPP 14 and potential habitat for up to six threatened flora species. In addition, fringing and emergent vegetation in and surrounding wetland habitats provides potential habitat for up to six threatened water birds and the Green and Golden Bell Frog. The potential impacts to these environmental values are assessed in **Appendix E**, and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 4, 6, 10, 12, 13, 14, 15, 17** and **18** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

Swamp Oak Floodplain Forests

Several areas of Swamp Oak Floodplain Forest lie adjacent to the proposed pipeline, including a 300 m section of Swamp Oak forest to the east of Woodberry Swamp at KP 86 and a 50 m section just south of the Williams River at KP 70. Although these areas would not be directly impacted, they could be disturbed by indirect impacts such as altered hydrology, movement of sediments, nutrients and pollutants, disturbance of wildlife during construction and introduction and spread of wetland weeds.

Table T14 lists environmental values that could be affected by these potential impacts. These values include wetland areas listed under Ramsar and SEPP 14 and potential habitat for up to six threatened flora species. In addition, fringing and emergent vegetation in and surrounding wetland habitats provides potential habitat for up to six threatened water birds and the Green and Golden Bell Frog. The potential impacts to these environmental values are assessed in **Appendix E**, and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 4, 6, 7, 8, 10, 12, 13, 14, 15, 17** and **18** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

Swamp Sclerophyll Forest of Coastal Floodplains

Swamp Sclerophyll Forest of Coastal Floodplains was recorded adjacent to the proposed pipeline for 0.2 km and is transected for about 30 m, just north of the Williams River at approximately KP 69. This wetland is mapped as a SEPP 14 wetland. If the full 30 m ROW was cleared, a maximum of 0.09 ha of swamp sclerophyll forest would be removed. This represents about 1.7% of the community at this site and only 0.03% of the community within the 5 km buffer (based on LHCC mapping). Clearing could be reduced by use of an existing 10 m clearing within the powerline easement and / or by reducing the clearing width in this short section. Dependent on further investigations, it may be possible to avoid any clearing of this community by rerouting of the proposed pipeline about 100 m to the west or by use of HDD beneath this area.

The proposed pipeline also lies adjacent to this wetland for approximately 200 m, so could cause indirect impacts such as altered hydrology, movement of sediments, nutrients and pollutants, disturbance of wildlife during construction and introduction and spread of wetland weeds.

Table T14 lists environmental values that could be affected by these potential impacts. These values include wetland areas listed under SEPP 42 and potential habitat for up to six threatened flora species. In addition, fringing and emergent vegetation in and surrounding wetland habitats provides potential habitat for up to six threatened water birds and the Green and Golden Bell Frog. The potential impacts to these environmental values are assessed in **Appendix E** and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 4, 6, 7, 8, 10, 12, 13, 14, 15, 17** and **18** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

Hunter Lowland Redgum Forest

A 100 m section of Hunter Lowland Redgum Forest was transected by the proposed pipeline route along Little Black Camp Creek at approximately KP 45.5.

The requirement for clearing could be reduced by utilising the existing 20 m wide clearing associated with Black Camp Creek Road and using a reduced ROW through this section of the alignment. This would reduce the clearing requirements to a maximum of 0.1 ha. Impacts could also be reduced by utilising the western edge of the road, which has been partially cleared with a canopy cover of only 10%.

Table T14 lists environmental values that could be affected by the proposed development, assuming no mitigation. **Appendix E** assesses potential impacts and identifies measures to avoid and mitigate impacts. **Recommendations 4, 6, 7, 8, 11, 12, 13, 14, 15, 17 and 18** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

Lowland Rainforest on Floodplain of the NSW North Coast Bioregion

The proposed alignment transects three narrow bands of Lowland Rainforest on Floodplain of the NSW North Coast Bioregion, totalling approximately 240 m, where it crosses the Karuah River (KP 19.3, 23.5 and 24.3). Conventional construction methods would require clearing of up to 0.72 ha of this community.

HDD techniques are proposed for all crossings of the Karuah River, which would avoid any clearing of this EEC. Therefore, potential impacts are likely to be limited to indirect impacts such as altered hydrology, movement of sediments, nutrients and pollutants, disturbance of wildlife during construction and introduction and spread of riparian weeds.

Table T14 lists environmental values that could be affected by the proposed development, assuming no mitigation. **Appendix E** assesses potential impacts and identifies measures to avoid and mitigate impacts. **Recommendations 4, 6, 11, 12, 13, 14, 15** and **17** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.2.3 Other Remnant Vegetation

In addition to ecological communities listed as threatened under the EBPC Act and / or the TSC Act, vegetation communities occur in the project area that are not listed themselves, but which provide potential or known habitat for listed threatened species of flora and / or fauna.

Marine Vegetation

The proposed pipeline crosses one small tidal channel beside Hunter River at KP 90. This channel is about 10 m wide and supports scattered mangroves. Approximatly 0.04 ha of mangroves potentially could be removed (depending on the construction method) for the proposed development (**Table T12** and **Table T13)**.

Riparian Rainforest

Excluding riparian communities along the Karuah River (which are discussed under the EEC Lowland Rainforest on Floodplain of the NSW North Coast Bioregion in Section 3.4.2), the proposed pipeline transects 10 streams that support riparian rainforest vegetation, totalling approximately 0.42 km. This would require removal of up to 1.26 ha of rainforest if the full 30 m ROW was cleared. This represents about 0.7% of this community within the 5 km buffer based on CRA mapping and 0.3% based on LHCC mapping. Using existing clearings and reducing clearing width at stream crossings would further reduce this figure. For example, using a 20 m ROW would require only 0.77 ha of clearing.

Pipeline construction may also impact indirectly on downstream riparian environments through altered hydrology, erosion, movement of sediments, nutrients and pollutants, disturbance of wildlife during construction and introduction and spread of riparian weeds.

Eucalypt forests

The proposed pipeline transects approximately 15.5 km of remnant eucalypt forests. If the full 30 m ROW was cleared, a maximum of 46.6 ha of eucalypt forest would be removed. This represents less than 0.2% of eucalypt communities within the 5 km buffer based on CRA mapping. Clearing would be reduced to 34.4 ha if existing unobstructed clearing within tracks and powerline easements could be utilised within the 30 m ROW. Existing clearings include the 5 m roadway along Black Camp Road and 5 to 10 m strips beside power transmission towers. This figure could be further reduced to 18.9 ha if clearing could be confined to a 20 m ROW. If clearing of vegetation could be avoided within Wallaroo National Park, total clearing of eucalypt forest would drop to 15.6 ha.

The clearing of vegetation and associated direct and indirect impacts could potentially affect a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to 14 flora species and up to 47 fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**, and they and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 4, 5, 6, 7, 8, 12, 13, 14, 15, 17** and **18** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.3 Loss of Hollow-Bearing Trees

Tree hollows are cavities formed in the trunk or branches of a living or dead tree. Hollows are usually more characteristic of older, mature to over-mature trees. Hollows may develop in the trunk and branches of trees as a result of wind breakage, lighting strikes, fire and / or following the consumption and decay of internal heartwood by fungi and invertebrates, primarily termites. Hollow entrances are more common in larger trunks and branches because damage is less likely to be covered by growth of external sapwood (DECC, 2005).

Hollows occur primarily in old eucalypt trees, and are uncommon in many other native and introduced species such as wattle (*Acacia*), cypress pine (*Callitris*), she-oak (*Allocasuarina*) and pine (*Pinus*). The presence, abundance and size of hollows are positively correlated with tree trunk diameter, which is an index of age. Hollows with large internal dimensions are the rarest and occur predominantly in large old trees, which are rarely less than 220 years old. Larger, older trees also provide a greater density of hollows per tree. As such, large old hollow-bearing trees are relatively more valuable to hollow-using fauna than younger hollow-bearing trees. The latter are important as a future resource (DECC, 2005).

Mature and old hollow-bearing trees offer other valuable resources. Mature trees provide more flowers, nectar, fruit and seeds than younger trees, and a complex substrate that supplies diverse habitats for invertebrate populations. When hollow-bearing trees collapse or shed limbs, they also provide hollow logs that serve as important foraging substrates and shelter sites (DECC, 2005). Hollow-bearing trees can be considered a finite resource in the study area, given the long time periods involved with the ontogeny of hollow development (Wormington and Lamb, 1999) and that the repercussions of the removal of hollow-bearing trees from an area may persist for several hundred years (Gibbons and Lindenmayer, 2002).

Some hollow-bearing trees may be removed by the proposal. "*Loss of hollow bearing trees*" is listed as a key threatening process under Schedule 3 of the TSC Act.

Impacts potentially arising from a loss of hollow-bearing trees have particular relevance in this proposal for up to 20 threatened fauna species listed under the TSC and EPBC Acts that are dependent on hollows and definitely or potentially occur in the study area or locality (**Table T14**). An assessment of potential impacts that could occur is provided for each of these species in **Appendix E**. These potential impacts could be potentially significant if they were not mitigated. Therefore, **Recommendation 7** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.4 Removal of Dead and Fallen Timber

Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals), disruption of ecosystem processes and soil erosion (DECC 2005).

Removal of dead old trees (either standing or on the ground) results in the loss of important habitat such as hollows and decaying wood (Gibbons and Lindenmayer, 2002) for a wide variety of vertebrates, invertebrates and microbial species and may adversely affect numerous threatened species. The proposal has the potential to remove dead and fallen timber wherever it occurs within the proposed pipeline footprint. "*Removal of dead wood and dead trees*" is listed as a Key Threatening Process under Schedule 3 of the TSC Act.

Impacts potentially arising from the removal of ground debris have particular relevance in this proposal for a number of threatened fauna species, in particular a large suite of woodland birds that are reliant on fallen timber and have been recorded or have the potential to occur in the study area.

This potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to five ecological communities and up to 22 fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendation 8** in **Section 5** outlines measures designed to avoid, minimise and / or mitigate these potential impacts.

4.5 Removal of Rock

Rocks serve many purposes in the natural environment. They provide habitat for many plants and animals, some of which are threatened. Many animals use rocks and rocky environments for shelter, to hide from predators, find food, avoid extreme weather conditions and escape bushfires. Bushrock is also known to provide egg-laying sites for reptiles (DECC, 2005). A number of reptile species are highly dependent on rocks for both protection and the thermal characteristics of rock shelters, and may become locally extinct in areas from which loose rocks and rock outcrops have been removed or destroyed (Shine et al., 1998; Webb and Shine, 2000; Shah et al., 2004).

"*Bushrock removal*" is listed as a Key Threatening Process under Schedule 3 of the TSC Act.

Impacts potentially arising from removal of rock have little relevance in this proposal because little if any outcropping rock and no rocky escarpment occur in the GFDA or the proposed pipeline route and no threatened species reliant on rocky microhabitats are likely to occur in the project footprint. Spotted-tailed Quoll can be impacted on by removal of rock where it occurs in rocky areas (DECC, 2005) but the species also occurs in areas without rock (Edgar and Belcher, 1995). **Recommendation 9** in **Section 5** outlines measures designed to avoid, minimise and / or mitigate potential impacts that might arise in the unlikely event that areas of bush rock were encountered in the proposed construction footprint.

4.6 Creation of Edge Effects

Indirect impacts of the proposed development may potentially include the increase or extension of edge effects where the proposed pipeline would run adjacent to previously undisturbed vegetation. Edge effects are caused by changed environmental conditions and may include alterations to light, wind, temperature and runoff along the edges of vegetated areas. Increased light exposure may lead to a reduction in the amount of water available due to increased evaporation and / or evapo-transpiration. Other potential edge effects resulting from the proposed development include further establishment of weeds and modification of habitat to the disadvantage of forest fauna assemblages and advantage of edge-specialist assemblages. This may result in changes to species composition in these areas. Bali (2000) concluded that effects from a new edge would extend at least 50 m towards the interior of the habitat.

Impacts potentially arising from edge effects have particular relevance in this proposal wherever the proposed pipeline would run through or immediately adjacent to timbered habitats. These potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to four ecological communities and up to 13 fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E.** Since the majority of the proposed route has been cleared previously and the landscape is highly fragmented, the potential impacts are not considered to be significant. Nevertheless, recommendations relating to vegetation clearing and rehabilitation in **Section 5** outline measures designed to avoid, minimise and / or mitigate these potential impacts.

4.7 Spread of Environmental Weeds

Several noxious weeds (**Table T7**) and numerous environmental weeds are present in the study area. Environmental weeds have many severe impacts on Australian environments, including smothering of native vegetation, competition with native vegetation, prevention of seedling recruitment and alteration of fire regimes. There is potential to spread weeds and increase their areas of infestation during the construction phase of the proposed development, during ongoing maintenance activities, and through modified drainage patterns. Schedule 3 of the TSC Act lists four Key Threatening Processes related to weed invasion:

- “invasion and establishment of exotic vines and scramblers”
- “invasion of native plant communities by bitou bush and boneseed”
- “invasion of native plant communities by exotic perennial grasses”
- “invasion, establishment and spread of lantana”.

This potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under Ramsar and SEPP 14, as well as up to five ecological communities, up to 14 flora species and up to 19 fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**, and they could be potentially significant if they were not mitigated. Therefore, **Recommendation 15** in **Section 5** outlines measures specifically designed to avoid potentially significant impacts.

4.8 Maintenance of the Easement

The actions associated with easement maintenance are recognised as threats to some listed flora species in NSW. Activities which can cause negative impacts include slashing, clearing of regrowth, spraying of weeds, fire, and trampling by vehicles and machinery. Priority action statements to address these potential impacts generally require that where threatened species or their potential habitats occur, planning and maintenance staff are made aware of threatened species before road, trail, or easement maintenance activities commence and processes are in place to avoid impacting upon them.

Impacts potentially arising from maintenance of the easement have particular relevance in this proposal to the population of Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) recorded during the field surveys within a previously cleared 25 m wide powerline corridor at approximately KP 59. The NPWS Threatened Species Information Sheet for Small-flower Grevillea (NPWS, 2002) identifies that the species often occurs in slightly disturbed areas such as easements. Therefore, widening and maintenance of easements and vehicular use are recognised threats to populations. High frequency fire may impact on populations and it is important that the interval between successive fires is sufficient to allow adequate accumulation of seeds in the soil seedbank for subsequent seedling recruitment. Although Small-flower Grevillea is not dependant solely on regeneration from seed, this form of regeneration is important for maintaining genetic diversity within populations.

Activities associated with maintenance of the easement potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to three ecological communities, up to 14 flora species and up to four fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendation 19** in **Section 5** outlines measures designed to avoid, minimise and / or mitigate these potential impacts.

4.9 Excavation Works

Many fauna species burrow or shelter in deep cracks in soil. There is potential for direct impact on some fauna species from being unearthed during construction of the proposed pipeline trench. While many larger and more mobile fauna such as birds, macropods and larger reptiles are likely to move away from the disturbance resulting from construction, smaller burrowing fauna (especially nocturnal species) are likely to remain under the surface and therefore risk being dug up and injured or killed. A broad range of burrowing and crack-dwelling fauna including frogs, lizards, snakes and small mammals are potentially present along the entire length of the proposed pipeline route.

To facilitate the laying of the pipeline, an open trench would be required. The trenching would be progressive and therefore the full length of the proposed pipeline would not be open at any given time. The open trench provides a temporary barrier to movement of ground-dwelling fauna. Ground-dwelling species, particularly smaller species such as reptiles and amphibian are also at risk of falling into open trenches, becoming trapped by the steep banks and being exposed to overheating, dehydration, predation and / or drowning. Fauna entrapment within proposed pipeline trenches has been recognised as a key environmental issue by the Australian Pipeline Industry Association Code of Environmental Practice (APIA, 2005). A broad range of ground-dwelling fauna species occurs in the project area.

Published information from other Australian pipeline projects has demonstrated that pipeline trenches can entrap high numbers of a wide diversity of terrestrial animals (including threatened species), particularly reptiles, frogs and small mammals, with the potential for very high levels of mortality (Ayers and Wallace, 1997; Woinarski et al., 2000; Doody et al. 2003, Wilson and Swan, 2004; Wilson, 2005).

Small-flower Grevillea relies on underground rhizomes for regeneration following fire. Excavation of the trench has the potential to inadvertently remove and destroy these rhizomes, where a population occurs within a previously cleared 25 m wide powerline corridor at approximately KP 59.

Excavation works may also impact indirectly on ecological values by exposing potential acid sulphate soils (PASS). These soils mostly occur below 5 m ASL, so are most likely to occur in the southern end of the proposed pipeline route, especially in low-lying wetlands and tidal areas where soils are often saturated. PASS contain iron sulfides, which form sulfuric acid when exposed to atmospheric oxygen. As well as impacting the local environment, acids can leach into surrounding ground and surface waters. If large quantities of PASS were disturbed in the southern section of the pipeline, acid leachate could impact on the lower Hunter estuary, including the Ramsar listed Hunter Estuary Wetlands.

This potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to five ecological communities, up to two flora species and up to 10 fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. Excavation works could also indirectly impact on the Ramsar wetland. The potential impacts to these environmental values are assessed in **Appendix E**, and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 3, 14** and **16** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.10 Soil Compaction

Small-flower Grevillea relies on underground rhizomes for regeneration following fire. Soil compaction from construction machinery and easement maintenance vehicles has the potential to inadvertently destroy these rhizomes, where a population occurs within a previously cleared 25 m wide powerline corridor at approximately KP 59. Soil compaction may also impair regeneration of vegetation following construction and result in increased erosion and sediment loss.

This potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to five ecological communities, up to one flora species and up to three fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendations 14** and **16** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.11 Barrier Effects to Wildlife Movement

In some circumstances, linear infrastructure projects can create barriers to wildlife movements, in particular terrestrial and arboreal fauna species. At their most extreme, these barriers can reduce gene flow in populations. This is mostly seen in major arterial roads with dual carriageways and fauna-proof fencing. In buried pipelines such as the current proposal, only the most sedentary species would be affected and the impacts would be largely short-term, resulting from disturbance and temporary loss of vegetation cover. The impacts are largely reversible with restoration of vegetation cover.

Barrier effects are considered unlikely to present significant or long-term impacts (**Table T14)** because:

- the pipeline will mostly follow existing cleared corridors through native vegetation
- the pipeline will require a maximum clearing of 30 m
- the clearing width will be reduced wherever possible by use of existing cleared corridors
- a significant proportion of the cleared area will be revegetated.

Nevertheless, **Recommendation 14** in **Section 5** outlines measures designed to avoid, minimise and / or mitigate these potential impacts.

4.12 Alterations to Hydrology

Alteration to natural flow regimes refers to reducing or increasing flows, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and subsurface water levels and changing the rate of rise or fall of water levels. The three primary human processes that have altered flows in streams, rivers and their floodplains, and wetlands in NSW are:

- building of dams
- diversion of flows by structures or extraction
- alteration of flows on floodplains with levees and structures (DECC, 2005).

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystems, including floodplains. Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands has been identified as a threat to a number of threatened species and communities. "*Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands*" is listed on Schedule 3 of the TSC Act as a Key Threatening Process.

Alterations to ground water hydrology may also lead to activation of PASS, by exposing normally water-logged soils to atmospheric oxygen. These soils mostly occur below 5 m ASL, so are most likely to occur in the southern end of the proposed pipeline route, especially in low-lying wetlands and tidal areas where soils are often saturated.

Impacts potentially arising from alteration to the natural flow regimes potentially could have direct and indirect impacts on a national park, and areas of wetlands listed under Ramsar and SEPP 14, as well as up to four ecological communities, up to six flora species and up to nine fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**, and they could be potentially significant if they were not mitigated. Therefore, **Recommendations 10 and 11** in **Section 5** outline measures specifically designed to avoid potentially significant impacts. Provided that the mitigation measures are implemented, it is considered unlikely that the development will impact significantly on hydrology.

4.13 Wild Fire

Construction activities could create unintended wild fires in the project area. Fires have the potential to spread rapidly and well beyond the intended project footprint. Wild fires could also be started by vegetation maintenance activities in the proposed pipeline easement throughout the operational phase of the proposed project. Conversely, the proposed pipeline easement may act as a fire break and retard wild fire in some areas.

Impacts potentially arising from changes to the local regime of wild fire potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under Ramsar and SEPP 14, as well as up to five ecological communities, up to 14 flora species and up to seven fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendations 1, 4 and 19** in **Section 5** outline measures designed to avoid, minimise and / or mitigate these potential impacts.

4.14 Construction Waste

Construction activities can generate large amounts of waste (e.g. wrapping and packaging from construction materials, domestic waste from crew members, etc). Linear infrastructure projects provide the potential to strew this waste extensively across a landscape.

Impacts potentially arising from construction waste potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to five ecological communities and up to nine fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. Construction waste could also indirectly impact on the Ramsar wetland. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendations 1** and **16** in **Section 5** outline measures designed to avoid, minimise and / or mitigate these potential impacts.

4.15 Erosion, Sedimentation and Dust Emissions

Earthworks, vegetation clearing, vehicle movements on unformed tracks and other machinery operations have the potential to cause erosion and dust emissions. Erosion is of particular concern in waterways and steep areas. Erosion and dust can cause sedimentation of waterways, including streams and freshwater wetlands. Potential impacts arising from dust emissions would likely be short-term and reversible, but could affect vegetation communities and flora species through smothering. Erosion and sedimentation could continue after construction is completed and the impacts of sedimentation could persist after erosion has ceased.

Erosion, sedimentation and dust emissions potentially could have direct and indirect impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to five ecological communities, up to 14 flora species and up to nine fauna species listed as threatened under the EPBC Act and / or the TSC Act (**Table T14)**. These impacts could also indirectly affect the Ramsar wetland. The potential impacts to these environmental values are assessed in **Appendix E**. **Recommendations 1, 16 and 19** in **Section 5** outline measures specifically designed to avoid potentially significant impacts.

4.16 Spread of the plant pathogen *Phytophthora cinnamomi*

Pytophthora cinnamomi (root rot fungus) is a microscopic, soil-borne plant pathogen that infects and destroys the root systems of susceptible plant species. Root rot has been responsible for significant mortaility of native plants and threatens native ecosystems, forestry and agricultural industries (DECC, 2008).

Pytophthora cinnamomi occurs worldwide and infects a wide range of plant species. It has infected thousands of hectares of native forest in Western Australia, Victoria, Tasmania and South Australia. It has been identified in several natural areas in New South Wales and coastal Queensland, although the extent of the spread in these areas is unclear. *Phytophthora* induced die-back has been identified in forest, woodland and heatAECOMnd communities in the Hunter-Central catchment within the proposed development area. *Phytophthora* is usually restricted to moister habitats along drainage lines, in gullies and depressions and in areas of surface seepage along ridge tops (DECC, 2008).

The fungus lives within the soil on the roots and stems of living plants. It produces zoospores which are transported between areas in contaminated soil and on footwear, tools, equipment and vehicles. The spores are also transported large distances in surface and sub-surface water supplies. They are attracted to the root systems of plants and quickly infect susceptible plant species (DECC, 2008).

Thousands of Australian native plant species are potentially susceptible to *Phytophthora,* although some plant species are more susceptible than others. This disease has the potential to significantly influence biodiversity and species composition, particularly in dry open woodlands, woodlands and heatAECOMnds, where the disease has been most destructive. Fauna can also be indirectly affected by *Phytophthora* through changes in habitat structure and in the availability of food and shelter resources (DECC, 2008).

'Infection of native plants by *Phytophthora cinnamomi'* has been listed as a key threatening process in Schedule 3 of the TSC Act and 'Dieback caused by the root rot fungus (*Phytophthora cinnamomi*) is listed as a key threatening process under the EPBC Act. Several threatened plants that could potentially be found along the proposed pipeline route, including *Grevillea guthrieana* and *Tetratheca juncea*, are susceptible to the *Phytophthora* pathogen (DECC, 2008).

The effects of *Phytophthor*a could potentially could have direct impacts on a national park, a nature reserve, and areas of wetlands listed under SEPP 14, as well as up to four ecological communities and up to 3 flora species listed as threatened under the EPBC Act and / or the TSC Act **(Table T14).** The potential impacts to these environmental values are assessed in **Appendix E** , and they could be potentially significant if they were not mitigated. Therefore, **Recommendation 17** in **Section 5** outlines measures specifically designed to avoid potentially significant impacts.

4.17 Spread of the amphibian pathogen 'Chytrid fungus'

Chytrid fungus is a fungal pathogen that infects amphibians and causes the disease chytridiomycosis. The pathogen was introduced to south-east Queensland in the 1970s and has spread throughout coastal eastern Australia. The pathogen infects the skin of frogs and in most cases causes death within 18 to 48 days (DEH, 2006b).

'Infection of amphibians with chytrid fungus resulting in chytridiomycosis' is identifid as a Key Threatening Process under the EPBC Act. The fungus is a known pathogen in 49 species of Australian frogs and is known to infect 52% of threatened frog species including *Litoria aurea* and *Mixophyes iterates*, which could potentially occur along the proposed development route (DEH, 2006b).

Chytrid fungus is spread through movement of infected water, transport of infected frogs and tadpoles, on equipment used by researchers and through handling frogs. There is no evidence that Chytrid fungus can survive outside of waterbodies and it is considered unlikely that the disease can be transported in dry soil (DEH, 2006b).

Although spread of the chytrid fungus has the potential to cause the extinction of many species of Australian frogs, it is unlikely that the proposed development will increase the spread of disease for three reasons (DEH, 2006b):

- The disease can only survive in water and it is unlikely that water will be transported between watercourses during the development.
- The disease is spread through contact with frogs and it is unlikely that staff or contractors will come into contact with frogs.
- To AECOM's knowledge there have be no recorded infections in areas affected by the proposed development.

Therefore the risk of spreading Chytrid fungus during the proposed development is considered negligible and no additional mitigation measures, other than general recommendations for minimising disturbance to wetlands and permanent streams, are required.

5.0 Mitigation Measures

5.1 Pre- Construction Phase

Recommendation 1: Develop and Implement best-practice site management measures within an Environmental Management Plan (EMP) framework.

Incorporate impact mitigation and environmental management measures into EMPs for the proposed development and include provisions for the preconstruction, construction and operational stages of the development. In the EMPs detail specific management strategies to be implemented during the construction phase of the proposed development, including strategies and protocols relating to soil and water management, protection of vegetation to be retained, fauna protection, rehabilitation strategies, containment of waste, and an emergency response program for accidental spills and other emergencies. Include a number of detailed management strategies in the EMPs sufficient to facilitate the implementation and auditing of all the mitigation measures recommended in this Section.

Develop an induction program for the EMP and induct all site workers involved in construction activities (whether directly or indirectly) into the EMP program prior to their commencement of duties.

Recommendation 2: Develop and implement an appropriate multi-faceted management plan for the Small-flower Grevillea in the powerline easement at approximately KP 59.

Develop strategies to minimise potential impacts during the construction phase, including, but not necessarily limited to:

- Conduct a detailed survey for the Small-flower Grevillea population within the proposed ROW along the powerline easement and adjacent area to determine population characteristics (including precise distribution, extent and abundance).
- Investigate and use the absolute minimum construction width within the ROW wherever the Grevillea occurs.
- Select the alignment of access tracks for vehicle and construction machinery along the powerline easement to minimise compaction of soil around the underground rhizomes of the Grevillea.
- Manage the construction process to minimise impacts on Grevilleas within and adjacent to the construction footprint, including:
  - fencing of the population adjacent to the development to avoid accidental damage
  - development and implementation of appropriate sediment and erosion control systems
  - stockpiling of topsoil containing seeds of this species and respreading it following construction
  - revegetation with native species as soon as possible following construction
  - development and implementation of weed management protocols (including hygiene and control) during and for at least two years following construction.

Develop strategies to minimise easement maintenance impacts during the operation phase, including, but not necessarily limited to:

- Liaise with relevant stakeholders and authorities (e.g. DECC, DEHWA, the electrical authority that currently maintains the powerline easement) to develop an appropriate management plan (including construction and operational / maintenance phases).
- Document the current management regime of the easement because it appears to be favourable for the species.
- Develop and implement appropriate maintenance strategies to minimise ongoing impacts on the existing population.
- Minimise any change to the current management regime of the easement.
- Consider the appropriateness of minor changes to the current management regime that may be beneficial, such as raising the height of slashing.
- Avoid causing any significant changes to current fire regime.
- Fit spark-arrestors to all machinery and equipment operating in the powerline easement during dry periods in summer.

Develop a monitoring program (including pre-construction baseline data) for the abundance and geographical extent of this species in the easement, including as far as possible, but not necessarily limited to the following:

- Conduct a detailed survey for the Small-flower Grevillea population within the proposed ROW along the powerline easement and adjacent area to determine population characteristics (including precise distribution, extent and abundance), as recommended above.
- Document the pre-construction (baseline) management regime of the powerline easement.
- Monitor and record the annual management regime of the powerline easement in a way that can be compared to baseline to detect any relevant changes.
- Monitor the Grevillea population during and for at least two years following construction to assess the effectiveness of the current management regime and modify the management plan, if required.

Develop an offset strategy to compensate for residual impacts that cannot be avoided or mitigated, following principles outlined in ***Recommendation 18****. The offset strategy will include, but not necessarily be limited to:*

- Develop the offset strategy in consultation with DECC.
- Assess the extent and number of plants that would be impacted and calculate the biodiversity credits required to offset the impact.
- Identify and procure an appropriate offset area nearby where a population of this species can be established, preferably adjacent to an existing conservation area.
- Investigate and develop appropriate translocation, propagation and cultivation techniques. Olde and Marriott (1995) note that *G. parviflora* adapts readily to cultivation and can be grown from seeds and cuttings of half-hardened new growth in early Spring. No published information on translocation of *G. parviflora* could be located, but other species of *Grevillea* have beeen successfully translocated (e.g. Stack *et al*., 2003).

- Undertake seed collection, propagation and translocation would be in accordance with currently accepted Australian guidelines, including:
  - Guidelines for the Translocation of Threatened Plants in Australia. 2nd edition (Vallee et al., 2004)
  - Germplasm Conservation Guidelines for Australia (ANPC, 1997)
  - Floradata: A guide to the collection, storage and propagation of Australian native plant seed (Mortlock and Lloyd, 2001)
  - Growing Australian Native Plants from Seed - for revegetation, tree planting and direct seeding (Murray, 2003).
- Propagate sufficient plants to offset the number impacted by the proposed development.
- Plant and maintain propagated plants (and translocated plants, if translocation is considered feasible) in the offset area for at least 2 years.
- Monitor to evaluate the success of the offset program for at least 5 years and identify any problems that require remedial actions.
- Manage weeds for at least 2 years following planting.
- Arrange for appropriate legislative protection of the offset area.

Recommendation 3: Undertake acid sulfate soil investigations in sections of the proposed pipeline route below 5 m ASL.

Develop an acid sulfate soil management plan in consultation with relevant authorities, to mitigate potential impacts from the disturbance of PASS in the vicinity of Hexham. As a minimum this would include:

- a detailed account of the geology, hydrology, physical characteristics and environmental receptors within the locality
- management options considered for the project, including construction, operation and decommissioning. The four main strategic options for the management of acid in the environment are:
  - containment within the soil profile in natural depressions, ponds or drains
  - neutralisation typically either lime ($CaCO_3$) or the bicarbonate (HCO_3) in seawater
  - dilution by use of freshwater to raise the pH
  - transformation reduction into stable compounds
- treatment measures proposed – including bunding, testing, application of lime or bicarbonate, sampling and any other relevant measures
- leachate controls
- monitoring requirements and frequencies
- requirements and application for disposal of ass materials
- responsibilities of individual members – including reporting requirements, authorities, and training requirements.

For further details, see the Soil and Geology Chapter in the main report.

5.2 Construction Phase

Recommendation 4: Minimise clearing of native vegetation during construction works.

The following general measures are recommended to minimise impacts on native vegetation:

- Retain and protect hollow-bearing trees wherever possible.
- Locate site compounds and parking areas, site-offices, stockpiles and other ancillary works areas in existing cleared areas, away from waterways or other sensitive areas.
- Install highly visible barriers (e.g. barrier webbing) between the construction area and adjacent native vegetation.
- Restrict access from the construction area into adjacent areas of native vegetation and waterways.
- Provide clear instructions regarding the limits of vegetation clearing to all workers and contractors.
- Minimise the amount of native vegetation (timber) to be cleared by employing the minimum construction footprint in timbered habitats.
- Avoid removal of large paddock trees wherever feasible.
- Fit spark arresters on diesel engines used in construction.
- Ensure fire extinguishers and personnel trained in fire fighting are on-hand during welding operations to minimise damage caused by accidental fires.

Recommendation 5: Minimise clearing of native vegetation in the GFDA.

The following measures are recommended to minimise clearing of native vegetation required for construction purposes:

- Adopt the following locational principles to locate envelopes for gas wells, flowlines and CPF:
  - not within 200 m of existing residences or as required to meet project noise goals
  - minimum of 40 m from a watercourse
  - avoiding native vegetation (about 6% of GFDA) and riparian areas
  - avoiding Indigenous and European heritage places or items
  - located adjacent to existing fence lines and access tracks where possible
  - located on relatively flat ground where possible
  - considering visual effects and opportunistic use of natural screening such as vegetation
  - considering land use and landowner preferences.
- Follow measures proposed in **Recommendation 4** to minimise impacts on native vegetation.

Recommendation 6: Minimise clearing of native vegetation along the pipeline route.

Avoid clearing of riparian rainforest vegetation at Karuah River crossings by using HDD at KP 19.3, KP 23.5 and KP 24.3.

Consider the use of construction techniques and management regimes to avoid clearing native vegetation at the following locations:

- At crossings of permanent streams identified as being sensitive during the ecological field assessment to avoid impacts to hydrological flow regimes and impacts to existing riparian vegetation (KP 36.9, KP 40.3).
- At the crossing of the tidal creek at KP 89.8. If marine vegetation is impacted at this point, a permit may be required.
- At the freshwater wetland (at KP 67.9 to KP 68) to avoid impacts to this Endangered Ecological Community and potential habitat for numerous protected fauna species.
- At the paperbark swamp forest (at KP 68.9) to avoid impacts to this endangered ecological community and potential habitat for numerous protected fauna species.
- Consider minor re-routing of the proposed pipeline route to avoid clearing of native vegetation at the following locations:
- At KP 27.6 to KP 28.5, move the proposed pipeline outside road reserve (which contains significant roadside vegetation), either east into the powerline easement or west into cleared pasture.
- At KP 35.7 to KP 36.4, move the proposed pipeline west into cleared pasture and the powerline easement to avoid remnant eucalypt forest.
- At KP 45.6 to KP 45.7, move the proposed pipeline east into the road alignment and / or regrowth forest on the western side of the road to avoid remnant Redgum forest (which is an Endangered Ecological Community).

Avoid clearing of native vegetation in Wallaroo National Park by using the minimum width ROW through the powerline easement from KP 59.7 to KP 63.

Avoid clearing of native vegetation in the proposed Nature Refuge by using the minimum width ROW through the powerline easement from KP 54 to KP 54.8.

Minimise clearing of native vegetation in the large remnant vegetation block along Black Camp Road by utilising the existing cleared roadway and reducing the width of the ROW from KP 31.5 to KP 38.

Minimise clearing of native riparian vegetation at other watercourses by utilising existing clearings (where present) and reducing the width of the ROW.

When transecting native vegetation, utilise existing cleared areas and reduce the width of the ROW wherever feasible.

Conduct pre-clearing surveys just prior to construction to identify minor route refinements that reduce clearing of native vegetation.

*Follow measures proposed in **Recommendation 4** to minimise impacts on native vegetation.*

Recommendation 7: Minimise the impacts arising from removal of large hollow-bearing trees wherever they are encountered.

Avoid the removal of large-hollow-bearing trees wherever possible.

Undertake surveys to map the location of hollow bearing trees in timbered habitats and large paddock trees prior to clearing and construction. Have wildlife-clearance surveys conducted by qualified people to identify hollow-bearing trees likely to be important for the following threatened species that occur or potentially occur in the project area, including:

- Barking Owl, which nests in large hollows in large hollow-bearing trees in open woodlands
- Powerful Owl, which nests in large hollows in large hollow-bearing trees in tall forests
- Sooty Owl, which nests in large hollows in large hollow-bearing trees in tall closed forests
- Masked Owl, which nests in large hollows in large hollow-bearing trees in woodlands and forests
- Yellow-bellied Glider, which dens in large hollows in large hollow-bearing trees in tall forests.
- Wherever it is not possible to avoid the removal of hollow bearing trees, all large hollows should be salvaged and strapped to standing trees nearby, to restore the potential habitat.
- The salvage and restoration of small hollows and the provision of nest boxes is not recommended. This is because the prevailing habitats in the project area are rural landscapes inhabited by three species of introduced cavity-nesting birds (Common Starling; Common Myna and House Sparrow). Provision of small hollows or nest boxes is more likely to benefit these species than native species.
- Recommendation 8: Minimise the impact of removing dead trees and fallen timber wherever possible.

Avoid felling dead trees wherever possible.

Avoid disturbing, removing or breaking up fallen timber (especially larger logs) wherever possible.

Wherever it is unavoidable to disturb fallen timber, either relocate it to adjacent areas of native vegetation or stockpile it and return to the ROW following completion of earthworks or as otherwise agreed.

Where possible, recycle timber cleared from the ROW by placing logs on the ground in the ROW following construction.

Recommendation 9: Minimise the potential impact from the removal of surface rock.

Little if any surface rock occurs in the project area, but this recommendation is included in case some rocky areas are encountered.

If an area of outcropping rock is encountered, adjust the local alignment of the proposed pipeline to avoid it.

Wherever it is unavoidable to disturb surface rock, stockpile it and return to the ROW following completion of earthworks or as otherwise agreed.

Recommendation 10: Minimise disturbance to freshwater wetlands and their associated vegetation.

Implement an appropriate acid sulphate soil management plan if PASS are detected during pre-construction investigations.

*Wherever feasible, avoid the construction footprint encroaching or impacting on wetlands identified in **Section 3.4.2**.This should include indirect impacts such as down-stream sedimentation, eutrophication and pollution.*

*Wherever the proposed pipeline cannot be routed around wetlands identified in **Section 3.4.2**, consider using HDD techniques to avoid disturbance to hydrology and threatened species.*

*Wherever feasible, avoid damage or modification to emergent vegetation (e.g. sedges, spike rushes. bulrushes and reeds) fringing the wetlands identified in **Section 3.4.2.***

Minimise the use and passage of heavy machinery and vehicles within and adjacent to wetlands during construction.

*Do not remove dead wood and dead trees from near the wetlands identified in **Section 3.4.2***

Recommendation 11: Minimise potential impacts to permanent streams.

Wherever the proposed pipeline crosses permanent streams, use HDD techniques to avoid disturbance to hydrology, riparian vegetation and threatened species (for further details, see the Water Chapter in main report)*.*

Avoid the development footprint encroaching or impacting on streams, including indirect impacts such as erosion, down-stream sedimentation, pollution and eutrophication.

Recommendation 12: Develop a detailed landscaping and rehabilitation plan for incorporation into project Environmental Management Plans.

Detail landscaping and rehabilitation strategies in an EMP for the proposed development.

Include a maintenance program in the landscaping and rehabilitation strategies, involving in planting and weed control, for at least 2 years after completion of construction activities. It is recommended that landscaping and rehabilitation works involve:

- Obtain local provenance native seeds, either from commercial seed suppliers or collection by qualified bush regenerators prior to clearing, for use in the revegetation of disturbed areas.
- Stockpile topsoil that is excavated from areas of native vegetation for application to rehabilitation areas in the ROW, to retain the natural seed bank from the site and assist in the regeneration of local flora.
- Revegetate progressively as construction proceeds, to reduce exposure of unstabilised surfaces and minimise opportunities for weed establishment.
- Revegetate with site-specific species compositions to match the characteristics of the local endemic communities.
- Wherever further fragmentation of existing native vegetation cannot be avoided, revegetate (using local native species) as soon as possible, in order to minimise edge effects.

- The landscaping and rehabilitation plan should aim to reconnect any patches of native vegetation isolated or fragmented by the proposed development, to improve connectivity for wildlife and reduce edge effects.
- Include *Allocasuarina* species in revegetation works wherever they occur naturally, to compensate for the loss of potential foraging habitat for the Glossy Black-cockatoo in the project footprint.
- Monitor vegetation re-establishment during and post-construction. A recommended key flora indicator is the percentage groundcover of desirable species (e.g. 50% of the desirable species cover occurring on adjoining undisturbed areas within two years). Desirable species may include native groundcover species in native vegetation areas or pasture grasses in agricultural landscapes (as requested by landholders).

Recommendation 13: Undertake wildlife-clearance surveys immediately before the vegetation clearing and / or trench excavation fronts.

Have wildlife-clearance surveys undertaken by appropriately qualified people immediately ahead of vegetation clearing operations to avoid disturbance to the following threatened fauna species:

- Conduct surveys for nests of the Bush Stone-curlew, which nests on the ground amongst fallen timber and undergrowth in open woodland. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Square-tailed Kite, which constructs large stick-nests in large trees. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Black-necked Stork, which constructs large stick-nests in large trees. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Barking Owl, which nests in large hollows in large hollow-bearing trees in open woodlands. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Powerful Owl, which nests in large hollows in large hollow-bearing trees in tall forests. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Sooty Owl, which nests in large hollows in large hollow-bearing trees in tall closed forests. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for nests of the Masked Owl, which nests in large hollows in large hollow-bearing trees in woodlands and forests. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for dens of the Yellow-bellied Glider, which nests in large hollows in large hollow-bearing trees in tall forests. If a nest is found in the clearing path then clearing operations should be locally suspended or rerouted.
- Conduct surveys for the presence of Koalas, which rest in trees by day. If a Koala is found in the clearing path then clearing operations should be suspended locally until the koala moves out of the impact zone.

Wherever it is not possible to avoid the removal of large, old-growth, hollow-bearing trees then the following protocols should to be employed:

- Clear the vegetation surrounding large, old-growth, hollow-bearing trees but leave the tree standing in order to give fauna an opportunity to move.
- Large, old-growth, hollow-bearing trees should be felled no less than two days after the removal of the surrounding vegetation.
- Large, old-growth, hollow-bearing trees should be felled carefully and left intact on the ground overnight to give fauna the opportunity to escape.

Authorised wildlife rescuers should be on hand to rescue and relocate fauna disaffected, disoriented or displaced by vegetation clearing and excavation of the trench.

- The NSW Roads and Traffic Authority has an applicable policy that could be used as a model.
- Whenever possible, release nocturnally active animals that are captured for relocation at dusk.
- Recommendation 14: Manage earthworks to minimise impacts on threatened fauna species.

Use temporary fencing to exclude access to the trench by livestock and larger native wildlife (APIA, 2005) where appropriate.

Trench progressively to minimise the period of time the trench is open and the length of open trench. The length of open trench at any one time should be the minimum practicable.

Construct ramps and trench plugs with slopes of no greater than 50% (APIA, 2005) and located at least every 500 m to assist escape for larger fauna species. Where possible, locate trench plugs to coincide with stock and wildlife trails.

Place branches, ramped gangplanks or similar to create ‘ladders’ at regular intervals to assist small fauna to exit the trench (APIA, 2005).

Supply some form of cool insulated cover in the trench to allow smaller fauna species to shelter in shade and / or climb above accumulated water. Following the method employed during construction of the North Queensland Gas Pipeline (Wilson and Swan, 2004), sawdust-filled hessian sacks used to support pipes prior to laying-in should be soaked in water and placed in pairs at approximately 250 m intervals.

Employ qualified fauna spotters and handlers to survey the open trench and remove any trapped fauna species. Such surveillance should occur along the entire length of the trench and not merely those areas described as fauna habitats or sensitive areas. Fauna spotters and handlers should be qualified or appropriately trained to assess and handle any injuries to native fauna that may occur due to trenchfall.

Have qualified veterinarian staff available on call to assess and treat or euthanase (as necessary) any large native vertebrates that are seriously injured.

Recommendation 15: Develop and implement a detailed weed management strategy.

Develop and implement a detailed weed management strategy as part of the EMPs. Include measures to control the spread of weeds into adjacent native vegetation (i.e. weed hygiene). Weed control measures would be particularly important where the proposed development traverses large, intact stands of vegetation, in riparian areas, and around freshwater wetlands. Include in the plan, as a minimum, the following measures:

- Remove existing noxious weeds within the project footprint.
- Destroy weed material removed from construction sites.
- Develop weed quarantine zones along the proposed pipeline route based on weed distribution and sub-catchments, for application of weed hygiene activities.
- Wash down vehicles, machinery and equipment moving between weed quarantine zones, especially after clearing activities and earthworks in weed infested areas.
- Implement a certification process to ensure that all vehicles and plant are weed-free whenever entering or leaving the site and whenever moving between weed quarantine zones within the site.
- Minimise the potential for the transport of weeds in soil, by not transporting excavated soil further than the nearest stockpile locations.
- Use shredded native plant material (uncontaminated by weeds) removed from the site as a mulch and groundcover on disturbed soil surfaces to reduce the potential for weed establishment.
- Use sediment control fencing to prevent soil contaminated with weed seeds from washing into waterways and wetlands.
- Conduct weed management works and monitor for at least two years following construction.

Recommendation 16: Develop and implement a detailed soil, water and waste management strategy.

Develop and implement a detailed soil, water and waste management strategy to control sediment and pollutant discharge from the construction area into adjoining vegetation, streams and wetlands. The following measures are recommended, as a minimum:

- Develop strategies and facilities to contain contaminants such as gross pollutants, weed seeds, fuels and oils, chemicals, etc.
- Stabilise exposed soil surfaces (e.g. through sterile grass seeding, erosion control meshing, progressive stabilisation and re-vegetation of finished soil surfaces and / or mulching using vegetative material removed from the project area.
- Vegetation and soil stockpiles should be separated where possible to maximise use of vegetation for sediment erosion control.
- Use erosion and sediment control fencing to prevent sedimentation of waterways.
- Implement a best practice self-auditing program for site stabilisation and erosion control.
- Dispose of waste materials and / or contaminants appropriately and away from adjacent native vegetation and waterways.
- Develop strategies to minimise erosion and related impacts on steep slopes and in riparian areas.

- Develop a strategy and facilities for the suppression of dust (e.g. dust trigger levels, air quality monitoring and water trucks).
- During construction, use matting to minimise the compaction and / or erosion of soft or erodible soils in sensitive areas such as watercourses and wetlands.
- Rehabilitate access tracks not required after construction, to minimise the potential for erosion and inappropriate vehicular access.
- Assess the potential for acid sulfate soils to occur along the proposed pipeline and implement an appropriate management strategy if they are present.
- If contaminated land is encountered during the construction phase, conduct a risk assessment immediately.

Measures to prevent the spread of weed seeds should be included in the strategy and integrated with the weed management strategy outlined in ***Recommendation 15.***

Recommendation 17: Develop and implement a *Phytopthora cinnamomi* management strategy

Develop and implement a detailed plant pathogen hygiene strategy as part of the EMPs. Include measures that minimise the transport of soil and vegetation and reduce disturbance to native vegetation as disturbed vegetation is most at risk of infection. Hygiene measures will be particularly important where the proposed development crosses watercouses and riparian vegetation. The plan should include the following measures as a minimum:

- Assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations and apply hygiene measures to reduce the risks.
- Schedule activity for periods when soil is dry, wherever possible.
- Educate staff and contractors on the threat of *P. cinnamomi*, management objectives and mitigation measures.
- Supervise staff to ensure compliance with the mitigation measures.
- Use existing roads and tracks wherever possible.
- Minimise the amount of water used on the site.
- Wash down vehicles, tools and equipment between quarantine zones. Recommended zones are the three major catchments - Hunter / Williams, Karuah and Manning / Avon.
- Implement a certification process to ensure vehicles and equipment are soil-free when entering or leaving the site and when moving between quarantine zones.
- Minimise the potential for the transport of infected soil by transporting excavated soil no further than the nearest stockpile locations.
- Use sediment control fencing to prevent soil infected with *P. cinnamomi* from washing into waterways and wetlands.
- Where possible, ensure vegetation cleared from the ROW is not removed from the development site.
- Avoid disturbing vegetation along streams and drainage lines as *P. cinnamomi* causes significant damage in disturbed habitats.
- Only revegetate with plants and seeds from a nursery that can guarantee potting medium and plants that are free of *P. cinnamomi*.

Recommendation 18: Develop and implement offset strategies for residual biodiversity impacts (e.g. loss of native vegetation, EECs, SEPP14 wetlands).

Develop and implement offset strategies to compensate for loss of biodiversity values that cannot be adequately avoided or mitigated by the proposed measures. Offset strategies may be required for:

- clearing and / or disturbance of small areas of three EECs (up to 0.45 ha of Freshwater Wetland on Coastal Floodplains of New South Wales North Coast, 0.09 ha of Swamp Sclerophyll Forest of Coastal Floodplains and 0.1 ha of Hunter Lowland Redgum Forest)
- clearing of up to 0.09 ha of SEPP14 wetland
- clearing of up to 3.3 ha of native vegetation in Wallaroo National Park
- clearing of up to 0.8 ha of native vegetation in a proposed nature reserve (Lot 68 DP753176)
- clearing of native vegetation totalling 16.7 to 25 ha for pipeline construction (and possibly a small area for GFDA development, to be assessed when locations of gas wells and gathering lines are determined)
- removal and / or disturbance of recorded *Grevillea parviflora* populations (discussed in **Recommendation 2**)

Offset plans will be developed according to the following principles:

- Impacts must first be avoided as far as possible by using prevention and mitigation measures.
- All regulatory requirements must be met.
- Offsets should complement other government programs.
- Offsets must be underpinned by sound ecological principles.
- Offsets should aim to result in a net improvement in biodiversity over time.
- Offsets must be enduring – they must offset the impact of the development for at least the period that the impact occurs.
- Offsets should be agreed prior to the impact occurring.
- Offsets must be quantifiable – the impacts and benefits must be reliably estimated.
- Offsets must be targeted – they must offset impacts on a like-for-like or better basis.
- Offsets must be located appropriately – they must offset the impact in the same region.
- Offsets must be supplementary – they must be beyond existing requirements and not already be funded under another scheme.
- Offsets and their actions must be enforceable – through development consent conditions, licence conditions, conservation agreements or a contract.

Offset plans will be developed in liaison with DECC before development commences to define types and levels of biodiversity loss (debits), calculate the amounts of offsets (credits) required and develop appropriate implementation, monitoring and protection strategies.

5.3 Operation Phase

Recommendation 19: Develop and implement detailed strategies to minimise the impacts of operations (including the operations and maintenance of the CPF, wells and pipelines).

Develop and implement best-practice site management measures within an Environmental Management Plan (EMP) framework. Specific EMPs should be developed for operation and maintenance of gas wells, flowlines, CPF and the transmission gas pipeline.

The EMPs should include strategies and protocols relating to soil and water management, protection of retained vegetation and rehabilitation areas, fauna protection, site closure and rehabilitation strategies, containment of waste, an emergency response program for accidental spills and other emergencies, and monitoring / auditing protocols. Integrate strategies with activities conducted by other users of the sites and surrounding land managers (e.g. electrical supplier, coal mine, graziers, NPWS).

Develop induction programs for the EMPs and induct all site workers involved in operation and maintenance activities (whether directly or indirectly) into the appropriate EMP(s) prior to their commencement of duties.

Specific strategies should include, but not necessarily be limited to:

- access protocols for operations and maintenance personnel
- fire management (e.g. ignition suppression devices such as spark arrestors on equipment, fire-fighting equipment, fuel load control around assets, planned burns)
- monitoring, maintenance and repair of installed sediment and erosion control devices
- track and firebreak maintenance and repair procedures and schedules
- vegetation control protocols within easements and around assets (e.g. slashing, herbicide application, tree lopping and trimming)
- weed management and hygiene
- maintenance of any rehabilitation and offset areas created during construction
- Monitoring areas of natural vegetation with high ecological values and / or sensitivity within or adjacent to the development (e.g. Endangered Ecological Communities, wetlands, riparian areas, population of Small-flower Grevillea, Wallaroo National Park, important habitats for protected wildlife)
- containment of contaminants such as gross pollutants, acid leachates, weed seeds, fuels and oils, chemicals, etc.
- monitoring of acid leachates from areas of PASS (e.g. low-lying areas below 5 m ASL, wetlands)
- contact details for qualified veterinarian staff to assess and treat or euthanase (as necessary) any large native vertebrates that are seriously injured.

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6.0 Conclusion

Based on desktop and field investigations, the proposed development has the potential to have a number of ecological impacts. These are summarised in **Table 1** below with an indication of the key measures employed to avoid significant impacts.

Table 1: Summary of Residual impacts

Potential Impact	Management Response/Residual Impacts
The loss of up to 49.3 ha of native vegetation for construction of the proposed pipeline, depending on construction methods.	Reduced ROW at key points which reduces loss to a small area between 16.72 and 25 ha of native vegetation. Flora and Fauna Management Plan to avoid indirect and downstream impacts. Development of an offset strategy to compensate for residual loss of vegetation. Minimal impacts identified post-mitigation.
Disturbance of very small areas of several Endangered Ecological Communities listed under the TSC Act along the proposed pipeline route, including:	
Freshwater Wetland on Coastal Floodplains around KP 68, which may require clearing of up to 0.45 ha.	HDD construction technique to be employed to avoid significant direct impacts. Flora and Fauna Management Plan to avoid indirect and downstream impacts. Development of an offset strategy to compensate for any residual loss of vegetation. No significant impacts identified post-mitigation.
Swamp Sclerophyll Forest of Coastal Floodplains at KP 68.9 just north of the Williams River, which may require clearing of up to 0.09 ha.	Clearing can be reduced by use of an existing 10 m clearing within the powerline easement and / or by reducing the clearing width in this short section. Flora and Fauna Management Plan to avoid indirect and downstream impacts. Development of an offset strategy to compensate for any residual loss of vegetation. No significant impacts identified post-mitigation.
Hunter Lowland Redgum Forest (an EEC) at KP 45.6 to KP 45.7, which may require clearing of up to 0.3 ha.	By moving the proposed pipeline east into the existing 20 m wide clearing associated with Black Camp Creek Road, clearing would be reduced to 0.1 ha. Impacts could also be reduced by utilising the western edge of the road, which has been partially cleared with a canopy cover of only 10%. Flora and Fauna Management Plan to address and avoid indirect and downstream impacts. Development of an offset strategy to compensate for any residual loss of vegetation. No significant impacts identified post-mitigation.

Potential Impact	Management Response/Residual Impacts
Lowland Rainforest on Floodplain of the NSW North Coast Bioregion at crossings of the Karuah River at KP 20.3, KP 24.5 and KP 25.3.	Avoid clearing of riparian rainforest vegetation at Karuah River crossings by using HDD construction techniques. Flora and Fauna Management Plan to avoid indirect and downstream impacts. No significant impacts identified post-mitigation.
Consider the use of construction techniques and management regimes to avoid clearing native vegetation at the following locations	
At all crossings of permanent streams to avoid impacts to hydrological flow regimes and impacts to existing riparian vegetation (KP 36.9, KP 40.3).	Black Camp Creek and Cedar Tree Creek are both 3rd Order watercourses (rather than higher order watercourses such as the Avon, the Karuah and Williams Rivers). As such, they are considered sensitive and worthy of more cautious construction and management. However, as 3rd order streams, their flow is variable depending on rainfall events and so open trench construction techniques would be suitable when waterflow is low. Open trench with flow diversions and environmental management measures will be employed at these two locations if waterflows are increased. Refer to Section 12.3 in the Surface Water Chapter of the main EA in Volume 1 for further detail regarding sensitivity of watercourses as linked to construction techniques.
At the crossing of the tidal creek at KP 90.5	Purgatory Creek will be open trenched with flow diversions. The Construction Environmental Management Plan will be prepared and implemented to control potential impacts arising from open trench construction techniques.
Consider minor re-routing of the proposed pipeline route to avoid clearing of native vegetation at the following locations	
At KP 27.6 to KP 28.5, move the proposed pipeline outside road reserve (which contains significant roadside vegetation), either east into the powerline easement or west into cleared pasture.	This recommendation will be incorporated into the detailed design. Current maps show the alignment used to assess potential ecological aspects on which basis these recommendations have been developed. With the incorporation of this recommendation, no significant impacts are anticipated to the significant roadside vegetation
At KP 35.7 to KP 36.4, move the proposed pipeline west into cleared pasture and the powerline easement to avoid remnant eucalypt forest.	This recommendation will be incorporated into the detailed design. Current maps show the alignment used to assess potential ecological aspects on which basis these recommendations have been developed. With the incorporation of this recommendation, no significant impacts are anticipated to the remnant eucalypt forest.

Potential Impact	Management Response/Residual Impacts
Avoid clearing of native vegetation in Wallaroo National Park by using the minimum width ROW through the powerline easement from KP 59.7 to KP 63.	Pipeline alignment through the National Park reduces amount of clearance required (alternate alignment outside the NP required further clearance of native vegetation). Construction activites through National Park to be restricted to existing cleared ROW. In principle agreement from NSW NPWS for this alignment. Minimum width ROW to be used. Flora and Fauna Management Plan to avoid indirect and downstream impacts. Development of an offset strategy to compensate for any residual loss of vegetation. No significant impacts identified post-mitigation.
Avoid clearing of native vegetation in the proposed Nature Refuge from KP 54.1 to KP 54.9	Minimum width ROW through the powerline easement from KP 54.1 to KP 54.9 to avoid significant impacts. Construction activites through Nature refuge to be restricted to existing cleared ROW. Development of an offset strategy to compensate for any residual loss of vegetation.
Minimise clearing of native vegetation in the large remnant vegetation block along Black Camp Road	Existing cleared roadway to be utilised and reduction in the width of the ROW from KP 31.5 to KP 38 to avoid significant impacts.
Disturbance of flora and fauna species protected under the EPBC Act and / or the TSC Act, including:	
transecting a known population of the Small-flower Grevillea (listed as Vulnerable under the EPBC Act and the TSC Act) by the proposed pipeline at KP 59.	Development and implementation of a detailed Flora and Fauna Management Plan. Development and implementation of a comprehensive management plan to mitigate and, if necessary, offset impacts on the population of the Small-flower Grevillea.
transecting potential habitat for a further 18 threatened flora and 47 threatened fauna species.	Development and implementation of a detailed Flora and Fauna Management Plan. Reduced ROW and HDD as noted above.
disturbing habitat features important for fauna, including hollow-bearing trees and dead and fallen timber.	Development and implementation of Flora and Fauna Management Plan including strategy for management and protection of these types of habitat
excavation works, which may kill ground-dwelling fauna.	Development and implementation of a detailed Flora and Fauna Management Plan.
entrapment of fauna by the pipeline trench.	Development and implementation of a detailed Flora and Fauna Management Plan.
increased fragmentation of fauna habitats.	Development and implementation of a detailed Flora and Fauna Management Plan.

Potential Impact	Management Response/Residual Impacts
Possible disturbance of potential acid sulfate soils in low-lying areas along the southern end of the proposed pipeline, either by excavation or alteration of hydrology, which could impact on downstream environments (such as the Ramsar-listed Hunter Estuary wetlands).	Development and implementation of an acid sulfate soil management plan to minimise the potential for impacts on downstream environments. No significant release of acid leachate, sediment or other contaminants from construction or operation activities associated with the development.
Introduction and spread of noxious and environmental weeds throughout the project area.	Development and implementation of a weed management plan.
Alteration to existing fire regimes.	Development and implementation of Flora and Fauna Management Plan
Erosion and dust emission, which can lead to increased sedimentation of wetlands and streams.	Development and implementation of an erosion and sediment control plan and soil and water management plans.
Spread of the plant pathogen *Phytophthora cinnamomi.*	Development and implementation of a *Phytophthora cinnamomi* management strategy.

Provided that the recommended mitigation measures outlined in **Section 5.0** are implemented effectively, impacts are anticipated to be limited to:

- Clearing of 16.72 to 25 ha of native vegetation.
- Impacts on one population of Small-flower Grevillea, which would not lead to any net loss in the total number of populations or area of extent.
- Little or no disturbance of native vegetation within Wallaroo National Park.
- Little or no disturbance of native vegetation in the proposed nature refuge at Lot 68 DP753176.
- Little or no impacts on any Endangered Ecological Communities.
- Little or no impacts on other threatened flora and fauna species listed at both State and Commonwealth levels.
- No indirect or downstream effects on threatened flora and fauna species or wetland areas.

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Tables

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Table T1: Significant Roadside Environment Areas Transected or Adjacent to the Proposed Pipeline

Description of Environment	Location Relative to Pipeline	Total Length (km)	KP Start	KP Finish
Open forest dominated by *Euc. siderophloia*	Follows Black Camp Road	0.8	27.6	28.4
Open forest dominated by *Cor. maculata* and *Euc. siderophloia*	30-40m to north of Black Camp Road	1.5	39.3	40.8
Open forest dominated by *Cor. maculata* and *Euc. siderophloia*	30-40m to east of Glen Martin Road	0.5	50.3	50.8
Open forest dominated by *Euc. siderophloia*	20-40m to south and north of Glen Martin Road	0.8	56.8	57.6
Open forest dominated by *Cor. maculata* and *Euc. siderophloia*	20-40m to east of East Seaham Road in Wallaroo National Park	1.4	61.1	62.5
Open forest dominated by *Cor. maculata* and *Euc. siderophloia*	Transects East Seaham Road	0.1	64.1	64.2

Table T2: Vegetation Recorded at Detailed Flora Assessment Sites

Flora site	Dominant species	Landform	LHCCREMS Vegetation	LHCCREMS Map Unit	CRA Forest Ecosystem	CRA FE code	NSW Vegetation Type	NSW code
FL 01	*Euc. propinqua, Euc. umbra*	Plain	-		South Coast Shrubby Grey Gum	134	Northern hinterland semi-mesic forest	21
FL 02	*Euc. moluccana*	Plain	-		?	?	Northern hinterland semi-mesic forest	21
FL 03	*Casuarina cunninghamiana, Angophora subvelutina*	Stream	-		Redgum / apple	47	Northern hinterland semi-mesic forest	21
FL 04	*Euc. siderophloia, Euc. umbra*	Plain	-		Ironbark	71	Hunter Macleay dry sclerophyll forest	69
FL 05	*Euc. umbra, Euc. siderophloia*	Dry stream / plain	-		Dry foothills spotted gum	33	Hunter Macleay dry sclerophyll forest	69

Flora site	Dominant species	Landform	LHCCREMS Vegetation	LHCCREMS Map Unit	CRA Forest Ecosystem	CRA FE code	NSW Vegetation Type	NSW code
FL 06	*Callistemon salignus, Backhousia myrtifolia,* numerous riparian species	Stream	-		Rainforest	168	Dry rainforest	4
FL 07	*Euc. punctata*	Hillslope	-		South coast shrubby grey gum	134	Northern hinterland semi-mesic forest	21
FL 08	*Waterhousia floribunda, Syzygium australe,* numerous riparian species	Stream	-		Rainforest	168	Dry rainforest	4
FL 09	*Euc. umbra, Euc. siderophloia*	Dry stream / foothill	-		Dry foothills spotted gum	33	Hunter Macleay dry sclerophyll forest	69
FL 10	*Waterhousia floribunda, Syzygium australe,* numerous riparian species	Stream	-		Rainforest	168	Dry rainforest	4
FL 11	*Euc. umbra, Euc. siderophloia*	Hillslope	-		Dry foothills spotted gum	33	Hunter Macleay dry sclerophyll forest	69
FL 12	*Euc. umbra, Cor. citrodora*	Hillslope	-		Dry foothills spotted gum	33	Hunter Macleay dry sclerophyll forest	69
FL 13	*Euc. propinqua, Euc. microcorys*		-		South coast shrubby grey gum	134	Northern hinterland semi-mesic forest	21
FL 14	*Euc. umbra, Cor. citrodora*		-		Dry foothills spotted gum	33	Hunter Macleay dry sclerophyll forest	69
FL 15	*Backhousia myrtifolia,* numerous riparian species	Stream	Hunter Valley dry rainforest	3	Rainforest	168	Dry rainforest	4

Flora site	Dominant species	Landform	LHCCREMS Vegetation	LHCCREMS Map Unit	CRA Forest Ecosystem	CRA FE code	NSW Vegetation Type	NSW code
FL 16	*Cor. citrodora, Euc. umbra, Melaleuca nodosa*	Plain	Seaham Spotted Gum Ironbark forest	16	Ironbark	71	Hunter Macleay dry sclerophyll forest	69
FL 17	*Euc. siderophloia, Cor. maculata*	Foothill	Seaham Spotted Gum Ironbark forest	16	Ironbark	71	Hunter Macleay dry sclerophyll forest	69
FL 18	*Euc. siderophloia, Cor. maculata*	Foothill	Seaham Spotted Gum Ironbark forest	16	Ironbark	71	Hunter Macleay dry sclerophyll forest	69
FL 19	*Cor. maculata, Euc umbra, Backhousia myrtifolia,* numerous species	Dry stream / foothill	Hunter valley dry rainforest	3	Rainforest	168	Dry rainforest	4
FL 20	*Carex appressa, Juncus pallidus.*	Swamp	Freshwater wetland complex	46	na	na	Coastal freshwater lagoon	56
FL 21	*Melaleuca quinquenervia*	Swamp	Swamp Mahogany paperbark swamp forest	37	Swamp Oak / Swamp Mahogany	143/142	Coastal floodplain wetland	50
FL 22	*Euc. siderophloia*	Plain	-		Regrowth	na	Regrowth	na

Table T3: Vegetation Transected by the Proposed Pipeline

Vegetation (CRA mapping)	Landform	Length (km)	KP start	KP end	Notes
Cleared	Plain	4	0	4	
Dry foothills spotted gum	Plain	0.06	4	4.06	
Cleared	Hillslope / Plain	4.3	4.06	8.36	
Rainforest	Stream	0.03	8.36	8.39	Bull Creek
Cleared	Hillslope / Plain	6.21	8.39	14.6	
South coast shrubby grey gum	Hillslope / Plain	0.65	14.6	15.25	
Cleared	Hillslope / Plain	3.97	15.25	19.23	
Rainforest	Stream	0.07	19.23	19.29	Karuah River
Cleared	Hillslope / Plain	1.68	19.29	20.97	
Rainforest	Gully	0.05	20.97	21.02	
Cleared	Hillslope / Plain	2.49	21.02	23.51	
Rainforest	Stream	0.06	23.51	23.57	Karuah River
Cleared	Plain	0.73	23.57	24.29	
Rainforest	Stream	0.11	24.29	24.4	Karuah River
Cleared	Hillslope / Plain / Stream	2.59	24.4	26.99	
Rainforest	Stream	0.09	26.99	27.08	Barnes Creek
Cleared	Plain	0.56	27.08	27.64	
Ironbark	Plain	0.82	27.64	28.45	Roadside Environment Area
Cleared	Plain	0.11	28.45	28.56	
Ironbark	Plain	0.13	28.56	28.69	
Cleared	Plain	0.91	28.69	29.6	

Vegetation (CRA mapping)	Landform	Length (km)	KP start	KP end	Notes
Ironbark	Plain	0.4	29.6	30	
Cleared	Plain	0.86	30	30.87	
Ironbark	Stream	0.04	30.87	30.91	Barnes Creek
Cleared	Hillslope / Plain	0.44	30.91	31.34	
Dry foothills spotted gum	Hillslope	5.11	31.34	36.45	
South coast shrubby grey gum	Hillslope	0.43	36.45	36.88	
Rainforest	Hillslope / Stream	0.07	36.88	36.95	Black Camp Creek
Dry foothills spotted gum	Hillslope	1.06	36.95	38.01	
Cleared	Plain	0.23	38.01	38.24	
Rainforest	Stream	0.03	38.24	38.27	
Cleared	Plain	1.94	38.27	40.21	
Rainforest	Stream	0.07	40.21	40.28	Cedar Tree Creek
Cleared	Plain	5.3	40.28	45.58	
Redgum / apple	Stream	0.1	45.58	45.67	Little Black Camp Creek
Cleared	Plain	0.1	45.67	45.77	
Ironbark	Plain	0.2	45.77	45.97	
Cleared	Hillslope / Plain	3.48	45.97	49.45	
Rainforest	Stream	0.04	49.45	49.5	Bridge Creek
Cleared	Hillslope / Plain	4.49	49.5	53.99	
Ironbark	Plain	0.82	53.99	54.81	Nature Reserve
Cleared	Plain	3.29	54.81	58.1	
Ironbark	Hillslope / Plain	1.37	58.1	59.47	

Vegetation (CRA mapping)	Landform	Length (km)	KP start	KP end	Notes
Cleared	Hillslope / Plain	0.23	59.47	59.7	
Ironbark	Hillslope / Plain	2.38	59.7	62.08	Wallaroo National Park
Rainforest	Stream	0.04	62.08	62.12	Wallaroo National Park
Ironbark	Hillslope / Plain	0.9	62.12	63.02	Wallaroo National Park
Cleared	Hillslope / Plain	1.05	63.02	64.07	
Ironbark	Plain	0.09	64.07	64.16	Roadside Environment Area
Cleared	Hillslope / Plain	3.72	64.16	67.88	
Freshwater wetland complex	Swamp	0.15	67.88	68.03	
Cleared	Hillslope / Plain	0.08	68.03	68.11	
Ironbark	Hillslope / Plain	0.49	68.11	68.6	
Cleared	Hillslope / Plain	0.27	68.6	68.88	
Swamp Oak / Swamp Mahogany	Swamp	0.06	68.88	68.91	
Cleared	Plain / Stream	1.63	68.91	70.54	Williams River
Ironbark	Hillslope / Plain	0.35	70.54	70.89	
Cleared	Hillslope / Plain	0.63	70.89	71.52	
Ironbark	Hillslope / Plain	0.14	71.52	71.66	
Cleared	Hillslope / Plain / Stream	18.09	71.66	89.75	Hunter River
Mangrove	Tidal channel	0.02	89.75	89.77	
Cleared	Plain	1.75	89.77	91.52	Hexham

Table T4: Endangered Populations under the TSC Act Potentially Occurring in the Wider Study Area.

Population		Preferred Habitat	Habitat Present in or Adjacent to Study Area		Recorded in Field Survey	Source**
Scientific Name	Common Name		GFDA	Pipeline		
Acacia pendula	Weeping Myall	*Acacia pendula* population in the Hunter Catchment. Occurs on heavy clay soils, sometimes on the margins of small floodplains, but also in more undulating locations.	No	Yes	No	DECC, PlantNet
Cymbidium canaliculatum	Tiger Orchid	*Cymbidium canaliculatum* population in the Hunter Catchment. Grows in the hollows of trees in dry sclerophyll forest or woodland	Yes	Yes	No	DECC, PlantNet
Eucalyptus camaldulensis	Red River Gum	*Eucalyptus camaldulensis* population in the Hunter Catchment. Occurs in major floodplains, especially in areas where water impoundment occurs after flood.	No	No	No	DECC, PlantNet
Eucalyptus parramattensis subsp*. parramattensis*	Parramatta Red Gum	*Eucalyptus parramattensis* population in Wyong and Lake Macquarie local government areas. Grows in low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils.	No	Yes	No	DECC, PlantNet
Eucalyptus seeana	Narrow-leaved Red Gum	*Eucalyptus seeana* population in the Greater Taree local government area. Grows woodlands and open forests on low, often swampy, sandy soils.	No	Yes	No	DECC, PlantNet
Leionema lamprophyllum subsp. obovatum	Shiny Phebalium	*Leionema lamprophyllum subsp.obovatum* population in the Hunter Catchment. Occurs in dry eucalypt forest and heath on exposed rocky terrain.	No	No	No	DECC, PlantNet
Rhizanthella slateri	Eastern Australian Underground Orchid	*Rhizanthella slateri* in the Great Lakes local government area. Various habitats. Mostly sclerophyll forests where the soils has been disturbed.	Yes	Yes	No	DECC, PlantNet

Population		Preferred Habitat	Habitat Present in or Adjacent to Study Area		Recorded in Field Survey	Source**
Scientific Name	Common Name		GFDA	Pipeline		
Dromaius novaehollandiae	Emu	Emu population in the NSW North Coast Bioregion and Port Stephens local government area. On the NSW north coast, largely restricted to coastal and near coastal areas between Evans Head and Red Rock; some records from the Port Stephens area.	No	No	No	DECC
Mastacomys fuscus	Broad-toothed Rat	Broad-toothed Rat at Barrington Tops in the local government areas of Gloucester, Scone and Dungog. The population is restricted to sub-alpine swamp complexes and associated grassland and streamside heath environments above 1400 metres elevation at Barrington Tops	No	No	No	DECC

**Source: DECC = NSW Threatened Species, Populations and Ecological Communities; PlantNet = NSW Flora Online

TableT5: Threatened Ecological Communities under the TSC Act as Potentially Occurring in the Wider Study Area

Threatened Ecological Community	Conservation Significance	Recorded in Field Survey	
		GFDA	Pipeline
Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions	EEC	No	No
Blue Gum High Forest in the Sydney Basin Bioregion	Critically EEC	No	No
Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion	EEC	No	No
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	No
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	EEC	No	No
Duffys Forest Ecological Community in the Sydney Basin Bioregion	EEC	No	No
Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion	EEC	No	No
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	Yes
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	EEC	No	Yes
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	EEC	No	No
Illawarra Subtropical Rainforest in the Sydney Basin Bioregion	EEC	No	No
Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	EEC	No	No
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	No
Lower Hunter Spotted Gum - Ironbark Forest in the Sydney basin Bioregion	EEC	No	Yes
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	EEC	No	No
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	EEC	No	Yes
Melaleuca armillaris Tall Shrubland in the Sydney Basin Bioregion	EEC	No	No
Milton Ulladulla Subtropical Rainforest in the Sydney Basin Bioregion	EEC	No	No
Moist Shale Woodland in the Sydney Basin Bioregion	EEC	No	No

Threatened Ecological Community	Conservation Significance	Recorded in Field Survey	
		GFDA	Pipeline
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern HigAECOMnds and Australian Alps bioregions	EEC	No	No
Mount Gibraltar Forest in the Sydney Basin Bioregion	EEC	No	No
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion	EEC	No	No
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	EEC	No	No
River-Flat Eucalypt Forest on Coastal Floodplains	EEC	No	No
Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion	EEC	No	No
Robertson Rainforest in the Sydney Basin Bioregion	EEC	No	No
Shale gravel Transition Forest in the Sydney Basin Bioregion	EEC	No	No
Southern HigAECOMnds Shale Woodlands in the Sydney Basin Bioregion	EEC	No	No
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion	EEC	No	No
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	Yes
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	Yes
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	EEC	No	No
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	No	No
Warkworth Sands Woodland of the Sydney Basin Bioregion	EEC	No	No
White Box Yellow Box Blakely's Red Gum Woodland	EEC	No	No

EEC = Endangered Ecological Community (Under TSC Act)

Table T6: Flora Species Listed under Commonwealth and / or State Legislation and Identified from database Searches as Previously Recorded from the Wider Study Area, or with Geographical Ranges that Overlap the Wider Study Area with Preferred Habitat.

Scientific Name	Common Name	Status*		Preferred Habitat	Habitat Present Within or Adjacent to Study Area		Recorded in Field Survey	Source**
		EPBC	TSC		GFDA	Pipeline		
Allocasuarina defungens	Dwarf Heath Casuarina	E	E	Mainly in tall heath on sand, but can also occur on clay soils and sandstone. Also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	No	No	No	A
Angophora inopina	Charmhaven Apple	V	V	Open woodland with a dense shrub understorey on deep white sandy soils over sandstone.	No	No	No	E, B, A
Asperula asthenes	Trailing Woodruff	V	V	Grows in damp soils often along river banks.	Yes	Yes	No	B, A
Callistemon linearifolius	Netted Bottle Brush		V	Dry sclerophyll forest on the coast and adjacent ranges.	No	Yes	No	B, A
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Various, including swamp-heath and woodland, mostly in coastal areas.	No	Yes	No	E, A
Cynanchum elegans	White-flowered Wax Plant	E	E	Edge of rainforest vegetation, especially in gullies in scrub and on scree slopes.	No	Yes	No	E, A
Diuris pedunculata	Small Snake Orchid	E	E	Grassy slopes or flats, often on peaty soils in moist areas. Also on shale and trap soils, on fine granite, and among boulders.	No	No	No	B, A
Eucalyptus glaucina	Slaty Red Gum	V	V	Grassy woodland on deep, moderately fertile and well-watered soil.	Yes	Yes	No	E, B, A
Eucalyptus parramattensis subsp. *decadens*		V	V	Dry sclerophyll woodland with dry heath understory, on sandy soils in low, often wet sites.	Yes	Yes	No	E, A

Scientific Name	Common Name	Status*		Preferred Habitat	Habitat Present Within or Adjacent to Study Area		Recorded in Field Survey	Source**
		EPBC	TSC		GFDA	Pipeline		
Grevillea guthrieana	Guthrie's Grevillea	E	E	Grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil.	Yes	Yes	No	B, A
Grevillea parviflora subsp*. parviflora*	Small-flower Grevillea	V	V	Grows in heath or shrubby woodland, in sandy or light clay soils usually over shale substrates.	Yes	Yes	Yes	E, B, A
Maundia triglochinoides			V	Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients.	Yes	Yes	No	B, A
Melaleuca groveana	Grove's Paperbark		V	Ridges, high mountain slopes and the summit of mountains in heath and eucalypt woodlands and forests with heathy understorey.	No	No	No	B, A
Persicaria elatior	Tall Knotweed	V	V	Growns in damp sites, especially beside streams and lakes and occasionally in swamp forest.	Yes	Yes	No	A
Pomaderris queenslandica	Scant Pomaderris		E	Moist eucalypt forest or sheltered woodlands with shrubby understorey; occasionally along creeks.	Yes	Yes	No	B, A
Rhizanthella slateri	Eastern Underground Orchid	E	V	Various. Mostly sclerophyll forests where the soils has been disturbed.	Yes	Yes	No	E
Rulingia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats, mainly in gullies along the escarpment.	No	No	No	E, B, A
Tetratheca juncea	Black-eyed Susan	V	V	Sandy, occasionally swampy heath and in dry sclerophyll forest; mostly in coastal districts.	Yes	Yes	No	E, B, A
Zannichellia palustris			E	Submerged in fresh or slightly saline stationary or slowly flowing water.	Yes	Yes	No	B, A

*Status: E = Endangered; V = Vulnerable

**Source of record: A = Atlas of NSW Wildlife; B = BioNet; E= EPBC Protected Matters

Table T7: Declared Weeds Recorded During Field Surveys

Scientific Name	Common Name	Status		Recorded During Field Study		Specific Sites Where Recorded During Field Surveys	
		Class*	WONS**	FD	Pipeline	Detailed Sites	Observational Sites
Ageratina riparia	Mistflower	4		No	Yes	FL 09, FL 10, FL 08	OB 18
Eichhornia crassipes	Water Hyacinth	4		No	Yes	FL 20	
Lantana camara	Lantana	5	Yes	No	Yes	FL 09, FL 10, FL 07, FL 13, FL 15, FL 18, FL 19	OB 03, OB 13, OB 17, OB 45
Ligustrum sinense	Small Leaf Privet	4		Yes	Yes	FL 10, FL 08, FL 03	OB 02
Oxalis spp.	Oxalis	5		No	Yes	FL 07	
Romulea rosea	Onion Grass	5		No	Yes	FL 07	
Rubus fruitcosus	Blackberry	4	Yes	No	Yes	FL 15	OB 03
Salix spp.	Weeping Willow	5	Yes	Yes	No		OB 01
Not recorded or not declared							
Alternanthera philoxeroides	Alligator Weed	2	Yes	No	No		
Sporobolus africanus	Parramatta Grass	-		No	Yes		OB 58, OB 59, OB 08

*Class: Under the NSW *Noxious Weeds Act 1993*, weed species are classified into 5 categories:

Classes 1 and 2: *This plant must be eradicated from the land and the land kept free of the plant.*

Class 3: *The plant must be fully and continuously suppressed and destroyed.*

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

Class 5: *The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*.

**WONS: Commonwealth Weeds of National Significance

Table T8: Fauna Habitats Recorded along Proposed Pipeline

Fauna Habitat	Corresponding vegetation communities	Total area impacted (ha)*
Woodland and open forests	Ironbark, dry foothills Spotted Gum, South Coast Shrubby Grey Gum, Redgum / apple	46.7
Riparian / closed forest	Rainforest, mangrove	2.1
Open freshwater wetlands	Freshwater wetland complex, Swamp Mahogany	0.42
Grasslands and pastures	-	243.1

* Assuming entire 30 m ROW requires clearing.

Table T9: Threatened Fauna Species Previously Recorded from the Wider Study Area, with Potential Habitat in the Project Site.

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Amphibians					
Litoria aurea	Green and Golden Bell Frog	V[1] / E[2,3]	Marshes, dams and streams particularly containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.), generally free of fish and unshaded but often disturbed.	Yes	A, B, E
Mixophyes balbus	Stuttering Frog	V[1,3] / E[2]	Typically associated with permanent streams through temperate and sub-tropical rainforest and wet sclerophyll forest, rarely in dry open tableland riparian vegetation (Mahony et al. 1997), and also in moist gullies in dry forest (Gillespie and Hines, 1999).	Yes	E
Mixophyes iteratus	Giant Barred Frog	E[1,2,3]	Wet sclerophyll forest and rainforest and riparian vegetation beside permanent streams; often in leaf litter near permanent fast-flowing streams.	Yes	B, E
Reptiles					
Hoplocephalus bitorquatus	Pale-headed Snake	V[2]	Dry eucalypt forests and woodlands, cypress woodland and occasionally rainforest or moist eucalypt forest. Prefers streamside areas, particularly in drier habitats. During the day, shelters between loose bark and tree trunks, or in hollow trunks and limbs of dead trees.	Yes	A, B
Hoplocephalus stephensii	Stephens' Banded Snake	V[2] / R / IK[3]	Rainforest and wet eucalypt forest along the coast and ranges from mid-NSW to SE Qld. Semi-arboreal, sheltering beneath loose bark, in tree hollows and rarely in rafters.	Yes	A, B
Birds					
Anseranas semipalmata	Magpie Goose	V[2]	Shallow wetlands (usually < 1 m deep) with dense growth of rushes and sedges. Wetlands associated with floodplains of rivers and large shallow wetlands formed by run off.	Yes	A, B
Botaurus poiciloptilus	Australasian Bittern	V[2,3]	Permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.).	Yes	A, B
Burhinus grallarius	Bush stone-Curlew	E[2] / NT[3]	Open woodlands, lightly timbered country, mallee and mulga - prefer groundcover of small sparse shrubs, grass or litter of twigs.	Yes	A, B

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Callocephalon fimbriatum	Gang-gang Cockatoo	V^2	In summer, generally in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also in sub-alpine Snow Gum *Eucalyptus pauciflora* woodland and occasionally in temperate rainforests. Favours old growth attributes for nesting and roosting. Moves to lower altitudes in winter, favouring drier more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or dry forest in coastal areas and often found in urban areas.	Yes	A, B
Calyptorhynchus lathami	Glossy black-Cockatoo	V^2 / NT^3	Coastal forest and open inland woodland. Feeds primarily on *Allocasuarina littoralis* or *Allocasuarina torulosa*.	Yes	A, B, E
Climacteris picumnus	Brown Treecreeper	V^2 / NT^3	Eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Euc. camaldulensis*) Forest bordering wetlands usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging. Less commonly, in similar woodland habitats on the coastal ranges and plains.	Yes	A, B
Coracina lineata	Barred Cuckoo-shrike	V^2	Rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses.	Yes	A, B
Ephippiorhynchus asiaticus	Black-necked Stork	E^2 / LC^3	Lakes, swamps, freshwater pools and mangroves. Nests in trees or large bushes, often over swamps.	Yes	A, B
Irediparra gallinacea	Comb-crested Jacana	V^2	Permanent wetlands with a good surface cover of floating vegetation, especially water lillies.	Yes	A, B
Ixobrychus flavicollis	Black Bittern	V^2	Freshwater and estuarine wetlands in areas of permanent water and dense vegetation. Where water is permanent, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	Yes	A, B
Lathamus discolor	Swift Parrot	$E^{1,2,3}$ / Ma^1	Breeds in Tasmania and over-winters in forests and woodlands on the Australian mainland, congregating where eucalypts are flowering profusely, including Red Ironbark, Redgum and Yellow Box forests.	Yes	A, B, E

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Lophoictinia isura	Square-tailed Kite	V^2 / LC^3	Sparsely distributed in open eucalypt forests, woodlands and sand plains.	Yes	A, B
Melanodryas cucullata	Hooded Robin	V^2 / NT^3	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey.	Yes	A, B, E
Melithreptus gularis	Black-chinned Honeyeater	V^2 / NT^3	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Euc. sideroxylon*), White Box (*Euc. albens*), Grey Box (*Euc. microcarpa*), Yellow Box (*Euc. melliodora*) and Forest Red Gum (*Euc. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees.	Yes	A, B
Neophema pulchella	Turquoise Parrot	V^2 / NT^3	Inhabits steep, rocky ridges and gullies, rolling hills, valleys and river-flats and the nearby plains of the Great Dividing Range (Higgins, 1999); eucalypt woodlands and open forests, with a ground cover of grasses and low understorey of shrubs (Jarman, 1973; Morris, 1980), usually with Cypress Pine *Callitris* and a variety of *Eucalyptus* species, Morris1980; Quinn and Baker-Gabb, 1993; Quinn and Reid, 1996). Occasionally in savannah and riparian woodlands and farmland, preferring edges of forest and pasture or other grassland	Yes	A, B
Ninox connivens	Barking Owl	V^2 / NT^3	Eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses.	Yes	A, B
Ninox strenua	Powerful Owl	V^2 / LC^3	Eucalypt forests along Great Dividing Range, preferring tall wet sclerophyll forests, where territories of 800-1000 ha centre on densely vegetated gullies.	Yes	A, B
Pomatostomus temporalis	Grey-crowned Babbler	V^2 / NT^3	Inhabits open box gum woodlands on the slopes, and Cypress Pine and open box gum woodlands on alluvial plains.	Yes	A, B

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Pyrrholaemus saggitatus	Speckled Warbler	V^2	Lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat includes scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Mostly requires large, relatively undisturbed remnants.	Yes	A, B
Rostratula (benghalensis) australis	Australian Painted Snipe	$V^{1,3}$ / E^2	Shallow muddy freshwater swamps and marshes.	Yes	A, B, E
Stagonopleura guttata	Diamond Firetail	V^2 / NT^3	Grassy eucalypt woodlands, including box-gum woodlands and Snow Gum *Eucalyptus pauciflora* woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	Yes	A, B
Tyto novaehollandiae	Masked Owl	V^2 / NT^3	Dry eucalypt forests and woodlands from sea level to 1,100 m.	Yes	A, B, E
Tyto tenebricosa	Sooty Owl	V^2	Dense subtropical and temperate rainforest and fern gullies; tall wet sclerophyll forest.	Yes	A, B
Xanthomyza phrygia	Regent Honeyeater	$E^{1, 2,3}$	Eucalypt woodland and open forest on the slopes of the Great Dividing Range and occasionally on the coast. Particularly favours box-ironbark woodland, and riparian forests of River She-oak.	Yes	A, B, E
Mammals					
Cercartetus nanus	Eastern Pygmy-Possum	V^2 / LC^3	Found in a broad range of habitats from rainforest through sclerophyll (including box-ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.	Yes	A, B
Chalinolobus dwyeri	Large-eared Pied bat	$V^{1,2,3}$	Dry forests and woodlands, moist eucalypt forests, caves and mines.	Yes	A, B, E

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Dasyurus maculatus	Spotted-tailed Quoll	E^1 / $V^{2,3}$	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individuals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. They make latrines.	Yes	A, B, E
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V^2 / LC^3	Moist forest habitats with trees taller than 20 m. Roosts in eucalypt hollows; also found under loose bark on tress or in buildings.	Yes	A, B
Macropus parma	Parma Wallaby	V^2 / NT^3	Moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest.	Yes	A, B
Miniopterus australis	Little Bent-wing Bat	V^2 / LC^3	Moist eucalypt forest, rainforest or dense coastal banksia scrub. Roosts in caves, tunnels and sometimes tree hollows Forages for small insects beneath the canopy of densely vegetated habitats.	Yes	A, B
Miniopterus schreibersii	Common Bent-wing Bat	V^2 / LC^3	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range typically in well-timbered gullies. Roosts in caves, derelict mines, storm-water tunnels, buildings and other man-made structures. Hunts in forested areas, catching moths and other flying insects above the tree tops.	Yes	A,B
Mormopterus norfolkensis	Eastern Free-tail Bat	V^2 / DD^3	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures.	Yes	A, B
Myotis adversus	Large-footed Myotis	V^2	Roosts in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools.	Yes	A, B
Petaurus australis	Yellow-bellied Glider	$V^{,2,3}$	Tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Prefers mixed coastal forests to dry escarpment forests in the north.	Yes	A, B, E
Petaurus norfolcensis	Squirrel Glider	V^2 / NT^3	Mature or old growth box, box-ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or acacia midstorey.	Yes	A, B

Scientific Name	Common Name	Status *	Preferred Habitat	Potential Habitat in site	Source **
Phascogale tapoatafa	Brush-tailed Phascogale	V^2 / NT^3	Dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also heath, swamps, rainforest and wet sclerophyll forest.	Yes	A, B
Phascolarctos cinereus	Koala	V^2 / NT^3	Inhabits eucalypt woodlands and forests. Feeds on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	Yes	A, B
Planigale maculata	Common Planigale	V^2 / LC^3	Inhabits rainforest, eucalypt forest, heatAECOMnd, marsAECOMnd, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks.	Yes	A, B
Potorous tridactylus	Long-nosed Potoroo	$V^{1,2,3}$	Coastal wet heath, dry and wet forests with thick ground cover.	Yes	A, B, E
Pteropus poliocephalus	Grey-headed Flying-fox	$V^{1,2,3}$	Roosting sites usually in dense forest adjacent to waterbodies. Forages within 15 km of camp in flowering trees or rainforests, eucalypts, paperbarks and banksias.	Yes	A, B, E
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	V^2 / LC^3	Roosts in tree hollows and buildings; and in mammal burrows in treeless areas. Forages in most habitats across its very wide range, with and without trees.	Yes	A, B
Scoteanax rueppellii	Greater Broad-nosed Bat	V^2 / NT^3	Woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows, sometimes in buildings.	Yes	A, B

*** Status:** [1]:= Commonwealth (EPBC) status ; [2]: = State (TSC Act) status [3]:= Action Plan; **E** = Endangered; **V** = Vulnerable; **NT** = Near Threatened; **LC** = Least Concern; **R** = Rare; **DD** = Data Deficient; **IK** = Insufficiently Known; **Mi/Ma** = Migratory and/or Marine

**** Source:** A = Atlas NSW; B = BioNet; E = EPBC Protected Matters.

Table T10: Threatened Fauna Species and Previously Recorded from the Wider Study Area, but without Potential Habitat in the Project Site.

Scientific Name	Common Name	Status *	Preferred Habitat	Reason for no Further Assessment	Source **
Amphibians					
Litoria booroolongensis	Booroolong Frog	E[1,2] / IK[3]	Mostly found along the western-flowing streams of the Great Divide, mostly the south-west slopes of NSW. Adults occur in permanent streams with fringing vegetation such as ferns or sedges. Shelters under rocks or in vegetation near the ground on the stream edge.	Recorded in region only from pristine forests in ranges to north of subject area	E
Litoria littlejohni	Littlejohn's Tree Frog	V[1,2]	Inhabits forest, coastal woodland and heath from 100 to 950 m ASL (White and Ehmann, 1997), but not tied to specific vegetation types.	Occcurs from the Watagan Mts south, well south of the subject site.	E
Reptiles					
Hoplocephalus bungaroides	Broad-headed Snake	V[1,]/ E[2]	Restricted to sandstone escarpments. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges. In summer moves to shelters in hollows in large trees within 200 m of escarpments.	No sandstone escarpments in the study site	E
Birds					
Calidris tenuirostris	Great Knot	V[2]	Sheltered coastal habitats with large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries, lagoons, sandy spits, islets and sometimes on exposed reefs or rock platforms.	Exclusively coastal in NSW	A, B
Charadrius leschenaultii	Greater Sand-Plover	V[2]	Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores, often with other waders.	Almost exclusively coastal in NSW	A, B
Charadrius mongolus	Lesser Sand Plover	V[2]	Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores, often with other waders.	Exclusively coastal in NSW	A, B, E
Diomedea (exulans) antipodensis	Antipodean Albatross	V[1,2,3]	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E

Scientific Name	Common Name	Status *	Preferred Habitat	Reason for no Further Assessment	Source **
Diomedea (exulans) gibsoni	Gibson's Albatross	V[1,2,3]	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E
Falco hypoleucos	Grey Falcon	V[2] /NT[3]	Mainly in semi-arid and arid regions; lightly timbered country, especially stony plains and lightly timbered acacia scrublands.	Essentially inland species, only vagrants reach coast	A, B
Hamirostra melanosternon	Black-breasted Buzzard	V[2]	Mainly in semi-arid and arid regions; nests in large trees along inland watercourses and hunts out over surrounding scrub or grassland plain.	Essentially inland species, only vagrants reach coast	A, B
Limicola falcinellus	Broad-billed Sandpiper	V[2]	Sheltered coastal estuaries, lagoons with soft inter-tidal mudflats; muddy coastal creeks, swamps, occasionally reefs.	Exclusively coastal in NSW	A, B, E
Limosa limosa	Black-tailed Godwit	V[2]	Sheltered bays, estuaries and lagoons with large intertidal mudflats and / or sandflats. In inland areas, found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Has also been recorded in wet fields and sewerage treatment works.	Mostly marine, occasionally on shores of large fresh water wetlands; neither found in project area	A, B, E
Macronectes giganteus	Southern Giant-Petrel	E[1,2] / V[3]	Breeds in subantarctic. Marine, over open seas and inshore waters; favours edge of continental shelf and edge of pack-ice.	Exclusively marine in NSW	E
Macronectes halli	Northern Giant-Petrel	V[1,2] / NT[3]	Breeding in Australian territory is limited to Macquarie Island. Adults usually remain near the breeding colonies throughout the year while immature birds disperse, many reaching seas off NSW.	Exclusively marine in NSW	E
Oxyura australis	Blue-Billed Duck	V[2]	Deep water in large permanent wetlands and swamps with dense aquatic vegetation. Completely aquatic, swimming low in the water along the edge of dense cover.	No deep water wetlands within the study site	A, B
Pandion haliaetus	Osprey	V[2]	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea. Sometimes follows rivers inland	Project would avoid large rivers, estuaries etc.	A, B
Pterodroma leucoptera	Gould's Petrel	E[1, 2] / V[3]	Marine and pelagic. Breeds at Cabbage Tree Island off Port Stephens	Exclusively marine	A, B, E

Scientific Name	Common Name	Status *	Preferred Habitat	Reason for no Further Assessment	Source **
Pterodroma neglecta	Kermadec Petrel	V[1,2] / CR / NT[3]	Marine and pelagic.	Exclusively marine in NSW	E
Pterodroma solandri	Providence Petrel	V[2,3]	Marine and pelagic.	Exclusively marine in NSW	A, B
Ptilinopus magnificus	Wompoo Fruit-Dove	V[2]	In or near rainforest, low elevation moist eucalypt forest and brush box forests.	No rainforest or wet sclerophyll forest with high plentiful fruit in proposed footprint	A, B
Ptilinopus regina	Rose-crowned Fruit-Dove	V[2]	Sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest where fruit is plentiful.	No rainforest or wet sclerophyll forest with high plentiful fruit in proposed footprint	A, B
Puffinus carniepes	Flesh-Footed Shearwater	V[2,3]	Marine and pelagic.	Exclusively marine	A, B
Sterna albifrons	Little Tern	E[2] / LC[3]	Almost exclusively coastal, preferring sheltered environments; may occur several kilometres from the sea in harbours, inlets and rivers Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuaries, coastal lakes and islands.	Almost exclusively coastal	A, B, E
Stictonetta naevosa	Freckled Duck	V[2] / LC[3]	Large, open freshwater swamps and fresh to salty open lakes.	No large, open wetlands in proposed footprint	A, B
Thalassarche bulleri	Buller's Albatross	V[1,3]	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E
Thalassarche cauta	Shy Albatross	V[1,2,3]	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E
Thalassarche (melanophris) impavida	Campbell Albatross	V[1,3]	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E

Scientific Name	Common Name	Status *	Preferred Habitat	Reason for no Further Assessment	Source **
Thalassarche (cauta) salvini	Salvin's Albatross	$V^{1,3}$	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E
Thalassarche (cauta) steadi	White-capped Albatross	$V^{1,3}$	Marine and oceanic, coastal seas. Follows ships and fishing boats.	Exclusively marine in NSW	E
Tyto capensis	Grass Owl	V^{2}	Tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass or sedges on flood plains.	Only occurs as a vagrant south of Harrington NSW (Hobcroft and James, 1997)	A, B
Xenus cinereus	Terek Sandpiper	V^{2}	Coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near mangroves, but also rocky pools and reefs. Roosts communally, often with related wader species.	Exclusively coastal in NSW	A, B, E
Mammals					
Petrogale penicillata	Brush-Tailed Rock-Wallaby	$V^{1,3}$ / E^{2}	Rock escarpments, rock piles and cliffs with ledges, caves and crevices in wet and dry sclerophyll forests.	No escarpments or outcrops in the study site	A, B, E
Kerivoula papuensis	Golden-Tipped Bat	V^{2} / NT^{3}	Found in rainforest and adjacent sclerophyll forest. Roosts in abandoned hanging nests of scrubwrens and gerygones, over first- and second-order streams. Forages up to 2 km from roosts in rainforest and sclerophyll forest on upper-slopes. Specialist feeder on small web-building spiders.	No rainforest or wet sclerophyll forest with rainforest elements in proposed footprint.	A, B
Pseudomys oralis	Hastings River Mouse	$E^{1,2,3}$	Dry open forest types with dense, low ground cover and diverse mixture of ferns, grass, sedges and herbs.	Within the region, only occurs in the Barrington sub-region above 400 m	A,B,E

Status: [1]:= Commonwealth (EPBC) status ; [2]: = State (TSC Act) status [3]:= Action Plan; **E** = Endangered; **V** = Vulnerable; **NT** = Near Threatened; **LC** = Least Concern; **R** = Rare; **DD** = Data Deficient; **IK** = Insufficiently Known;
**** Source:** A = Atlas NSW; B = BioNet; E = EPBC Protected Matters.

Table T11: Assessment of migratory species listed under the EPBC Act

This table summarises the impact assessment for Migratory and / or Marine species listed under the EPBC Act that were considered to potentially occur in the study area, or for which there is potential habitat within the study area. The impact assessment follows the 'significant impact criteria' as outlined in the EPBC Act Policy Statement 1.1, Significant Impact Guidelines (DEH 2006).

Species	Distribution, ecology and habitat	Substantially modify, destroy or isolate an area of important habitat?	Result in an invasive species becoming established in an area of important habitat?	Seriously disrupt the lifecycle of an ecologically significant proportion of the population?	Conclusion
Haliaeetus leucogaster White-bellied Sea-Eagle	Usually coastal, over islands, reefs, headlands, beaches, bays, estuaries, mangroves, seasonally flooded inland swamps, lagoons and floodplains; often far inland on large pools of major rivers.	Only small, widely dispersed numbers in locality, not a significant proportion of the national population. Habitat not important for a significant proportion of the national population. Widely distributed species, not near the limits of its range. Not listed as threatened so not considered to be in decline.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development
Ardea alba Great Egret *Ardea ibis* Cattle Egret *Gallinago hardwickii* Latham's Snipe	Wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs; moist pastures with tall grass; low vegetation around wetlands in shallows, sedges, reeds, heaths, saltmarsh, irrigated crops; rank and inundated grasslands	Only small, widely dispersed numbers potentially in the locality, so not a significant proportion of the national population. Habitat not important for a significant proportion of the national population. Widely distributed species, not near limits of their ranges. Not listed as threatened so not considered to be in decline.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt the migration or resting behaviour of any migratory species. Therefore, the proposal would not disrupt the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development

Species	Distribution, ecology and habitat	Substantially modify, destroy or isolate an area of important habitat?	Result in an invasive species becoming established in an area of important habitat?	Seriously disrupt the lifecycle of an ecologically significant proportion of the population?	Conclusion
Arenaria interpres Ruddy Turnstone *Calidris acuminate* Sharp-tailed Sandpiper *Calidris ferruginea* Curlew Sandpiper *Pluvialis fulva* Pacific Golden Plover *Tringa nebularia* Common Greenshank *Limosa lapponica* Bar-tailed Godwit *Numenius madagascariensis* Eastern Curlew *Numenius phaeopus* Whimbrel	Breed outside Australia. Mainly coastal: inter-tidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes.	These species breed outside Australia. They all primarily inhabit coastal wetlands. Occasionally they occur in freshwater wetlands but rarely if ever at nationally significant levels (Watkins 1993). No freshwater wetlands habitats large enough to support significant numbers of these species occur in the project area. Widely distributed species, not near the limits of ranges. Not listed as threatened so not considered to be in decline.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development

Species	Distribution, ecology and habitat	Substantially modify, destroy or isolate an area of important habitat?	Result in an invasive species becoming established in an area of important habitat?	Seriously disrupt the lifecycle of an ecologically significant proportion of the population?	Conclusion
Apus pacificus Fork-tailed Swift *Hirundapus caudacutus* White-throated Needletail	Breed outside Australia Low to very high, open airspace over almost any habitat, including oceans, forests and deserts. At times gather over ranges, headlands, often in humid, unsettled weather preceding thunderstorms.	No breeding habitat and no substantial areas of feeding habitat in project area; therefore no significant populations occur in or are reliant on habitat within the proposed development footprint. Widely distributed species, not near the limits of ranges. Not listed as threatened so not considered to be in decline	The proposed works will not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development
Merops ornatus Rainbow Bee-eater	Open country of woodlands, open forest, semi-arid scrub, grasslands, clearings in heavier forests, farmlands; avoids heavy forest. In breeding season, requires open clearing or paddock with loamy soil soft enough for nest tunnelling, yet firm enough to support the tunnel.	Species does not congregate in large flocks to feed or breed, so populations are dispersed. During migration flocks occur in virtually any habitat and not reliant on specific habitats or sites. Widely distributed species, not near the limits of range. Not listed as threatened so not considered to be in decline.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development

Species	Distribution, ecology and habitat	Substantially modify, destroy or isolate an area of important habitat?	Result in an invasive species becoming established in an area of important habitat?	Seriously disrupt the lifecycle of an ecologically significant proportion of the population?	Conclusion
Lathamus discolor Swift Parrot *Xanthomyza phrygia* Regent Honeyeater	Breed outside project area. Migrate to woodlands of eastern Australia during winter, where attracted to winter flowering eucalypts, especially box-ironbark woodlands and riparian forests of River She-oak.	No breeding habitat and no substantial areas of feeding habitat in project area; therefore no significant populations occur in or are reliant on habitat within the proposed development footprint.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development
Monarcha melanopsis Black-faced Monarch *Monarcha trivirgatus* Spectacled Monarch *Myiagra cyanoleuca* Satin Flycatcher *Rhipidura rufifrons* Rufous Fantail	Usually rainforests, eucalypt forests and mangroves; often in moist gullies of dense wet eucalypt forests.	Very little potential habitat for these species occurs in the project area. These species may occur in the forests at the southern end of Black Camp Road. However, area is too small to support ecologically significant numbers of the species. Widely distributed species, not near the limits of range. Not listed as threatened so not considered to be in decline.	The proposed works would not result in the establishment of any invasive species in the project area. No 'important habitat' for the listed migratory species under consideration exists in the project area.	The study area does not support important breeding or feeding habitat. The proposal is not likely to disrupt migration or resting behaviour of migratory species, nor the lifecycle of an ecologically significant proportion of a population.	No significant impact is expected from the proposed development

Table T12: Lengths of Remnant Vegetation Transected and Potential Areas to be Cleared along Proposed Pipeline

Vegetation	Land form	Length (km)	KP start	KP end	Existing cleared width (m) ^	Free width (m) *	30m ROW	Clearing	Area	Required	(ha) #	Location Notes
								30 m ROW - free width	20 m ROW - free width	20 m ROW - free width, HDD of Karuah	20 m ROW - free width, HDD of Karuah, NP uncleared	
Dry foothills Spotted Gum	Plain	0.06	4	4.06	5	5	0.18	0.15	0.09	0.09	0.09	
Rainforest	Stream	0.03	8.36	8.39	0	0	0.09	0.09	0.06	0.06	0.06	Bull Creek
South Coast Shrubby Grey Gum	Hillslope / Plain	0.65	14.6	15.25	40	15	1.95	0.975	0.325	0.325	0.325	
Rainforest	Stream	0.07	19.23	19.29	0	0	0.21	0.21	0.14	0	0	Karuah River
Rainforest	Gully	0.05	20.97	21.02	0	0	0.15	0.15	0.1	0.1	0.1	
Rainforest	Stream	0.06	23.51	23.57	0	0	0.18	0.18	0.12	0	0	Karuah River
Rainforest	Stream	0.11	24.29	24.4	0	0	0.33	0.33	0.22	0	0	Karuah River
Rainforest	Stream	0.09	26.99	27.08	0	0	0.27	0.27	0.18	0.18	0.18	Barnes Creek
Ironbark	Plain	0.82	27.64	28.45	6	6	2.46	1.968	1.148	1.148	1.148	Roadside Environment Area
Ironbark	Plain	0.13	28.56	28.69	6	6	0.39	0.312	0.182	0.182	0.182	
Ironbark	Plain	0.4	29.6	30	6	6	1.2	0.96	0.56	0.56	0.56	
Ironbark	Stream	0.04	30.87	30.91	5	5	0.12	0.1	0.06	0.06	0.06	Barnes Creek
Dry foothills Spotted Gum	Hillslope	5.11	31.34	36.45	5	5	15.33	12.775	7.665	7.665	7.665	
South Coast Shrubby Grey Gum	Hillslope	0.43	36.45	36.88	5	5	1.29	1.075	0.645	0.645	0.645	

Vegetation	Land form	Length (km)	KP start	KP end	Existing cleared width (m) ^	Free width (m) *	30m ROW	Clearing	Area	Required	(ha) #	Location Notes
								30 m ROW - free width	20 m ROW - free width	20 m ROW - free width, HDD of Karuah	20 m ROW - free width, HDD of Karuah, NP uncleared	
Rainforest	Hillslope / Stream	0.07	36.88	36.95	5	5	0.21	0.175	0.105	0.105	0.105	Black Camp Creek
Dry foothills Spotted Gum	Hillslope	1.06	36.95	38.01	5	5	3.18	2.65	1.59	1.59	1.59	
Rainforest	Stream	0.03	38.24	38.27	0	0	0.09	0.09	0.06	0.06	0.06	
Rainforest	Stream	0.07	40.21	40.28	0	0	0.21	0.21	0.14	0.14	0.14	Cedar Tree Creek
Redgum / apple	Stream	0.1	45.58	45.67	20	20	0.3	0.1	0	0	0	Little Black Camp Creek
Ironbark	Plain	0.2	45.77	45.97	20	20	0.6	0.2	0	0	0	
Rainforest	Stream	0.04	49.45	49.5	0	0	0.12	0.12	0.08	0.08	0.08	
Ironbark	Plain	0.82	53.99	54.81	40	15	2.46	1.23	0.41	0.41	0.41	Nature Reserve
Ironbark	Hillslope / Plain	1.37	58.1	59.47	25	10	4.11	2.74	1.37	1.37	1.37	
Ironbark	Hillslope / Plain	2.38	59.7	62.08	25	10	7.14	4.76	2.38	2.38	0	Wallaroo National Park
Rainforest	Stream	0.04	62.08	62.12	25	10	0.12	0.08	0.04	0.04	0	Wallaroo National Park
Ironbark	Hillslope / Plain	0.9	62.12	63.02	25	10	2.7	1.8	0.9	0.9	0	Wallaroo National Park

Vegetation	Land form	Length (km)	KP start	KP end	Existing cleared width (m) ^	Free width (m) *	30m ROW	Clearing Area Required (ha) # 30 m ROW - free width	20 m ROW - free width	20 m ROW - free width, HDD of Karuah	20 m ROW - free width, HDD of Karuah, NP uncleared	Location Notes
Ironbark	Plain	0.09	64.07	64.16	10	10	0.27	0.18	0.09	0.09	0.09	Roadside Environment Area
Freshwater wetland complex	Swamp	0.15	67.88	68.03	0	0	0.45	0.45	0.3	0.3	0.3	
Ironbark	Hillslope / Plain	0.49	68.11	68.6	25	10	1.47	0.98	0.49	0.49	0.49	
Swamp Mahogany	Swamp	0.03	68.88	68.9	10	5	0.09	0.075	0.045	0.045	0.045	
Ironbark	Hillslope / Plain	0.35	70.53	70.88	0	0	1.05	1.05	0.7	0.7	0.7	
Ironbark	Hillslope / Plain	0.14	71.51	71.65	0	0	0.42	0.42	0.28	0.28	0.28	
Mangrove	Tidal channel	0.02	89.74	89.76	0	0	0.06	0.06	0.04	0.04	0.04	
TOTAL CLEARED		16.4					49.2	36.92	20.52	20.04	16.72	

^ Existing cleared width = width of existing clearing within the Right of Way (ROW).

* Free width = width of existing clearing within the ROW that is unobstructed by electrical transmission towers.

Maximum area of remnant vegetation that would be cleared under various scenarios:

30 m ROW = entire 30 m ROW containing remnant vegetation cleared

30 m ROW - free width = unobstructed cleared width included in 30 m ROW, remainder assumed to be entirely remnant vegetation

20 m ROW - free width = same as previous, but assumes only 20 m ROW is required for construction

HDD of Karuah = assumes HDD of Karuah River crossings (no clearing of riparian rainforest communities)

NP uncleared = assumes ROW contained entirely within existing cleared powerline easement (no clearing of remnant vegetation) in Wallaroo National Park.

Table T13: Summary of Potential Areas of Remnant Vegetation to be Cleared along Proposed Pipeline

Vegetation	30m ROW	Clearing	Area	Required	(ha) #	Buffer Area	(ha) ^	% of Buffer	Cleared *
		30 m ROW - free width	20 m ROW - free width	20 m ROW - free width, HDD of Karuah	20 m ROW - free width, HDD of Karuah, NP uncleared	Area in 5 km buffer (CRA mapping)	Area in 5 km buffer (LHCC mapping)	% of total in buffer (CRA mapping)	% of total in buffer (LHCC mapping)
Dry foothills spotted gum	18.69	15.575	9.345	9.345	9.345	1828.45	5248.11	1.02	0.36
South Coast Shrubby Grey Gum	3.24	2.05	0.97	0.97	0.97	17576.30	1851.14	0.02	0.18
Ironbark	24.39	16.7	8.57	8.57	5.29	7560.16	5248.11	0.32	0.46
Redgum / apple	0.3	0.1	0	0	0	1242.78	161.34	0.02	0.19
Eucalypt forests	46.62	34.425	18.885	18.885	15.605				
Freshwater wetland complex	0.45	0.45	0.3	0.3	0.3	-	2967.95	-	0.015
Swamp Mahogany	0.09	0.075	0.045	0.045	0.045	172.43	327.79	0.05	0.027
Wetlands	0.54	0.525	0.345	0.345	0.345				
Rainforest	1.98	1.905	1.245	0.765	0.725	178.00	402.84	1.11	0.49
Mangrove	0.06	0.06	0.04	0.04	0.04	3.26	6457.62	1.84	0.001
Total Area	49.2	36.92	20.52	20.04	16.72	38076.28	24652.25	0.13	0.20

Table legend on following page.

Table T13 Legend

Maximum area of remnant vegetation that would be cleared under various scenarios:
30 m ROW = entire 30m Right of Way (ROW) containing remnant vegetation cleared
30m ROW - free width = unobstructed cleared width included in 30m ROW, remainder assumed to be entirely remnant vegetation
(free width = width of existing clearing within the ROW that is unobstructed by electrical transmission towers)
20 m ROW - free width = same as previous, but assumes only 20 m ROW is required for construction
HDD of Karuah = assumes HDD of Karuah River crossings (no clearing of riparian rainforest communities)
NP uncleared = assumes ROW contained entirely within existing cleared powerline easement (no clearing of remnant vegetation) in Wallaroo National Park.

^ Area of each remnant vegetation community estimated within 5 km buffer area surrounding pipeline route:
CRA = Forest ecosystem mapping for Comprehensive Regional Assessment of North East Region - covers entire pipeline route (NPWS, 1999)
LHCC = Mapping for Lower Hunter and Central Coast - covers only southern third of pipeline route (NPWS, 2000)

* Percentage of total area of each remnant vegetation community within 5 km buffer area that would be cleared, assuming entire 30m ROW is cleared for pipeline construction.

Table T14: Protected Environmental Values and Likelihood of Identified Potential Impacts Without Mitigation

Environmental Value	Sources of Potential Impacts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Protected Areas															
Wallaroo National Park	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	
Nature Reserve at KP 54 (Lot 68 DP753176)	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes	Yes	
SEPP 14 wetlands	Yes	Yes	Yes	-	-	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	
Ramsar Hunter Estuary Wetland	-	-	-	-	-	Yes		Yes	-	Yes	Yes	Yes	Yes	Yes	
Threatened Ecological Communities															
Freshwater wetlands on coastal floodplains of the Sydney Basin Bioregion	Yes	Yes	Yes	-	-	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes
Hunter lowland Redgum forest in the Sydney Basin Bioregion	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes	Yes	Yes
Lower Hunter Spotted Gum - Ironbark forest in the Sydney Basin Bioregion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Yes
Swamp Oak floodplain forest of the Sydney Basin Bioregion	-	-	Yes	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes
Swamp sclerophyll forest on coastal floodplains of the Sydney Basin Bioregion	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes
Lowland Rainforest on floodplain of the NSW North Coast Bioregion	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes

Environmental Value	Sources of Potential Impacts														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Endangered Populations															
Weeping Myall (*Acacia pendula*) population in the Hunter catchment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymbidium cancaliculatum population in the Hunter Catchment	Yes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus parramattensis subsp. *parramattensis* in the Wyong and Lake Macquarie LGA's	Yes	-	-	-		-	-	-	-	-	Yes	-	-	-	-
Narrow-leaved Red Gum (*Eucalyptus seena*) population in the Greater Tarree LGA	Yes	-	-	-	-	Yes	-	-	-	-	-	-	-	-	-
Rhizanthella slateri population in the Great Lakes LGA	Yes	-	-	-	-	-	-	Yes	-	-	-	-	-	-	-
Threatened Flora															
Asperula asthenes Trailing Woodruff	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	
Callistemon linearifolius Netted Bottle Brush	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	
Cryptostylis hunteriana Leafless Tongue Orchid	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	
Cynanchum elegans White-flowered Wax Plant	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	

Environmental Value	Sources of Potential Impacts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Eucalyptus glaucina Slaty Red Gum	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	
Eucalyptus parramattensis subsp. *decadens*	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	
Grevillea guthrieana Guthrie's Grevillea	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	Yes
Grevillea parviflora subsp. *parviflora* small-flower Grevillea	Yes	-	-	-	-	Yes	Yes	Yes	Yes	-	-	Yes	-	Yes	Yes
Maundia triglochinoides	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	
Persicaria elatior Tall Knotweed	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	
Pomaderris queenslandica Scant Pomaderris	Yes	-	-	-	-	Yes	Yes	-	-	-	-	Yes	-	Yes	
Rhizanthella slateri Eastern Underground Orchid	Yes	-	-	-	-	Yes	Yes	Yes	Yes	-	-	Yes	-	Yes	
Tetratheca juncea Black-eyed Susan	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	Yes
Zannichellia palustris	Yes	-	-	-	-	Yes	Yes	-	-	-	Yes	Yes	-	Yes	
Threatened Fauna															
Litoria aurea Green and Golden Bell Frog	Yes	-	Yes	-	-	Yes	Yes	Yes	Yes	-	Yes	?	Yes	Yes	
Mixophyes balbus Stuttering Frog	Yes	-	Yes	-	-	Yes	Yes	Yes	Yes	-	Yes	?	Yes	Yes	

Environmental Value	Sources of Potential Impacts														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Mixophyes iteratus Giant Barred Frog	Yes	-	Yes	-	-	Yes	Yes	Yes	Yes	-	Yes	?	Yes	Yes	
Hoplocephalus bitorquatus Pale-headed Snake	Yes	Yes	Yes	-	-	Yes	-	Yes	-	-	-	Yes	-	-	
Hoplocephalus stephensii Stephens' Banded Snake	Yes	Yes	Yes	-	-	Yes	-	Yes	-	-	-	Yes	-	-	
Anseranas semipalmata Magpie Goose	Yes	-	-	-	-	Yes	-	-	-	-	Yes	-	Yes	Yes	
Botaurus poiciloptilus Australasian Bittern	Yes	-	-	-	-	Yes	-	-	-	-	Yes	-	Yes	Yes	
Burhinus grallarius Bush Stone-curlew	Yes	-	Yes	-	-	Yes	-	-	-	-	-	?	-	-	
Callocephalon fimbriatum Gang-gang Cockatoo	Yes	Yes	-	-	-	-	-	-	-	-	-	?	-	-	
Calyptorhynchus lathami Glossy Black-Cockatoo	Yes	Yes	-	-	Yes	-	-	-	-	-	-	Yes	-	-	
Climacteris picumnus Brown Treecreeper	Yes	-	Yes	-	-	Yes	-	-	-	-	-	?	-	-	
Coracina lineate Barred Cuckoo-shrike	Yes	-	-	-	Yes	-	-	-	-	-	-	?	-	-	
Ephippiorhynchus asiaticus Black-necked Stork	Yes	-	-	-	-	-	-	-	-	-	Yes	-	Yes	Yes	
Irediparra gallinacean Comb-crested Jacana	Yes	-	-	-	-	Yes	-	-	-	-	Yes	-	Yes	Yes	

Environmental Value	Sources of Potential Impacts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ixobrychus flavicollis Black Bittern	Yes	-	-	-	-	-	-	-	-	-	Yes	-	Yes	Yes	
Lathamus discolor Swift Parrot	Yes	-	-	-	-	-	-	-	-	-	-	?	-	-	
Lophoictinia isura Square-tailed Kite	Yes	-	Yes	-	-	-	-	-	-	-	-	?	-	-	
Melanodryas cucullata Hooded Robin	Yes	-	Yes	-	-	Yes	-	-	-	-	-	?	-	-	
Melithreptus gularis Black-chinned Honeyeater	Yes	-	-	-	-	-	-	-	-	-	-	?	-	-	
Neophema pulchella Turquoise Parrot	Yes	Yes	Yes	-	-	Yes	-	-	-	-	-	?	-	-	
Ninox connivens Barking Owl	Yes	Yes	Yes	-	-	-	-	-	-	-	-	?	-	-	
Ninox strenua Powerful Owl	Yes	Yes	-	-	Yes	-	-	-	-	-	-	Yes	-	-	
Pomatostomus temporalis Grey-crowned Babbler	Yes	-	Yes	-	-	Yes	-	-	-	-	-	?	-	-	
Pyrrholaemus saggitatus Speckled Warbler	Yes	-	Yes	-	Yes	Yes	-	-	-	-	-	Yes	-	-	
Rostratula benghalensis Painted Snipe	Yes	-	Yes	-	-	Yes	-	-	-	-	Yes	-	Yes	Yes	
Stagonopleura guttata Diamond Firetail	Yes	-	Yes	-	-	Yes	-	-	-	-	-	Yes	-	-	

Environmental Value	Sources of Potential Impacts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tyto novaehollandiae Masked Owl	Yes	Yes	Yes	-	-	-	-	-	-	-	-	?	-	-	
Tyto tenebricosa Sooty Owl	Yes	Yes	Yes	-	Yes	-	-	-	-	-	-	Yes	-	-	
Xanthomyza phrygia Regent Honeyeater	Yes	-	-	-	-	-	-	-	-	-	-	?	-	-	
Cercartetus nanus Eastern Pygmy-Possum	Yes	Yes	-	-	Yes	-	-	-	-	-	-	?	-	-	
Chalinolobus dwyeri Large-eared Pied Bat	Yes	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dasyurus maculatus Spotted-tailed Quoll	Yes	Yes	Yes	?	Yes	Yes	-	Yes	-	-	-	?	-	-	
Falsistrellus tasmaniensis Eastern False Pipistrelle	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	
Macropus parma Parma Wallaby	Yes	-	Yes	-	Yes	?	-	Yes	-	-	-	-	-	-	
Miniopterus australis Little Bent-wing Bat	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	
Miniopterus schreibersii Common Bent-wing Bat	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	
Mormopterus norfolkensis Eastern Free-tail Bat	Yes	Yes	-	-	?	-	-	-	-	-	-	-	-	-	
Myotis adversus Large-footed Myotis	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	

Environmental Value	Sources of Potential Impacts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Petaurus australis Yellow-bellied Glider	Yes	Yes	-	-	Yes	-	-	-	-	-	-	Yes	-	-	
Petaurus norfolcensis Squirrel Glider	Yes	Yes	-	-	Yes	-	-	-	-	-	-	Yes	-	-	
Phascogale tapoatafa Brush-tailed Phascogale	Yes	-	Yes	-	Yes	-	-	Yes	-	-	-	Yes	-	-	
Phascolarctos cinereus Koala	Yes	-	-	-	Yes	-	-	-	-	-	-	Yes	-	-	
Planigale maculata Common Planigale	Yes	-	Yes	-	-	Yes	-	Yes	-	-	-	?	-	-	
Potorous tridactylus Long-nosed Potoroo	Yes	-	Yes	-	Yes	Yes	-	Yes	-	-	-	Yes	-	-	
Pteropus poliocephalus Grey-headed Flying-fox	Yes	-	-	-	-	-	-	-	-	-	-	-	-	-	
Saccolaimus flaviventris Yellow-bellied Sheath-tail Bat	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	
Scoteanax rueppellii Greater Broad-nosed Bat	Yes	Yes	-	-	-	-	-	-	-	-	-	-	-	-	

Sources of potential impacts:. 1 loss of vegetation; 2 Loss of hollow-bearing trees; 3 removal of dead and fallen timber; 4 removal of rock; 5 edge effects; 6 spread of environmental weeds; 7 easement maintenance; 8 soil excavation; 9 soil compaction; 10 barrier effects to wildlife movement; 11 alterations to hydrology; 12 wild fire; 13 construction waste; 14 sediment, erosion and dust, 15 Phytopthora

Table T15: Assessment of flora species listed under the EPBC Act

This table summarises the impact assessment for flora species listed under the EPBC Act that were considered to potentially occur in the study area, or for which there is potential habitat within the study area. The impact assessment follows the 'significant impact criteria' as outlined in the EPBC Act Policy Statement 1.1, Significant Impact Guidelines (DEH 2006).

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:*									Conclusion
		1. decrease population long-term	**2. reduce species' area of occupancy**	**3. fragment existing population**	**4. adversely affect critical habitat**	**5. disrupt population breeding cycle**	**6. alter the availability or quality of habitat**	**7. encourage harmful invasive species**	**8. introduce harmful disease**	**9. interfere with species' recovery**	
Endangered											
Cynanchum elegans White-flowered Wax Plant	Refer **Table T6** and **Appendix E** (Seven-part Tests). White-flowered Wax Plant was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term White-flowered Wax Plant population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the White-flowered Wax Plant's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), White-flowered Wax Plant population fragmentation is unlikely.	No critical habitat has been declared for the White-flowered Wax Plant (Web1).	With the recommended mitigation measures (**Section 5.0**), the White-flowered Wax Plant's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species. (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.
Rhizanthella slateri Eastern Underground Orchid	Refer **Table T6** and **Appendix E** (Seven-part Tests). Eastern Underground Orchid was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Eastern Underground Orchid's population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Eastern Underground Orchid area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Eastern Underground Orchid population fragmentation is unlikely.	No critical habitat has been declared for the Eastern Underground Orchid (Web1).	With the recommended mitigation measures (**Section 5.0**), the Eastern Underground Orchid's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species. With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 3 recovery actions listed in the *Conservation Advice for Rhizanthella slateri* 2007.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:* 1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	Conclusion
Vulnerable											
Asperula asthenes Trailing Woodruff	Refer **Table T6** and **Appendix E** (Seven-part Tests). Trailing Woodruff was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Trailing Woodruff population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Trailing Woodruff's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Trailing Woodruff population fragmentation is unlikely.	No critical habitat has been declared for the Trailing Woodruff (Web1).	With the recommended mitigation measures (**Section 5.0**), the Trailing Woodruff's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 8 recovery actions listed in the *Conservation Advice for Asperula asthenes* 2008.	No significant impact is expected from the proposed development.
Cryptostylis hunteriana *Maundia triglochinoides*	Refer **Table T6** and **Appendix E** (Seven-part Tests). Leafless Tongue Orchid was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Leafless Tongue Orchid population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Leafless Tongue Orchid's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Leafless Tongue Orchid population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1).	With the recommended mitigation measures (**Section 5.0**), the Leafless Tongue Orchid's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 15 recovery actions listed in the *Conservation Advice for Cryptostylis hunteriana* 2008.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:*									Conclusion
		1. decrease population long-term	**2. reduce species' area of occupancy**	**3. fragment existing population**	**4. adversely affect critical habitat**	**5. disrupt population breeding cycle**	**6. alter the availability or quality of habitat**	**7. encourage harmful invasive species**	**8. introduce harmful disease**	**9. interfere with species' recovery**	
Eucalyptus glaucina Slaty Red Gum	Refer **Table T6** and **Appendix E** (Seven-part Tests). Slaty Red Gum was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Slaty Red Gum population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Slaty Red Gum's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Slaty Red Gum population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1).	With the recommended mitigation measures (**Section 5.0**), the Slaty Red Gum's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 15 recovery actions listed in the *Conservation Advice for Eucalyptus glaucina* 2008.	No significant impact is expected from the proposed development.
Eucalyptus parramattensis subsp. decadens	Refer **Table T6** and **Appendix E** (Seven-part Tests). *Eucalyptus parramattensis* subsp. *decadens* was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term *Eucalyptus parramattensis* subsp. *decadens* population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the *Eucalyptus parramattensis* subsp. *decadens* area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), *Eucalyptus parramattensis* subsp. *decadens* population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1)	With the recommended mitigation measures (**Section 5.0**), the *Eucalyptus parramattensis* subsp. *decadens* breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species. (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.
Grevillea guthrieana Guthrie's Grevillea	Refer Table T6 and Appendix E (Seven-part Tests). Guthrie's Grevillea was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term *Eucalyptus parramattensis* subsp. *decadens* population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Guthrie's Grevillea's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Guthrie's Grevillea population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1)	With the recommended mitigation measures (**Section 5.0**), the Guthrie's Grevillea breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), the risk of spreading of *Phytopthora cinnamomi* is unlikely.	There is no NRP for this species. (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:* 1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	Conclusion
Grevillea parviflora subsp. parviflora Small-flower Grevillea	Refer **Table T6** and **Appendix E** (Seven-part Tests). Small-flower Grevillea was recorded during the field survey in a previously cleared powerline corridor.	With the recommended mitigation measures and , if necessary, offset measures (**Section 5.0**), long-term Small-flower Grevillea population size decrease is unlikely.	With the recommended mitigation measures and , if necessary, offset measures (**Section 5.0**), significant reduction of the Small-flower Grevillea's area of occupancy is unlikely.	With the recommended mitigation measures and , if necessary, offset measures (**Section 5.0**), Small-flower Grevillea population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1).	With the recommended mitigation measures and , if necessary, offset measures (**Section 5.0**), the Small-flower Grevillea's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures and , if necessary, offset measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 11 recovery actions listed in the *Conservation Advice for Grevillea parviflora subsp. parviflora* 2008.	No significant impact is expected from the proposed development.
Persicaria elatior Tall Knotweed	Refer **Table T6** and **Appendix E** (Seven-part Tests). Tall Knotweed was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Tall Knotweed population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Tall Knotweed's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Tall Knotweed population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1).	With the recommended mitigation measures (**Section 5.0**), the Tall Knotweed's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 13 recovery actions listed in the *Conservation Advice for Persicaria elatior* 2008.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:*									Conclusion
		1. decrease population long-term	**2. reduce species' area of occupancy**	**3. fragment existing population**	**4. adversely affect critical habitat**	**5. disrupt population breeding cycle**	**6. alter the availability or quality of habitat**	**7. encourage harmful invasive species**	**8. introduce harmful disease**	**9. interfere with species' recovery**	
Tetratheca juncea Black-eyed Susan	Refer **Table T6** and **Appendix E** (Seven-part Tests). Black-eyed Susan was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Black-eyed Susan population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Black-eyed Susan's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Black-eyed Susan population fragmentation is unlikely.	No critical habitat has been declared for this species (Web1).	With the recommended mitigation measures (**Section 5.0**), the Black-eyed Susan's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), the risk of spreading of *Phytopthora cinnamomi* is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 14 recovery actions listed in the *Conservation Advice for Tetratheca juncea* 2008.	No significant impact is expected from the proposed development.

NRP- National Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Web1 - 2009. Register of critical habitat. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl

Web2 - 2009. Recovery Plans for Australian Species. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/biodiversity/threatened/recovery-list-scientific.html

Web3 - 2009. Species profiles and threats database. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Table T16: Assessment of fauna species listed under the EPBC Act

This table summarises the impact assessment for fauna species listed under the EPBC Act that were considered to potentially occur in the study area, or for which there is potential habitat within the study area. The impact assessment follows the 'significant impact criteria' as outlined in the EPBC Act Policy Statement 1.1, Significant Impact Guidelines (DEH 2006). The information was sourced from the SPRAT database (Web3) unless otherwise stated.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:*									Conclusion
		1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	
Endangered											
Mixophyes iterates Giant Barred Frog	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Giant Barred Frog was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Giant Barred Frog population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Giant Barred Frog's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Giant Barred Frog population fragmentation is unlikely.	No critical habitat has been declared for the Giant Barred Frog (Web1).	With the recommended mitigation measures (**Section 5.0**), the Giant Barred Frog's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Giant Barred Frog.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species (*Gambusia holbrooki*) is unlikely.	With the recommended mitigation measures (**Section 5.0**), the risk of spreading harmful disease (Chytrid fungus) is significantly reduced.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 4 recovery objectives listed in the *Action Plan for Australian Frogs* 1997.	No significant impact is expected from the proposed development.
Lathamus discolor Swift Parrot	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Swift Parrot was not recorded during the field survey.	Long-term population size decrease is unlikely as the Swift Parrot Is not expected to be reliant on habitat within the study area.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Swift Parrot's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Swift Parrot population fragmentation is unlikely.	The NRP lists priority winter foraging habitats that occur in the proposed pipeline route. 15 to 35 ha of this would be cleared in narrow strips. This is minimal compared to large areas of undisturbed habitat in surrounding	Breeding cycle disruption is unlikely as the Swift Parrot's breeding range is confined to Tasmania.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 6 recovery objectives listed in the *Swift Parrot NRP for (2001-2005)* (Web2).	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:* 1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	Conclusion
Xanthomyza phrygia Regent Honeyeater	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Regent Honeyeater was not recorded during the field survey.	Long-term population size decrease is unlikely as the Regent Honeyeater is not expected to be reliant on habitat within the study area.	With the recommended mitigation measures (**Section 5.0**), reduction of the Regent Honeyeater's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Regent Honeyeater population fragmentation is unlikely.	No critical habitat has been declared for the Regent Honeyeater (Web1).	Breeding cycle disruption is unlikely as the known Regent Honeyeater breeding regions in NSW (2) are not within the study area.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Regent Honeyeater.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 6 recovery objectives listed in the *Regent Honeyeater NRP for (1999-2003)* (Web2).	No significant impact is expected from the proposed development.
Dasyurus maculatus Spotted-tailed Quoll	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Spotted-tailed Quoll was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Spotted-tailed Quoll population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Spotted-tailed Quoll's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Spotted-tailed Quoll population fragmentation is unlikely.	No critical habitat has been declared for the Spotted-tailed Quoll (Web1)	With the recommended mitigation measures (**Section 5.0**), the spotted-tailed quoll's breeding cycle would is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), the species habitat would not be adversely impacted to the extent that the species is likely to decline.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species. (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.
Vulnerable											
Litoria aurea Green And Golden Bell Frog	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Green And Golden Bell Frog was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Green And Golden Bell Frog population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), reduction of the Green And Golden Bell Frog's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Green And Golden Bell Frog population fragmentation is unlikely.	No critical habitat has been declared for the Green And Golden Bell Frog (Web1).	With the recommended mitigation measures (**Section 5.0**), the Green And Golden Bell Frog's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Green And Golden Bell Frog.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species (*Gambusia holbrooki*) is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease (Chytrid fungus) is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 2 recovery objectives listed in the *Action Plan for Australian Frogs* 1997.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:* 1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	Conclusion
Mixophyes balbus Stuttering Frog	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Stuttering Frog was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Stuttering Frog population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Stuttering Frog's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Stuttering Frog population fragmentation is unlikely.	No critical habitat has been declared for the Stuttering Frog (Web1).	With the recommended mitigation measures (**Section 5.0**), the Stuttering Frog's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Stuttering Frog.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species (*Gambusia holbrooki*) is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease (Chytrid fungus) is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 4 recovery objectives listed in the *Action Plan for Australian Frogs* 1997.	No significant impact is expected from the proposed development.
Rostratula (benghalensis) australis Painted Snipe	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Painted Snipe was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Painted Snipe population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Painted Snipe's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Painted Snipe population fragmentation is unlikely.	No critical habitat has been declared for the Painted Snipe (Web1).	With the recommended mitigation measures (**Section 5.0**), the Painted Snipe's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Painted Snipe.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.
Chalinolobus dwyeri Large-eared Pied Bat	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Large-eared Pied Bat was not recorded during the field survey.	Long-term population size decrease is unlikely as the Large-eared Pied Bat is not expected to be reliant on habitat within the study area.	With the recommended mitigation measures (**Section 5.0**), reduction of the Large-eared Pied Bat's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Large-eared Pied Bat population fragmentation is unlikely.	No critical habitat has been declared for the Large-eared Pied Bat (Web1).	With the recommended mitigation measures (**Section 5.0**), the Large-eared Pied Bat's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Large-eared Pied Bat.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 3 recovery objectives listed in the *Action Plan for Australian Bats* 1999.	No significant impact is expected from the proposed development.

Species	Distribution, ecology and habitat	EPBC Assessment Criteria *Is there a real chance or possibility that the action will:* 1. decrease population long-term	2. reduce species' area of occupancy	3. fragment existing population	4. adversely affect critical habitat	5. disrupt population breeding cycle	6. alter the availability or quality of habitat	7. encourage harmful invasive species	8. introduce harmful disease	9. interfere with species' recovery	Conclusion
Potorous tridactylus Long-nosed Potoroo	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Long-nosed Potoroo was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Long-nosed Potoroo population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Long-nosed Potoroo's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Long-nosed Potoroo population fragmentation is unlikely.	No critical habitat has been declared for the Long-nosed Potoroo (Web1)	With the recommended mitigation measures (**Section 5.0**), the Long-nosed Potoroo's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Long-nosed Potoroo.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**), the proposal is unlikely to have an adverse affect on the species recovery.	No significant impact is expected from the proposed development.
Pteropus poliocephalus Grey-headed Flying-fox	Refer **Table T9** and **Appendix E** (Seven-part Tests). The Grey-headed Flying-fox was not recorded during the field survey.	With the recommended mitigation measures (**Section 5.0**), long-term Grey-headed Flying-fox population size decrease is unlikely.	With the recommended mitigation measures (**Section 5.0**), significant reduction of the Grey-headed Flying-fox's area of occupancy is unlikely.	With the recommended mitigation measures (**Section 5.0**), Grey-headed Flying-fox population fragmentation is unlikely.	No critical habitat has been declared for the Grey-headed Flying-fox (Web1).	With the recommended mitigation measures (**Section 5.0**), the Grey-headed Flying-fox's breeding cycle is unlikely to be disrupted.	With the recommended mitigation measures (**Section 5.0**), habitat alteration would be minimal and therefore pose little threat to the survival of the Grey-headed Flying-fox.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful invasive species is unlikely.	With the recommended mitigation measures (**Section 5.0**), introduction of harmful disease is unlikely.	There is no NRP for this species (Web2). With the recommended mitigation measures (**Section 5.0**) the proposal is unlikely to interfere with any of the 4 recovery objectives listed in the *Action Plan for Australian Bats* 1999.	No significant impact is expected from the proposed development.

NRP- National Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Web1 - 2009. Register of critical habitat. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl

Web2 - 2009. Recovery Plans for Australian Species. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/biodiversity/threatened/recovery-list-scientific.html

Web3 - 2009. Species profiles and threats database. Department of Environment, Water, Heritage and the Arts, Commonwealth of Australia, viewed 8 April 2009. URL: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

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Plates

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Plate P1: Cleared Powerline Easement through Wallaroo National Park at KP 61.9

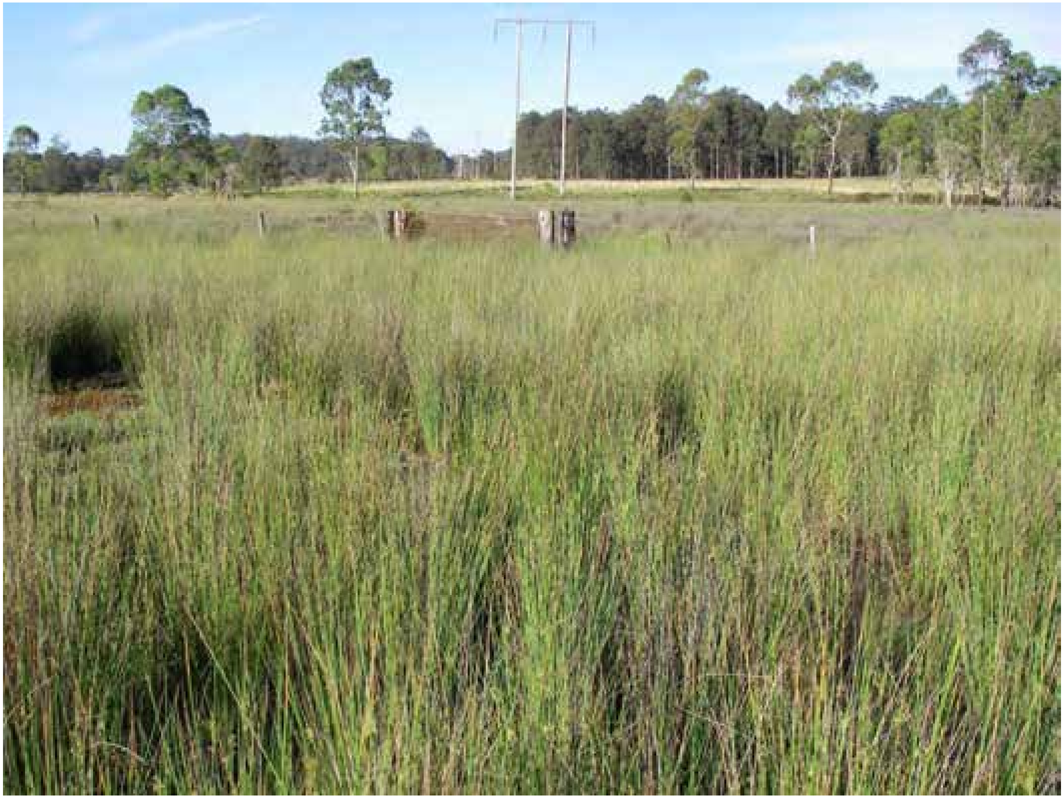

Plate P2: Freshwater Wetland Transected by the Proposed Pipeline at KP 67.9

Plate P3: Swamp Oak Forest Adjacent to the Proposed Pipeline at KP 86

Plate P4: Swamp Sclerophyll Forest Adjacent to the Proposed Pipeline at KP 68.8

Plate P5: Swamp Scerophyll Forest Transected by the Proposed Pipeline at KP 68.9

Plate P6: Redgum Forest Transected by the Proposed Pipeline at KP 45.6

Plate P7: Tidal Channel with Mangroves the Proposed Pipeline at KP 89.8

Plate P8: Riparian Rainforest Transected by the Pipeline on the Karuah River at KP 19.2


Plate P9: Flowers and Leaves of *Grevillea parviflora* subsp*. parviflora* at KP 58.9

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Figures

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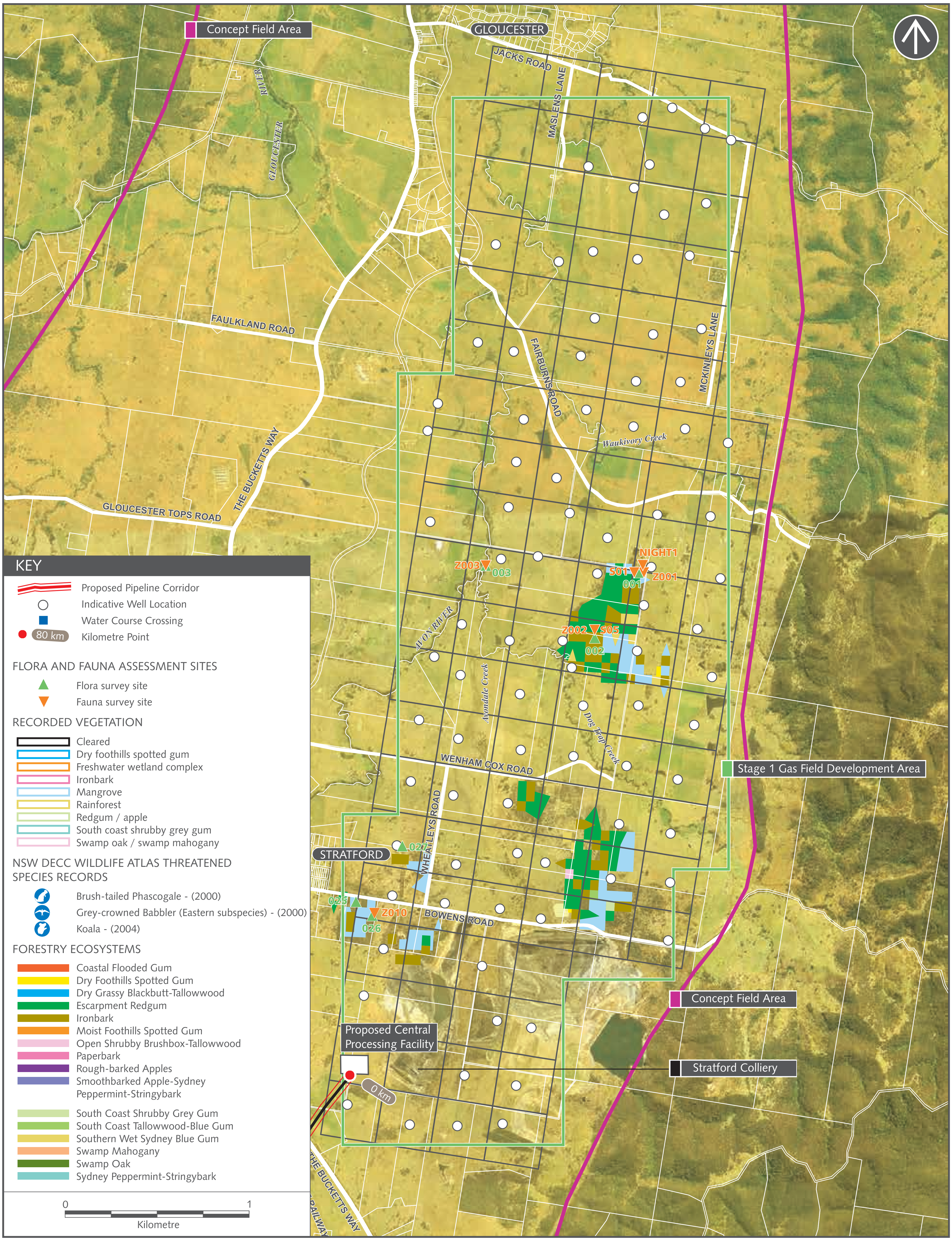

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS - STAGE 1 GAS FIELD DEVELOPMENT AREA

Figure 1

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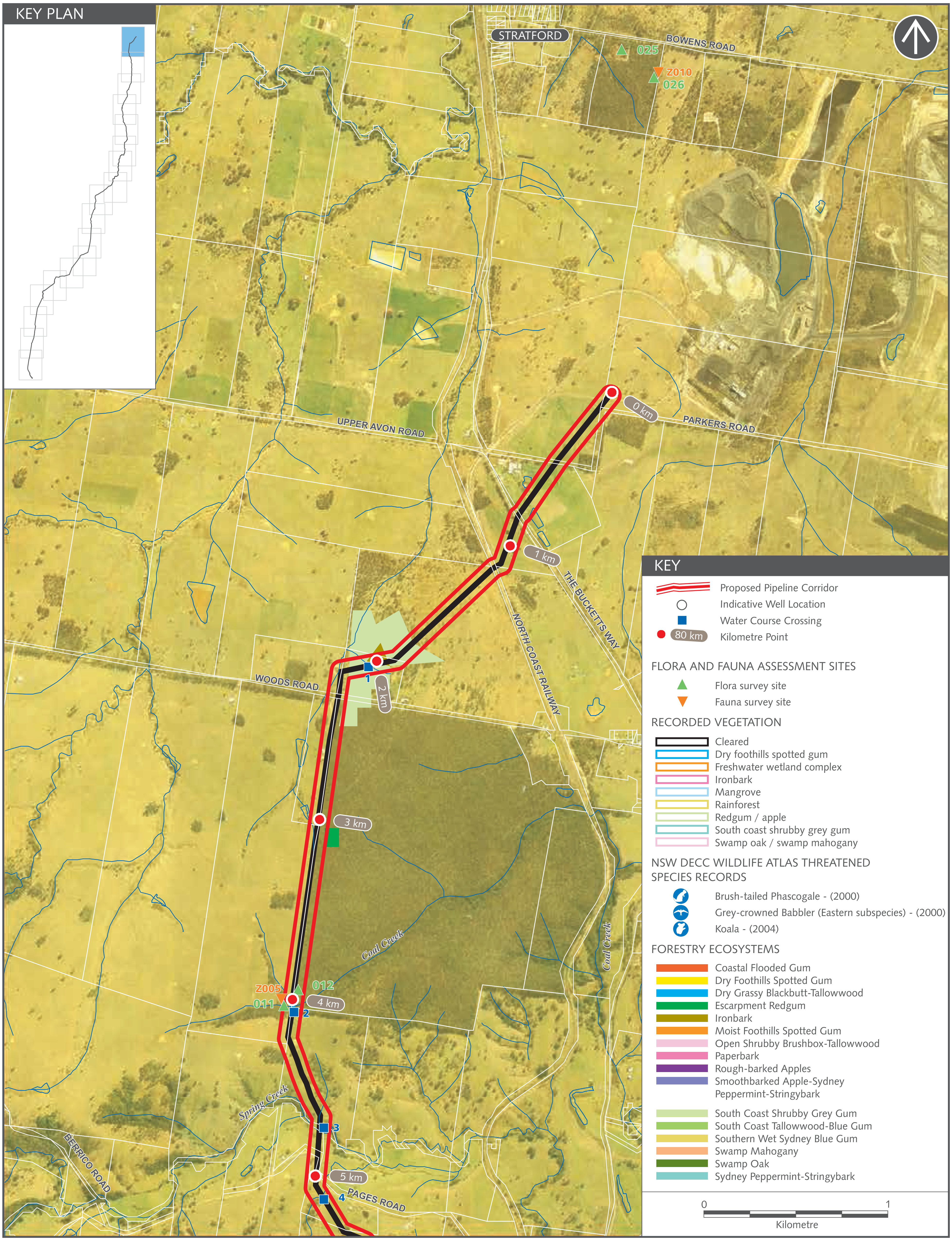

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 0-5KM - SHEET 1 OF 18

Figure 2

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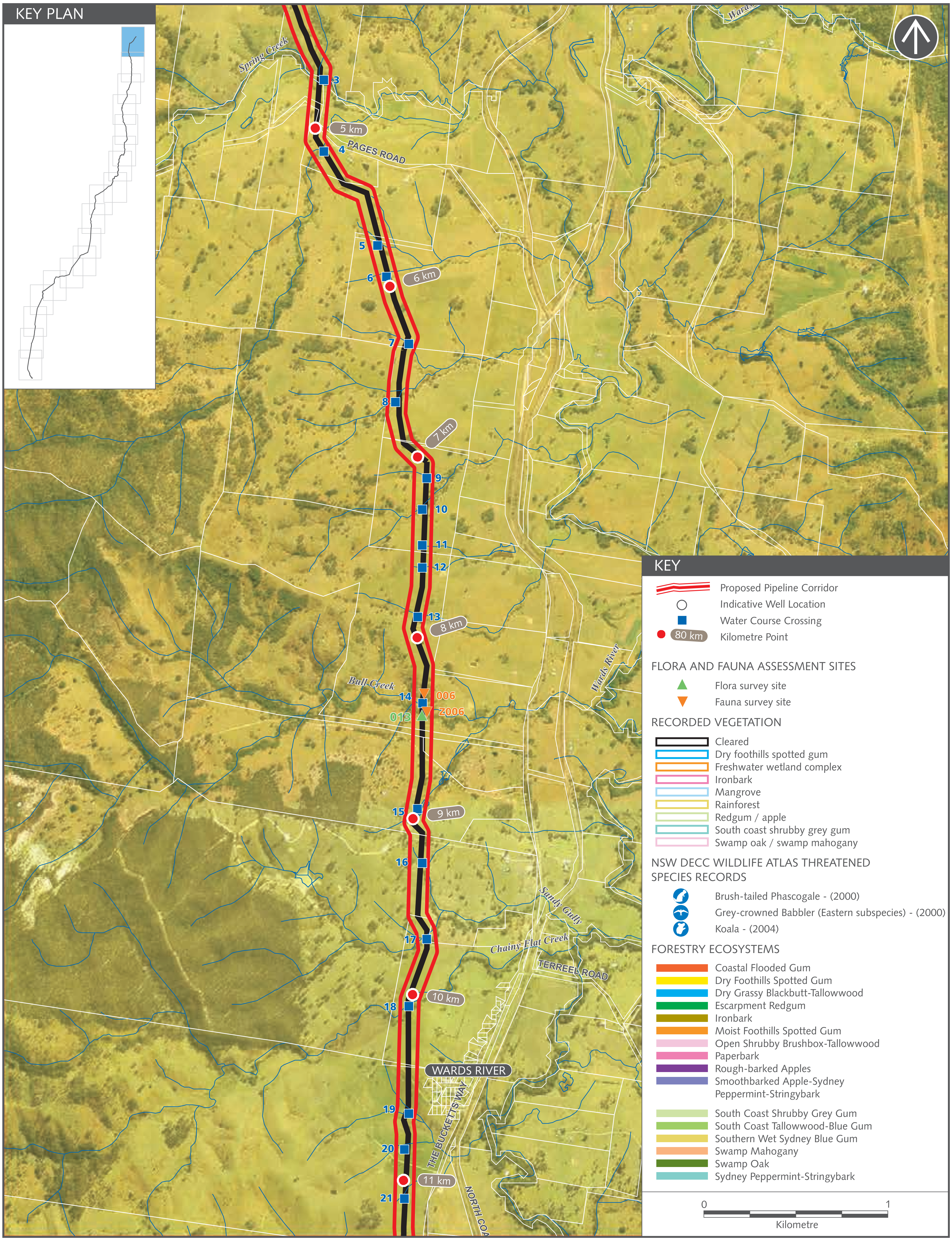

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KILOMETRE POINT 5-10KM - SHEET 2 OF 18

Figure 3

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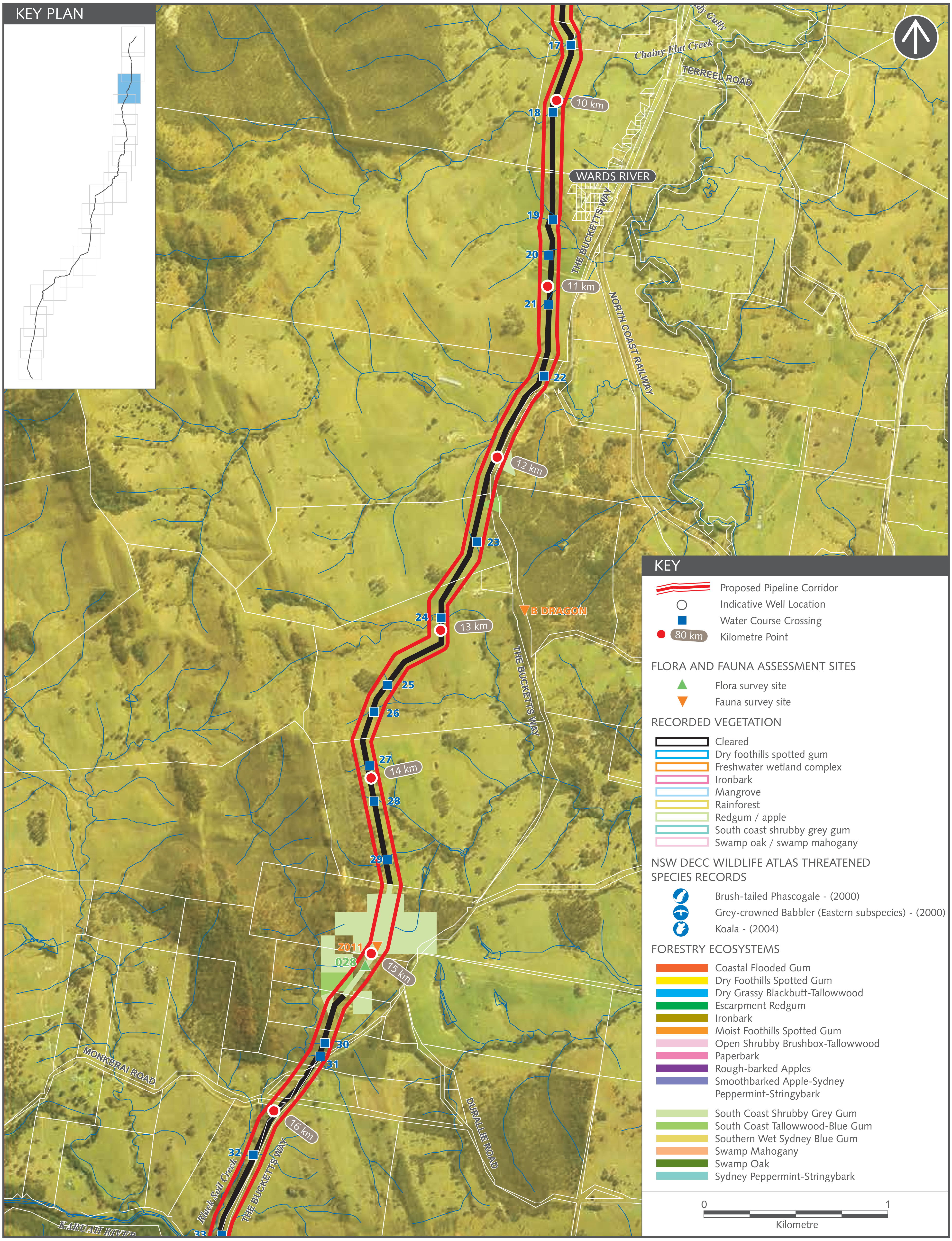

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KILOMETRE POINT 10-15KM - SHEET 3 OF 18

Figure 4

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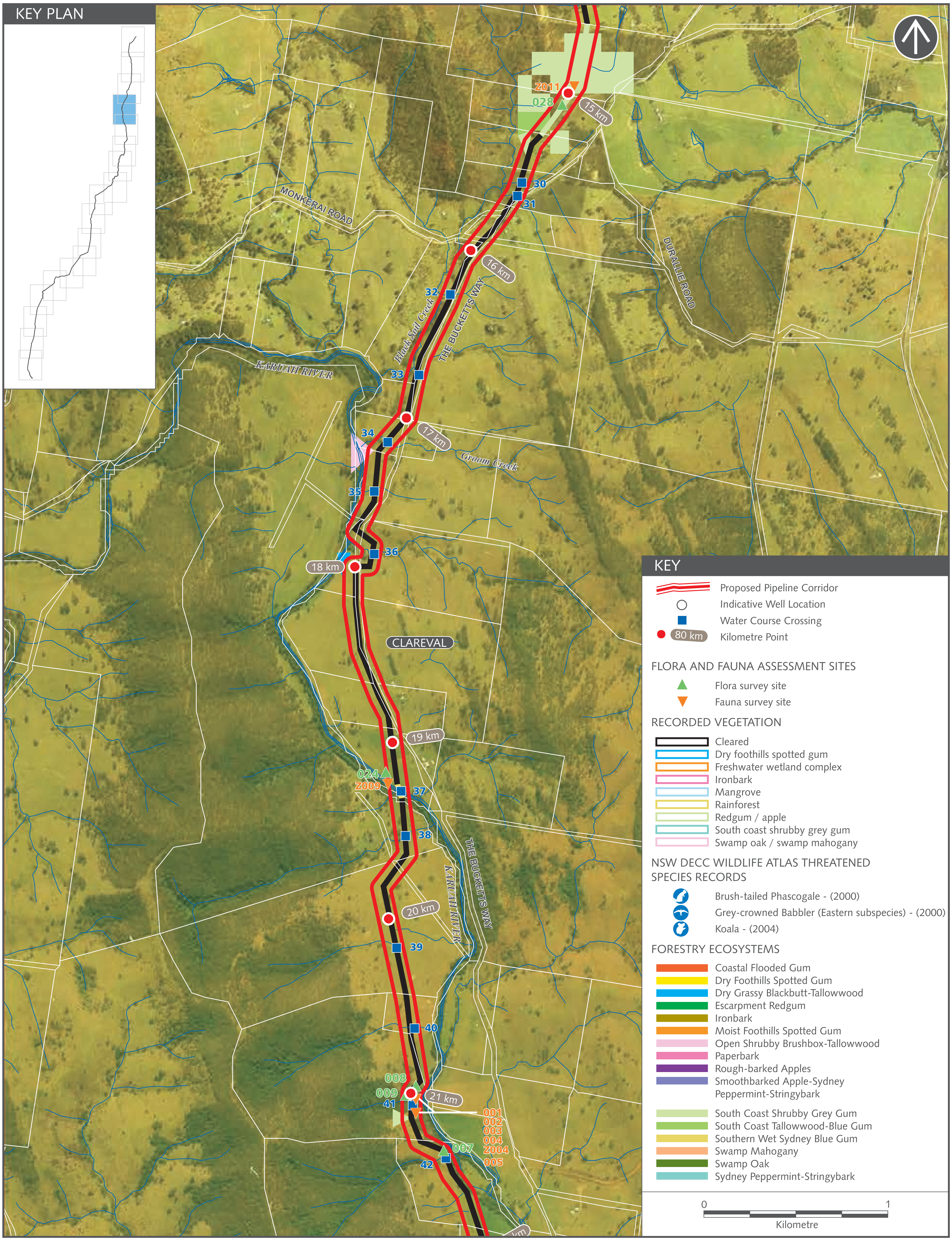

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KILOMETRE POINT 15-20KM - SHEET 4 OF 18

Figure 5

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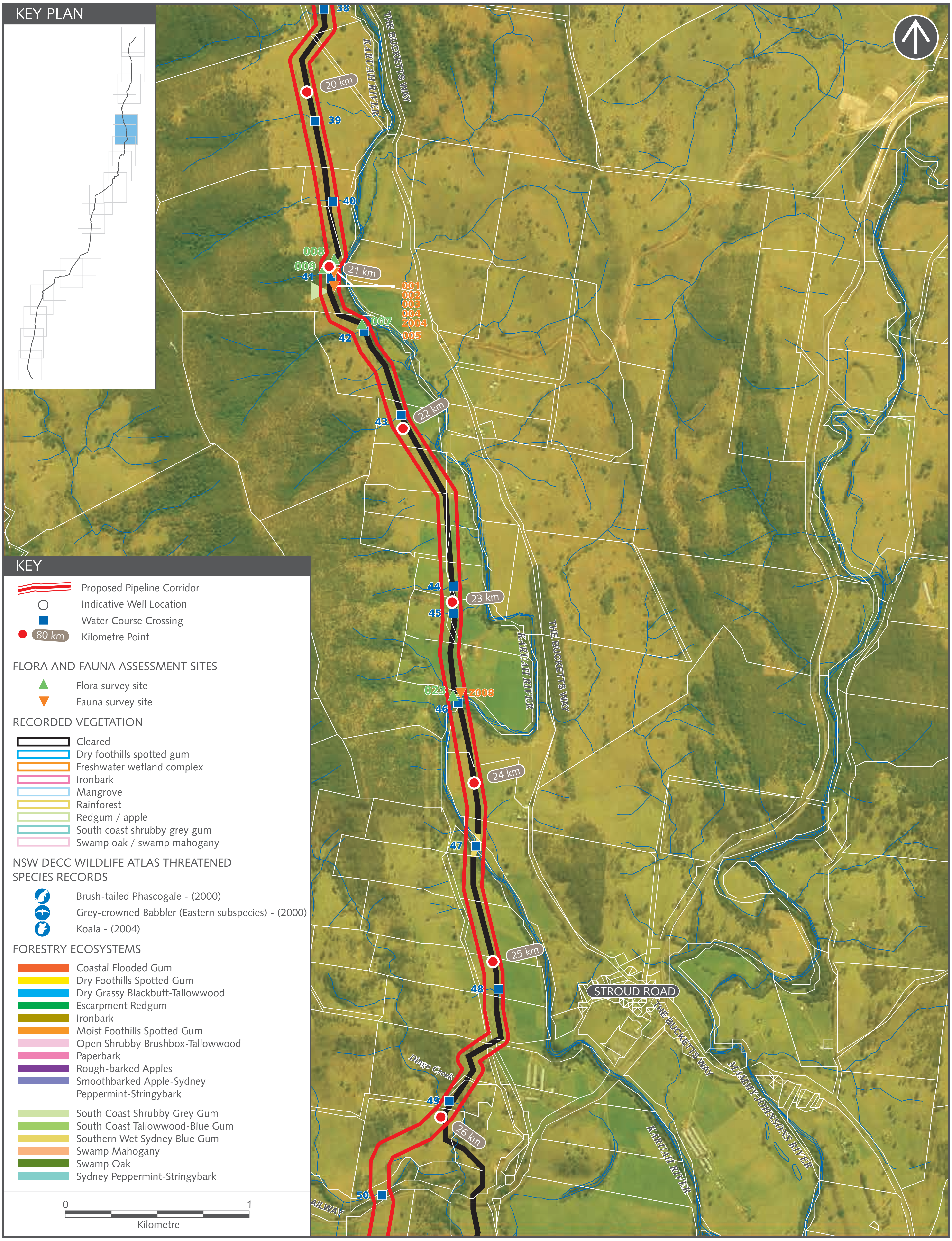

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 20-25KM - SHEET 5 OF 18

Figure 6

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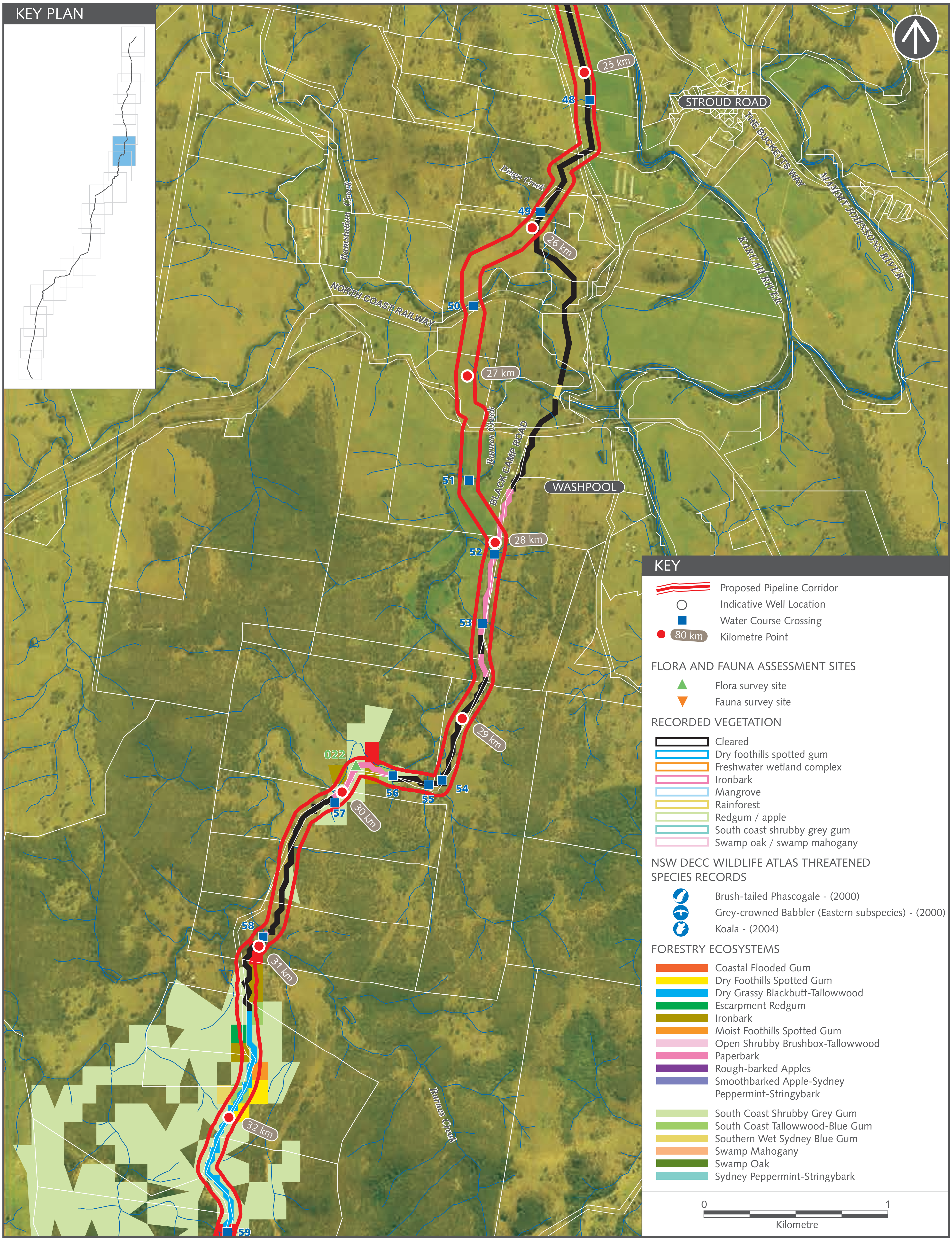

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 25-30KM - SHEET 6 OF 18

Figure 7

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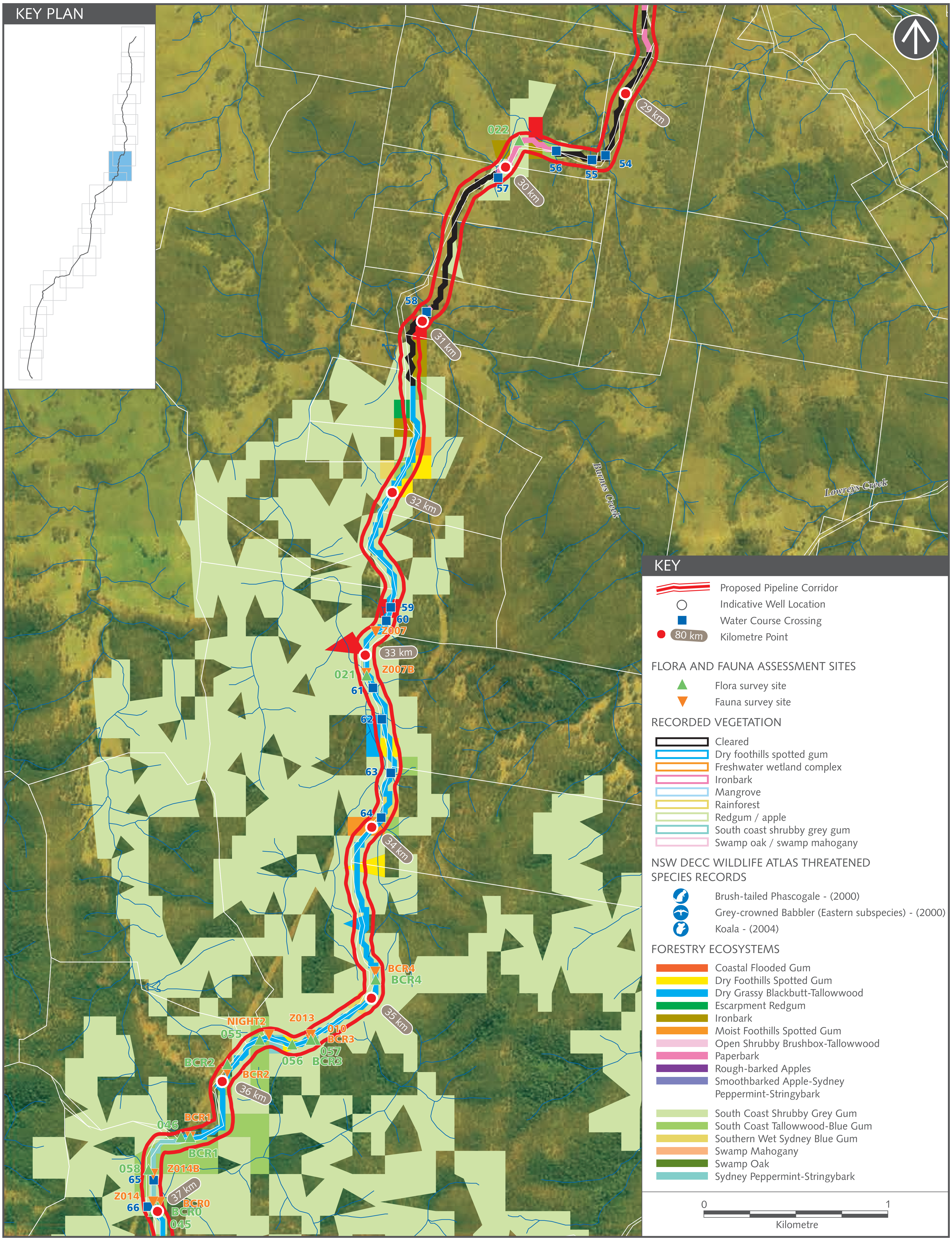

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 30-35KM - SHEET 7 OF 18

Figure 8

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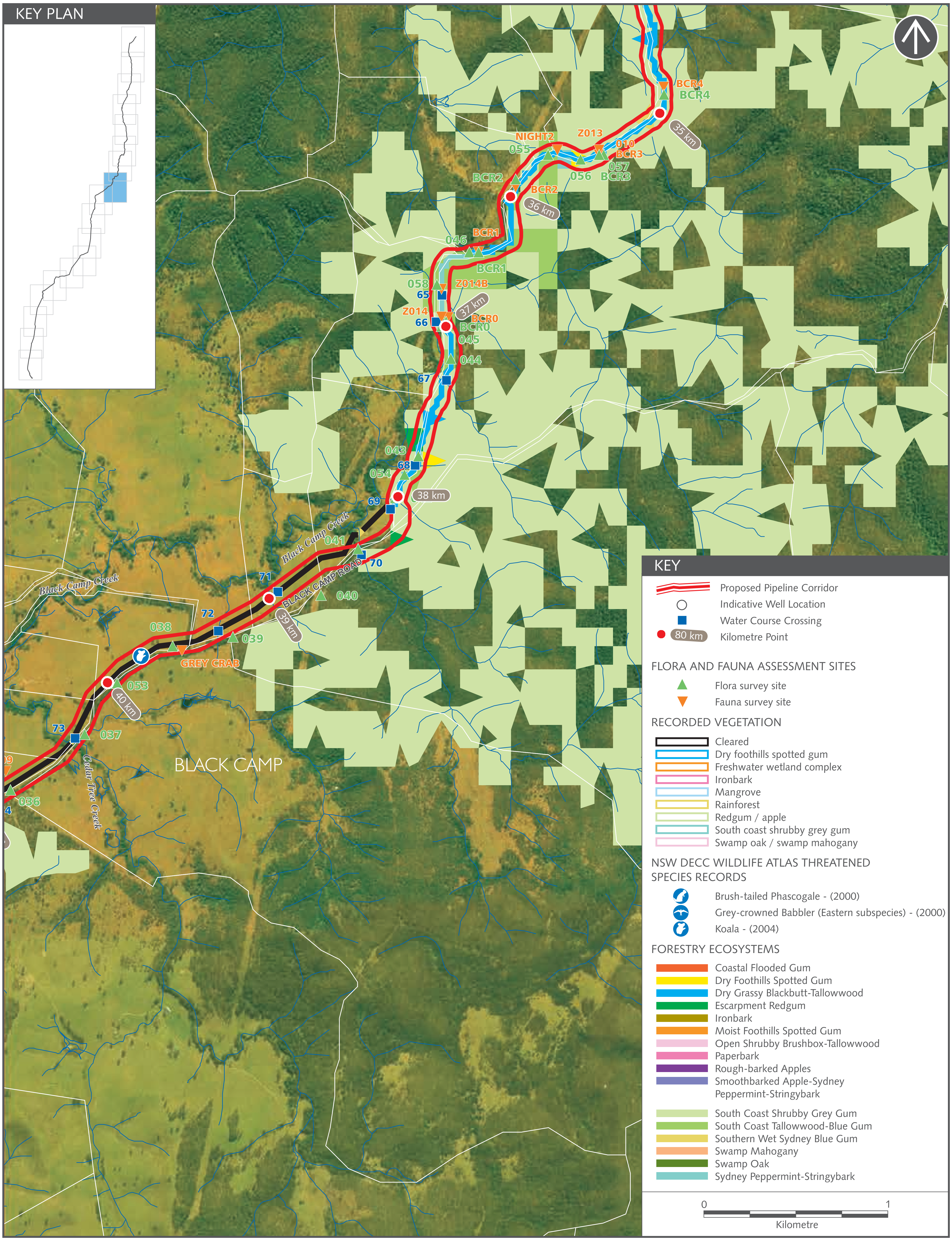

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 35-40KM - SHEET 8 OF 18

Figure 9

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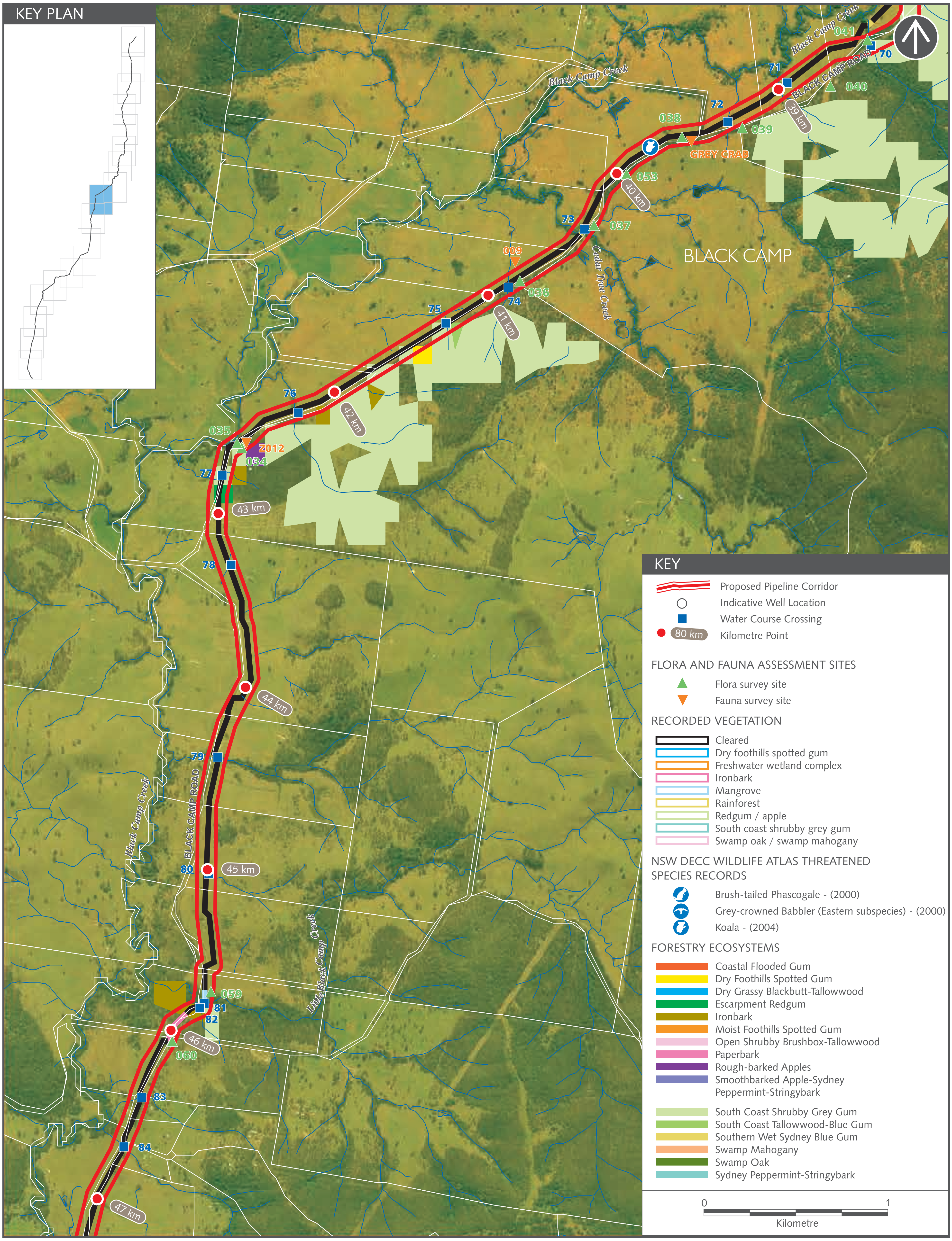

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 40-45KM - SHEET 9 OF 18

Figure 10

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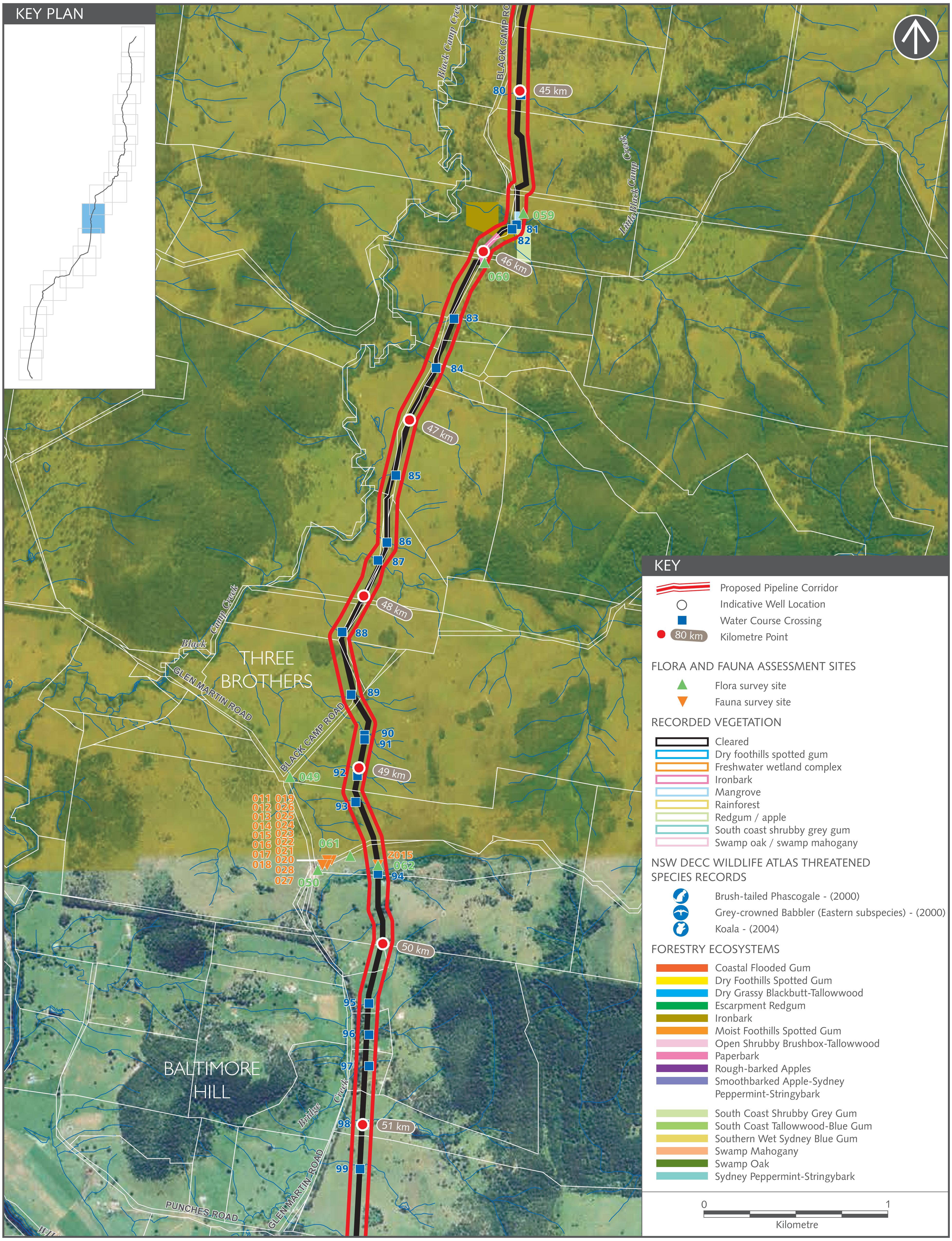

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 45-50KM - SHEET 10 OF 18

Figure 11

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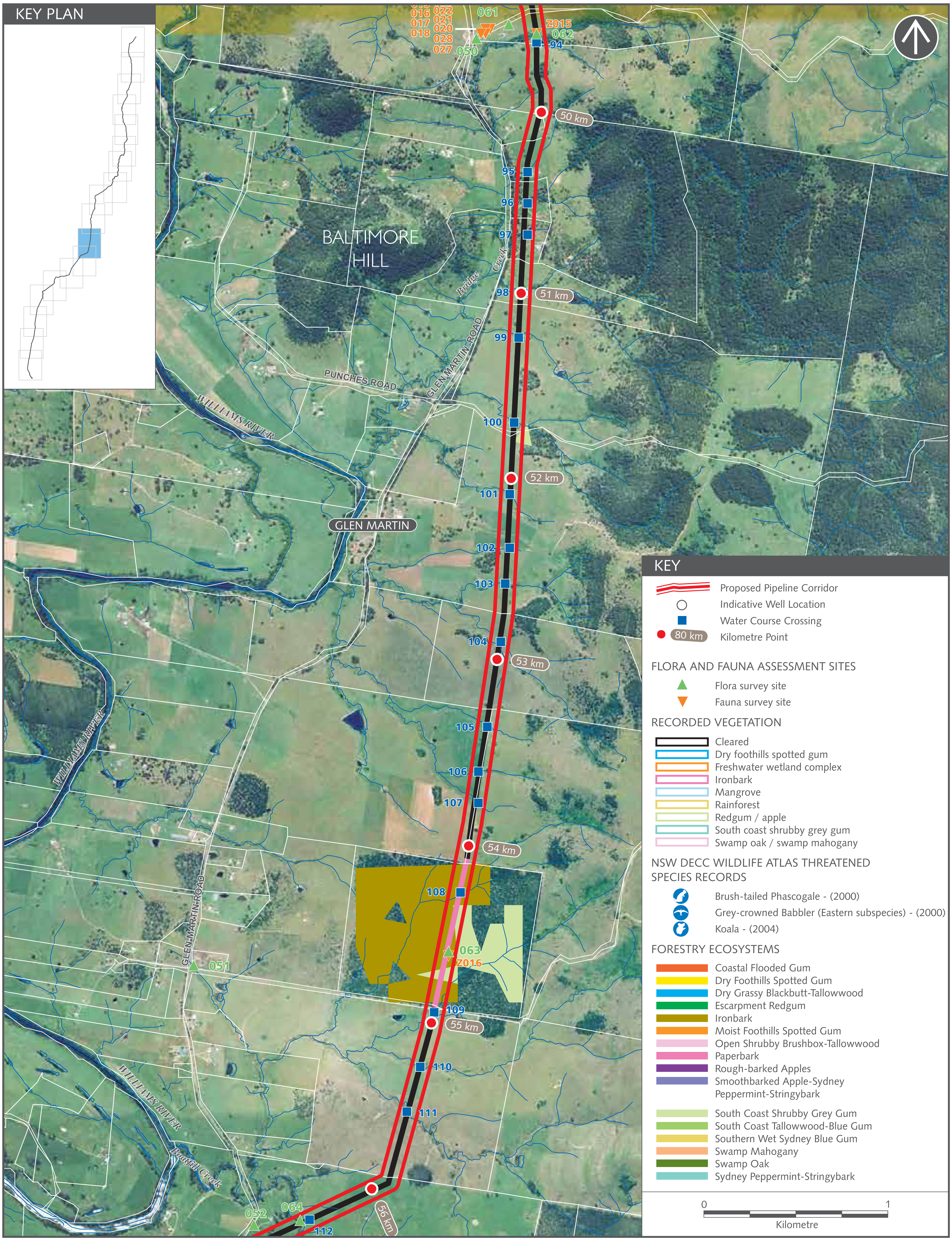

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 50-55KM - SHEET 11 OF 18

Figure 12

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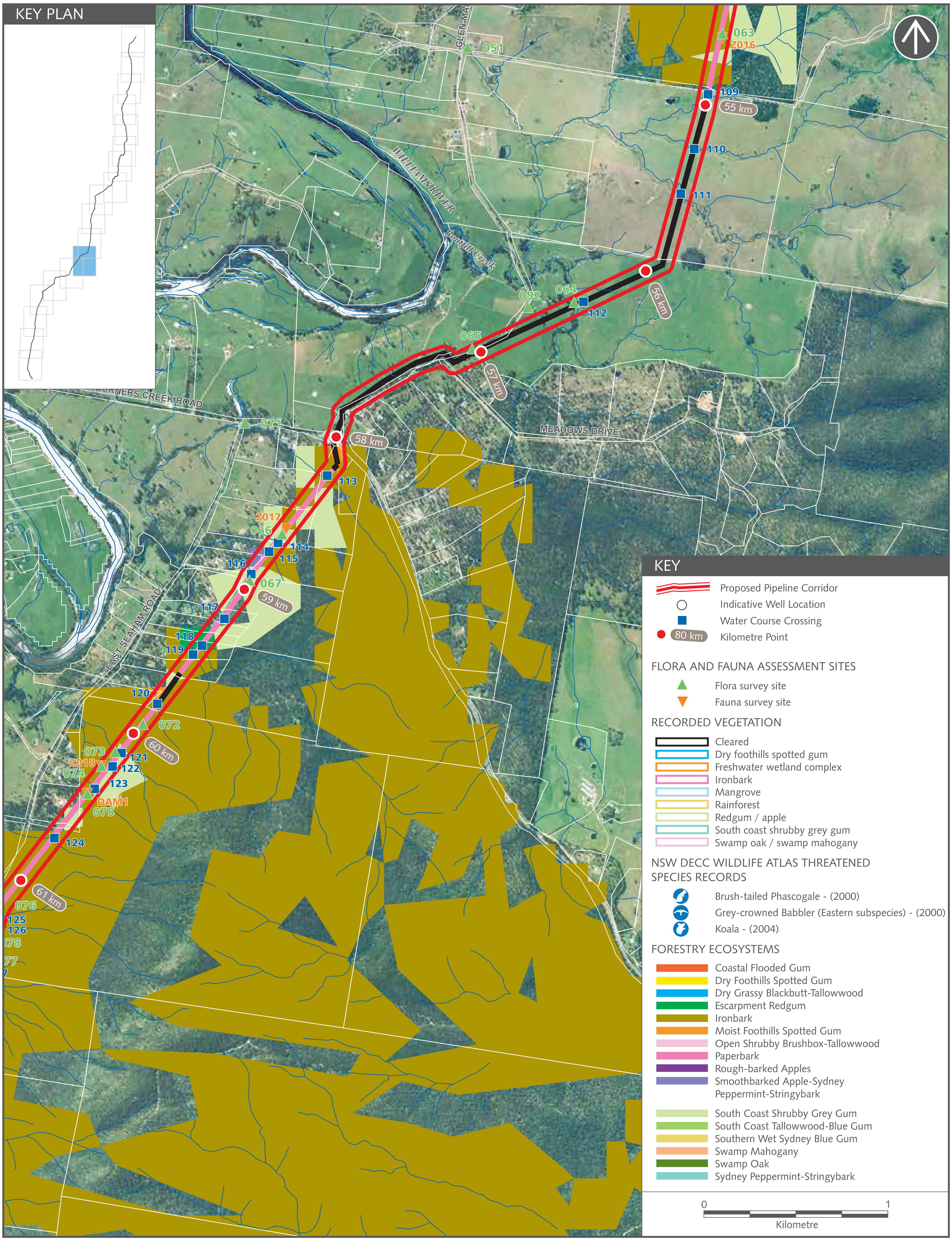

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS KILOMETRE POINT 55-60KM - SHEET 12 OF 18

Figure 13

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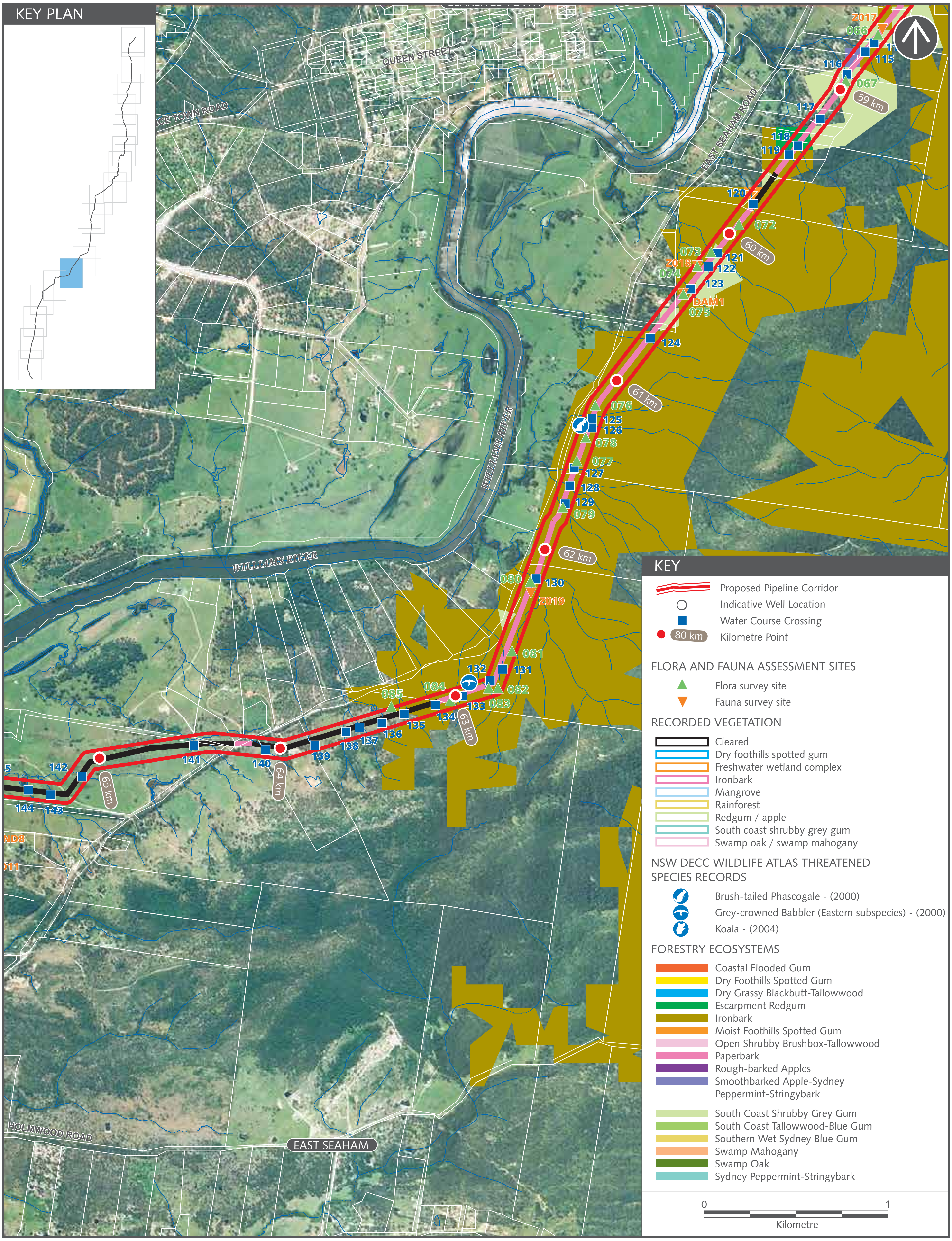

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 60-65KM - SHEET 13 OF 18

Figure 14

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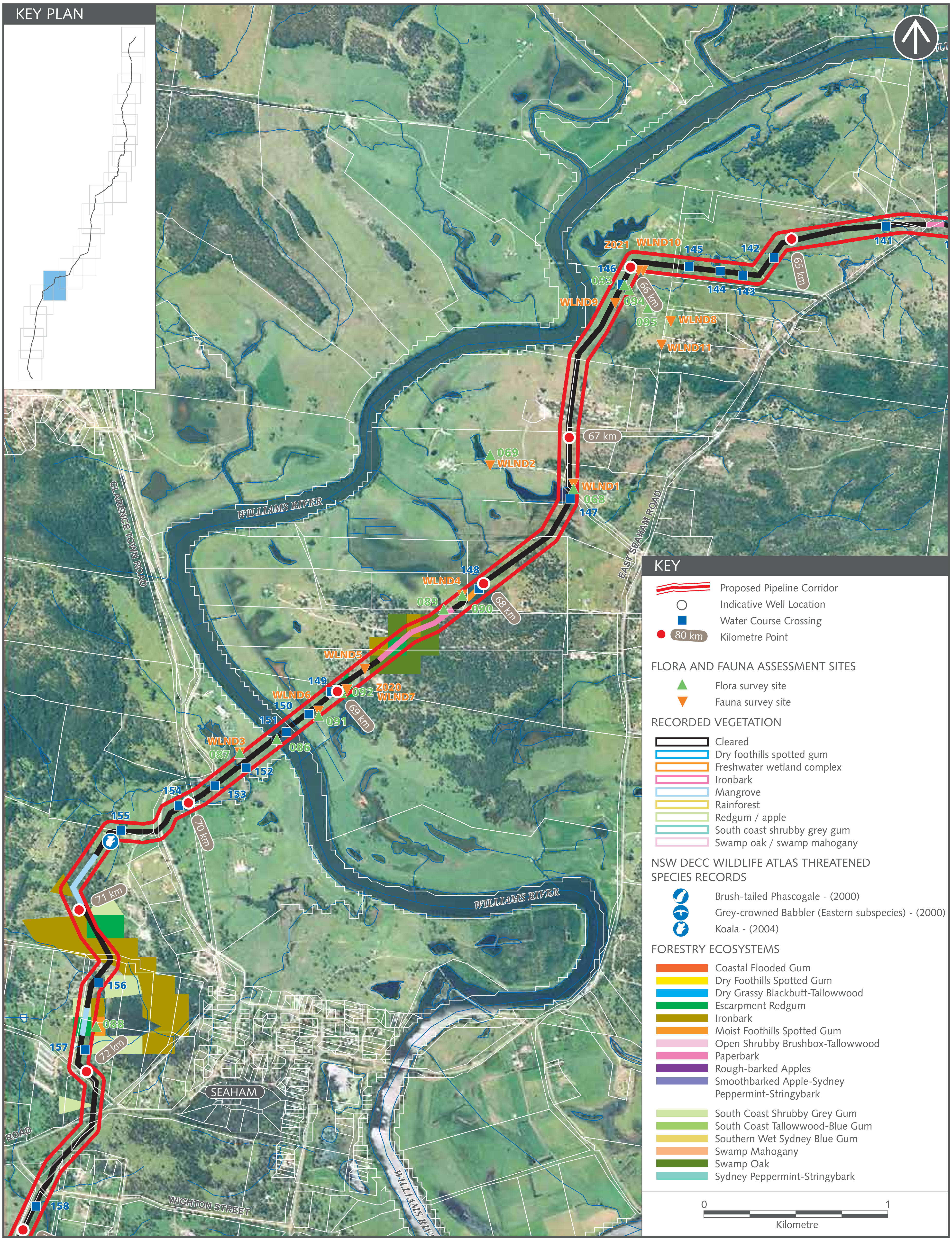

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 65-70KM - SHEET 14 OF 18

Figure 15

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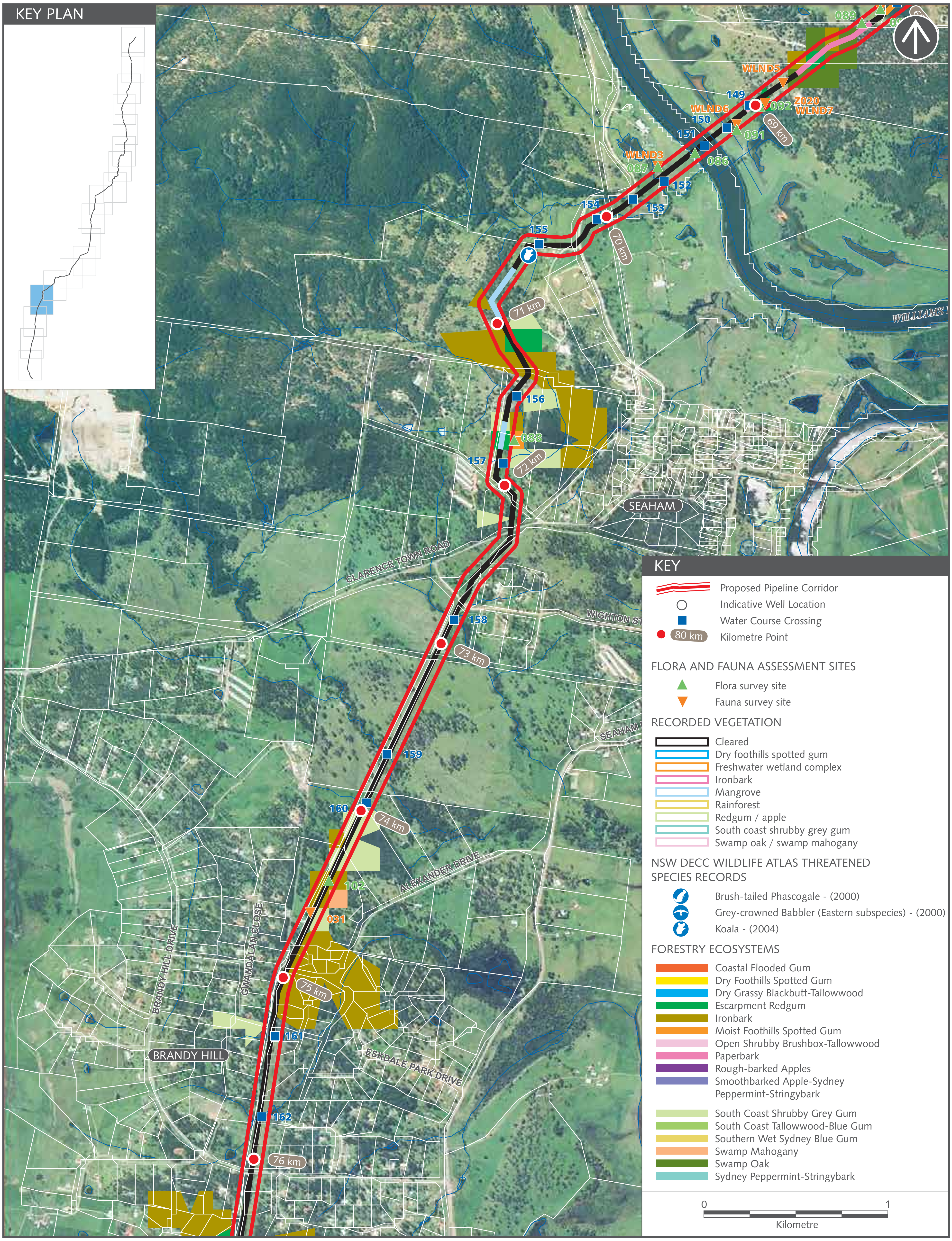

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 70-75KM - SHEET 15 OF 18

Figure 16

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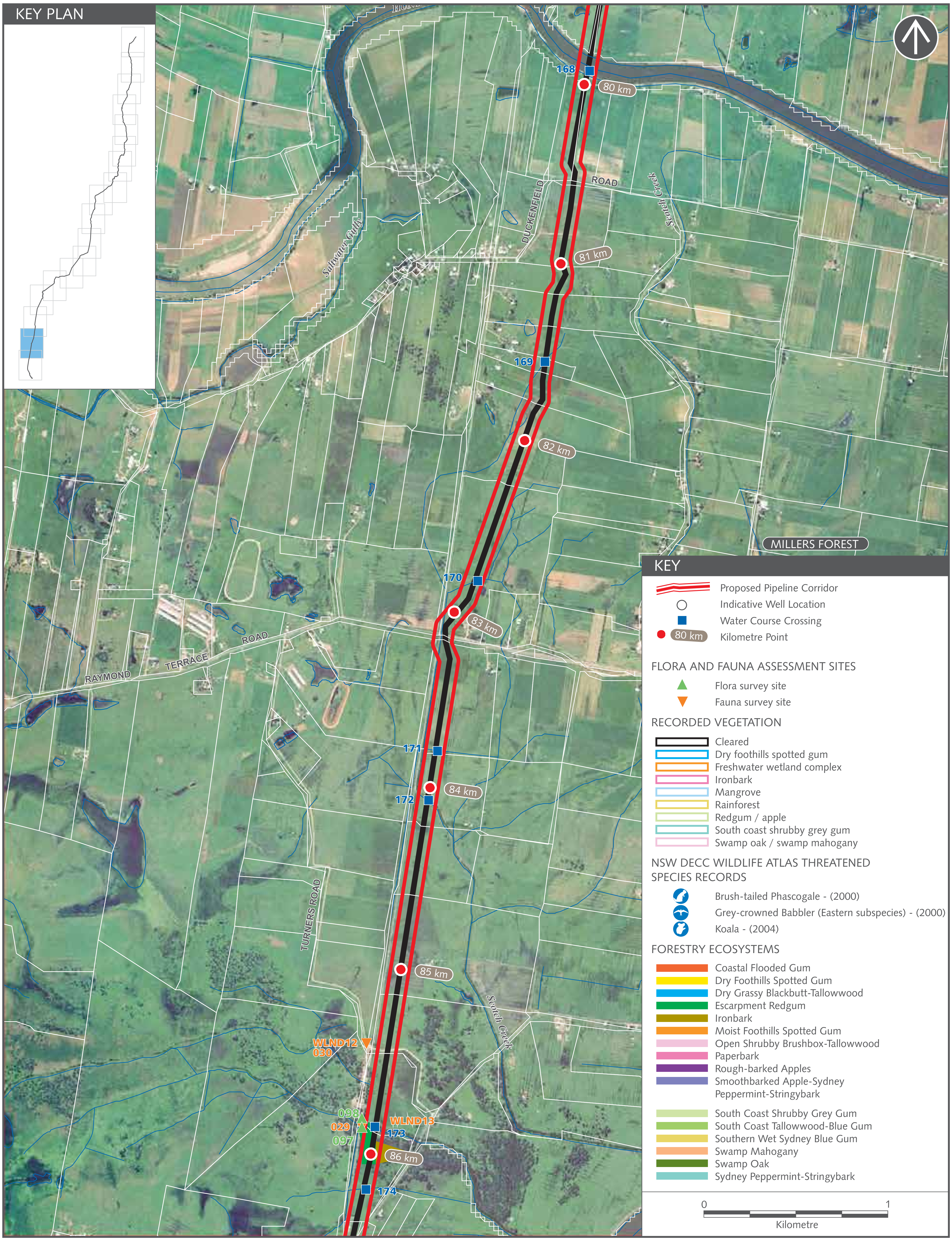

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 80-85KM - SHEET 17 OF 18

Figure 18

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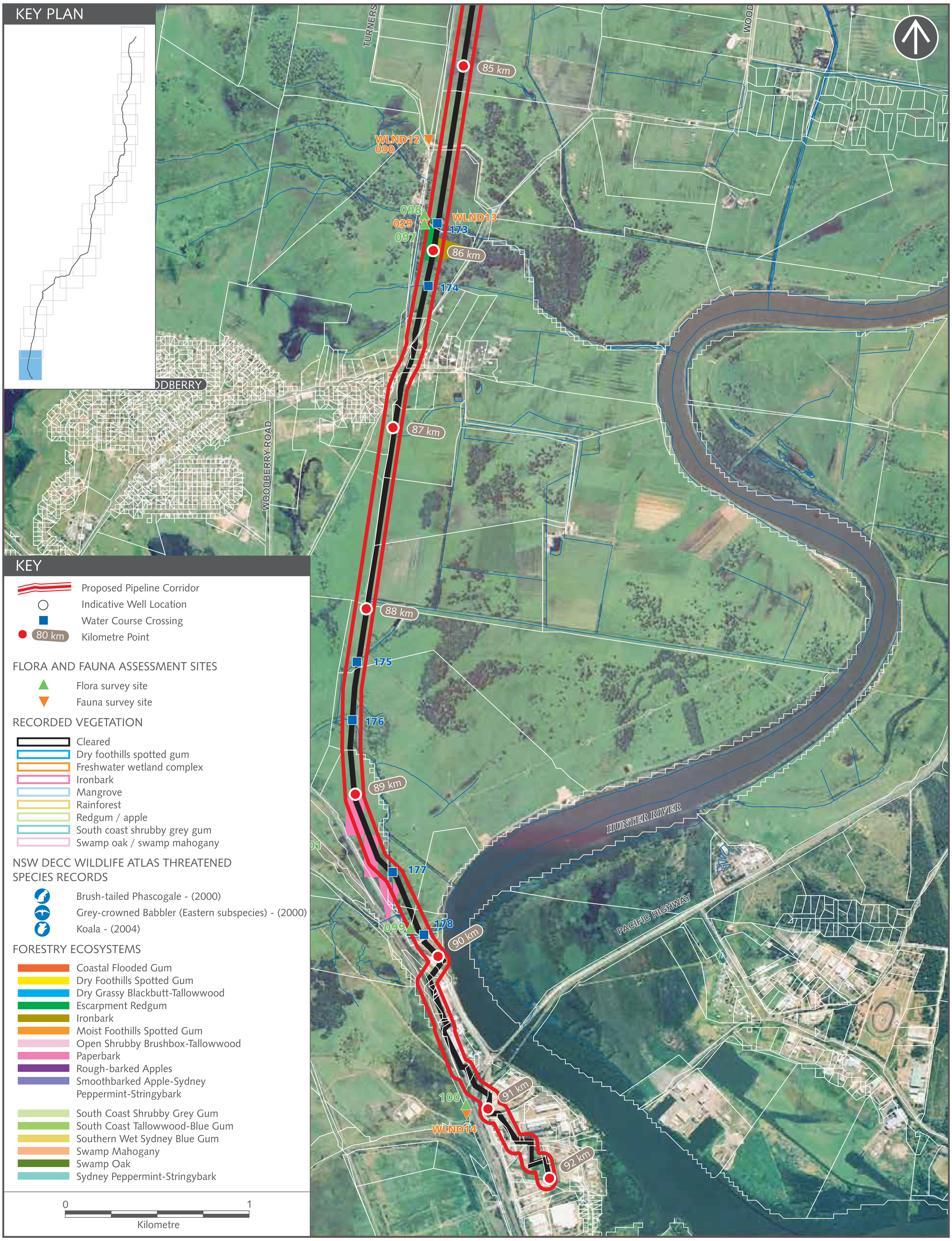

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FLORA AND FAUNA SURVEY ASSESSMENT SITES, RECORDED VEGETATION ALONG PIPELINE ROUTE, NSW DECC WILDLIFE ATLAS THREATENED SPECIES RECORDS, FORESTRY ECOSYSTEMS AND WATER COURSE CROSSINGS
KILOMETRE POINT 85-90KM - SHEET 18 OF 18

Figure 19

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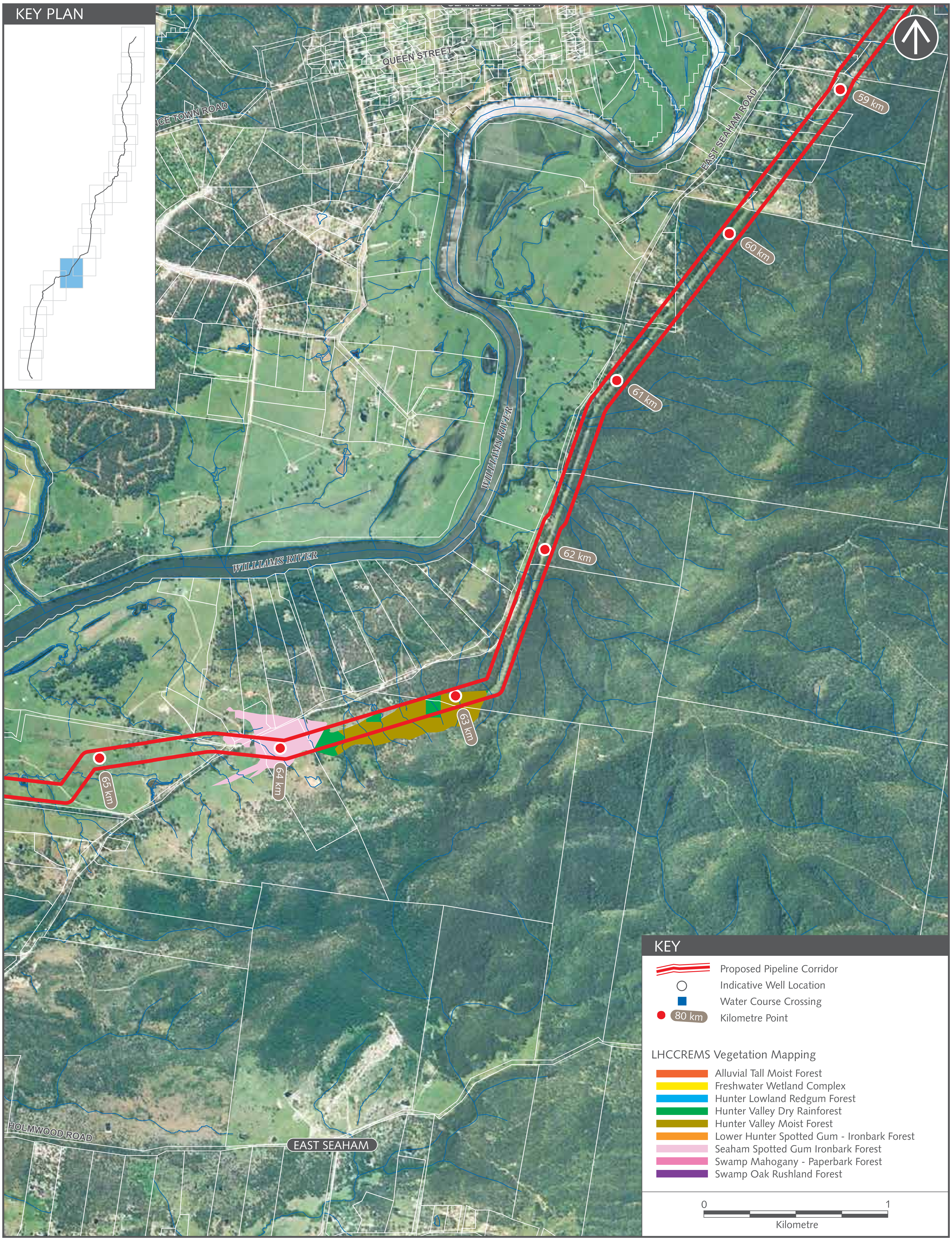

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EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 60-65KM - SHEET 1 OF 6

Figure 20

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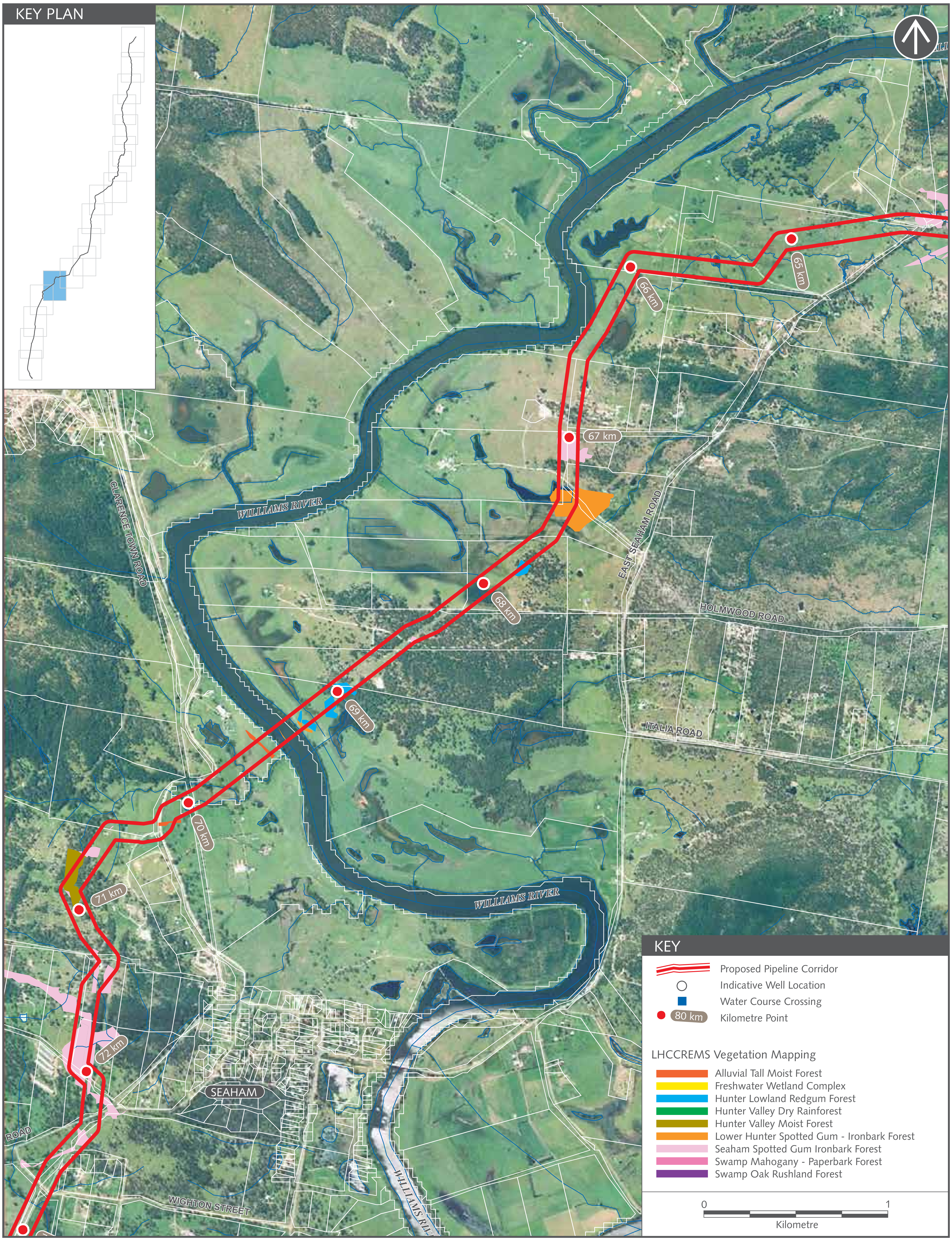

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EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 65-70KM - SHEET 2 OF 6

Figure 21

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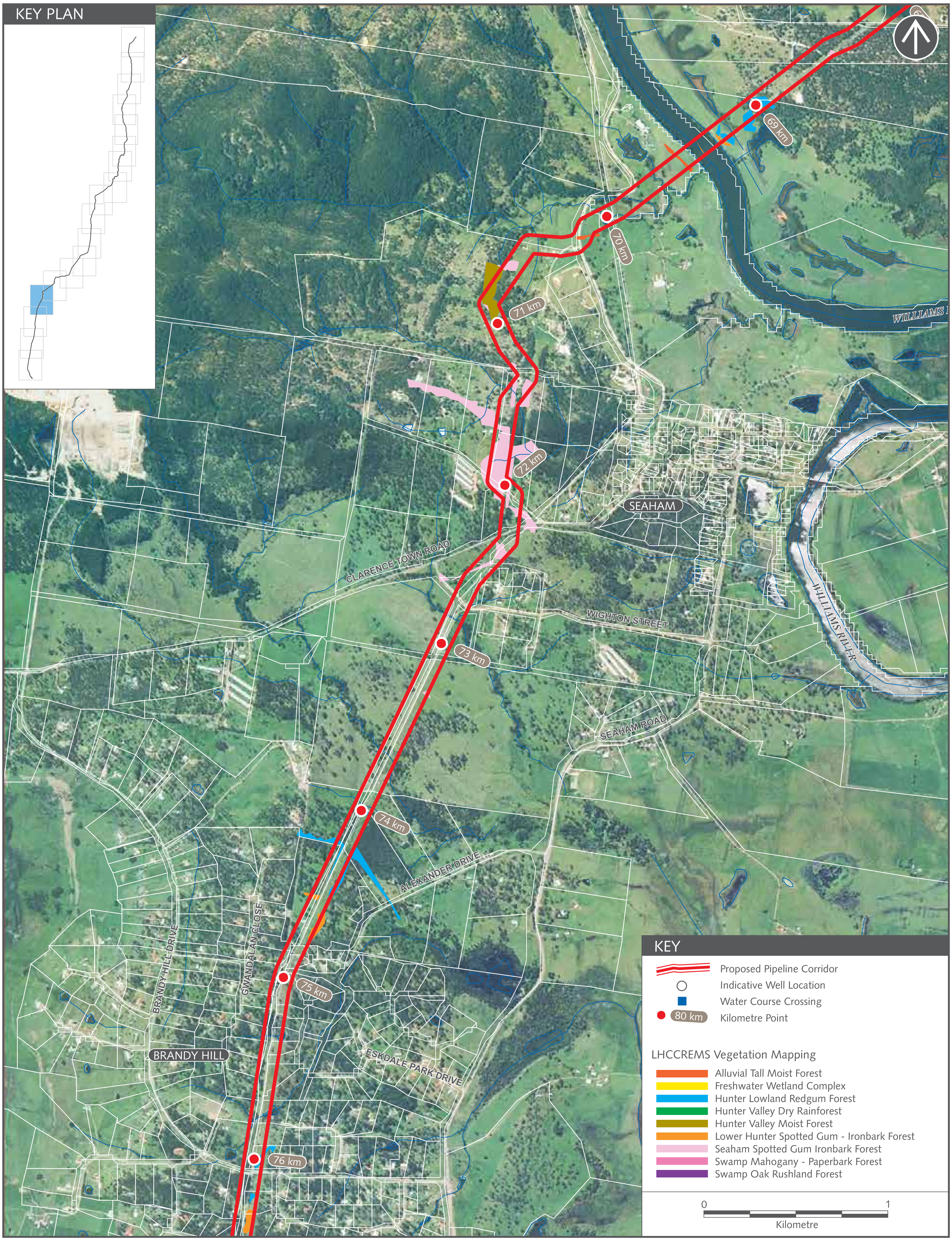

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EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 70 - 75KM - SHEET 3 OF 6

Figure 22

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EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 75-80KM - SHEET 4 OF 6

Figure 23

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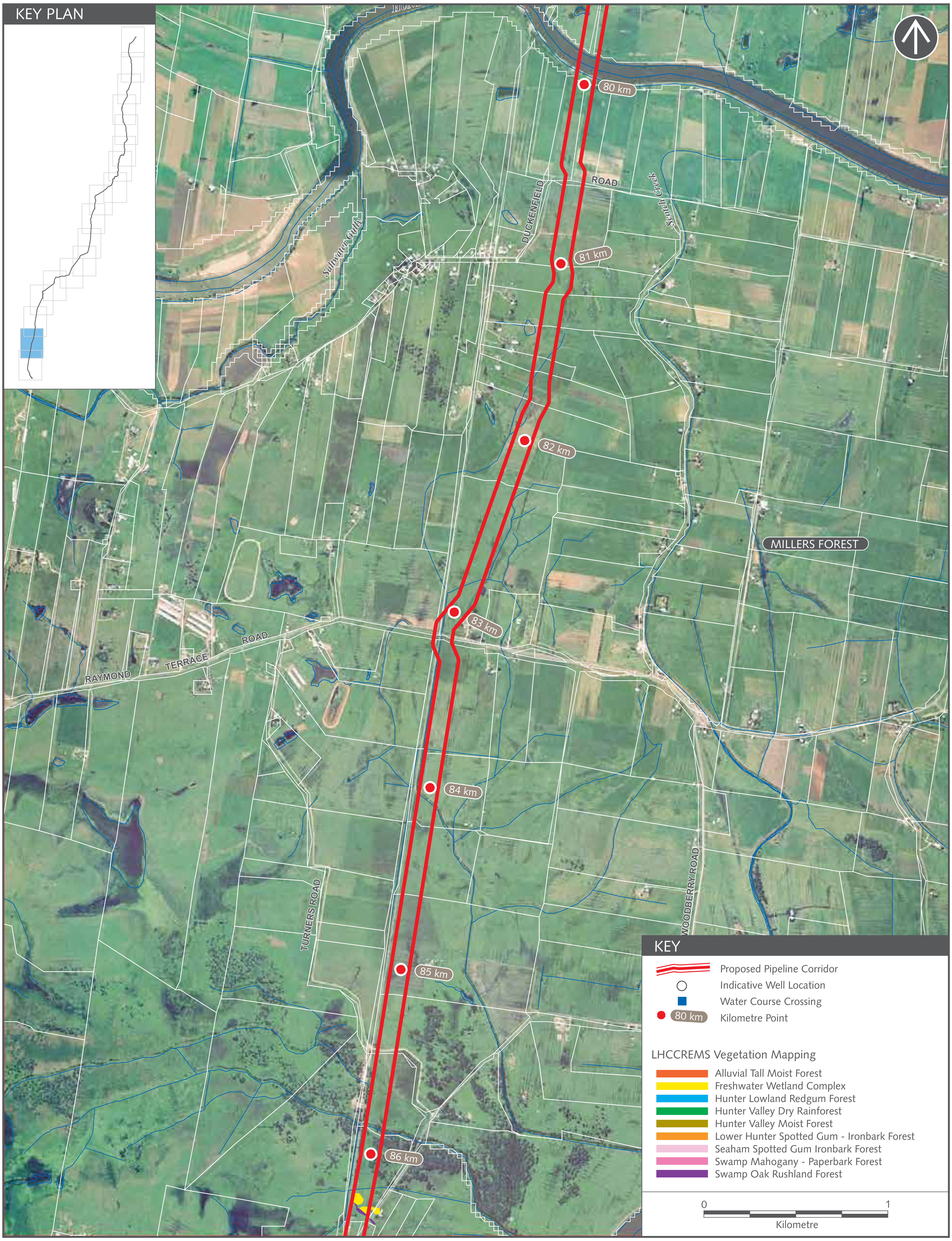

ENSR | AECOM

EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 80-85KM - SHEET 5 OF 6

Figure 24

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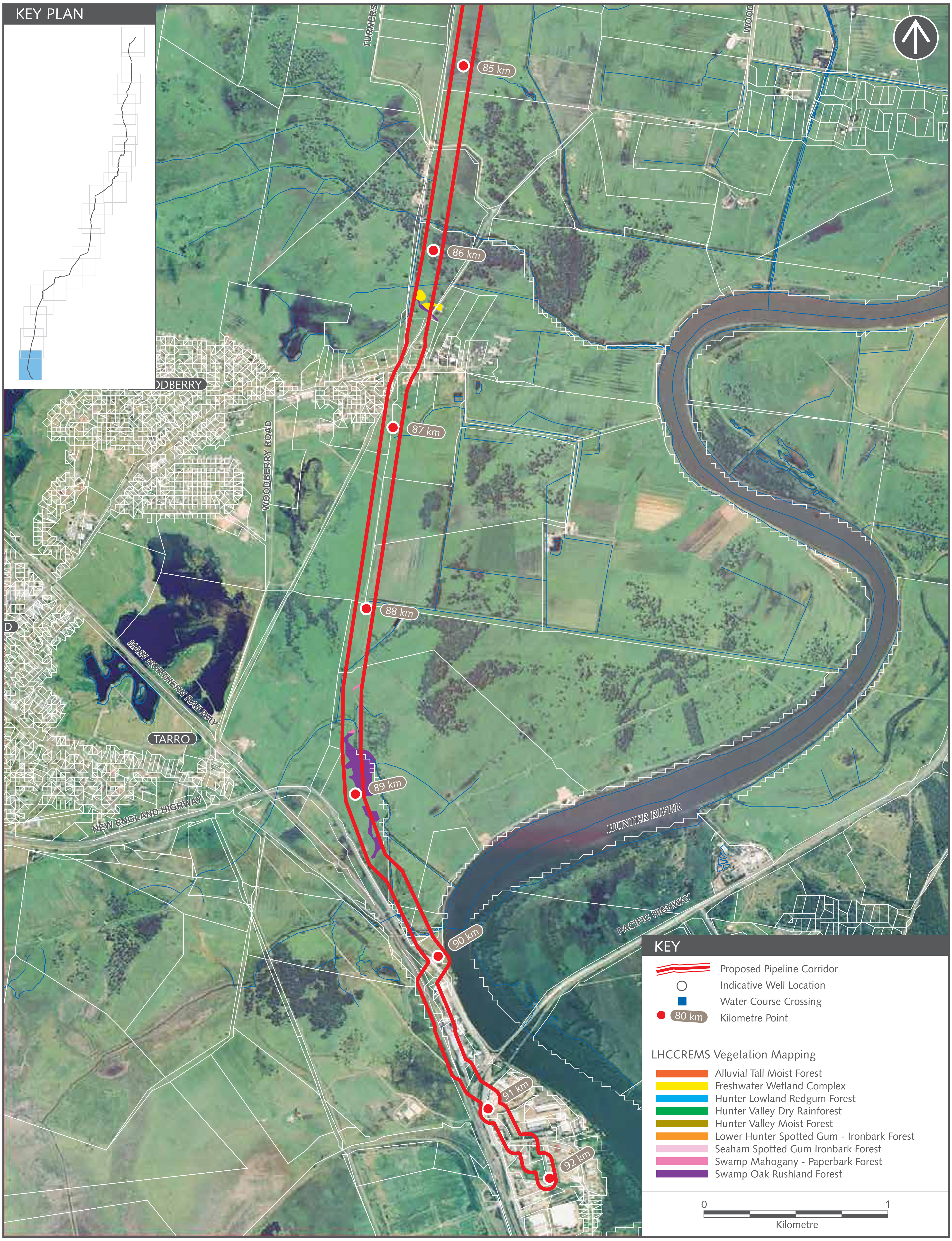

ENSR | AECOM

EXTANT VEGETATION OF THE LOWER HUNTER & CENTRAL COAST
KILOMETRE POINT 85-92KM - SHEET 6 OF 6

Figure 25

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Appendix A

Vegetation Assessment Data Sheets

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Vegetation Monitoring Data Sheet Job Number: S60665

Site Number: FL01 Assessor: JB + CL Date: 29 / 06 /2008

Location: Large Remnant – Gas Fields

GPS Projection: Lat-Long; UTM Datum: GDA94; WGS84; AGD84 Zone: 56

Latitude / Easting: 403 614 Longitude / Northing: 6449196 Waypoint #: 001

Photo: 2632 / 2633

Soil Colour	Soil Secondary Texture	Soil Primary Texture	Other Soil Notes
Whitish	Clayey	Clay	
Pale	Silty	Silt	
Yellow	Sandy	Loam	
Orange	Gravely	Sand	
Brown	Stony	Gravel	
Red			
Dark		Saline Mud	
Black			
Mottled			

Altitude: 145 m Slope: Gentle Aspect: N; NE; E; SE; S; SW; W; NW

Landform:

Table 24 CORVEG landform situation codes

Landform situation	Code	Landform situation	Code
PLAIN		HILLS, MOUNTAINS, TABLELANDS	
Not otherwise specified, flat gentle slopes, undulating terrain	A	Slope of hill not specified	[illegible]
Downs, open downs, rolling downs, ashy downs, pebbly downs	[illegible]	Cliff (steep rocky faces), rocky ledge, rocky outcrop, scarp, crack in rock, crevices	[illegible]
Alluvial plain or flat, a levee, flood plain	[illegible]	Coastal rocky headland	N
Inland clay pan, salt flat or pan (inland)	U	Top, crest of mountain or ridge	R
Tidal flat, salt flat (coastal)	V	Jump-up, mesa, tableland, plateau	O
STREAMS		DUNE	
Lakes, banks of lake, river, stream, water course, levee + permanent water	C	Fore coastal dune, high dune	[illegible]
Gully, drainage line, ravine gorge, [illegible] + intermittently wet	D	Unspecified coastal dune, beach dune, [illegible] coastal dune, low dune, coastal swales	H
Bed of channel—distributaries of inland streams, beds + intermittently flooded	F	Inland dune, inland sandhill	I
		WATER	
		Freshwater lake, lagoon, spring, stream	X
		Freshwater swamp, marsh, soak, seepage area	W
		Other: melon hole, sinkhole	Z
		Saltwater, sea, saltwater swamp	Y

Table 26 CORVEG types of erosional landform patterns by slope and relief class codes

Slope class							
Class	LE Level	VG Very gently inclined	GE Gently inclined	MO Moderately inclined	ST Steep	VS Very steep	PR Precipitous
Percentage	<1	1–3	3–10	10–32	32–56	56–100	100
Degrees (rounded to nearest whole number)	0	1–2	3–6	7–18	19–29	30–45	>45
Relief class		Erosional landform pattern					
M Very high >300 m (about 500 m)	–	–		RM Rolling mountains	SM Steep mountains	VM Very steep mountains	PM Precipitous
H High 90–300 m (about 150 m)	–	–	UH Undulating hills	RH Rolling hills	SH Steep hills	VH Very steep hills	PH Precipitous hills
L Low 30–90 m (about 50 m)			UL Undulating low hills	RL Rolling low hills	SL Steep low hills	VL Very steep low hills	B Badlands
R Very low 9–30 m (about 15 m)		GR Gently undulating rises	UR Undulating rises	RR Rolling rises	SR Steep rises	B Badlands	B Badlands
P Extremely low <9 m	LP Level plain	GP Gently undulating plain	UP Undulating plain	RP Rolling plain	B Badlands	B Badlands	B Badlands

Disturbance

Fire scars: Slight 2-3m hight %10

Feral animal: – %

Weeds: Thistle (minor) <%5

Other: Logging <%5

Health: Pristine / Excellent / Very Good / Good / Average / Degraded / Completely Degraded (almost without natives)

Special significance

Cultural: –

Recreational: –

Conservation: Last large remnant in area

Commercial: –

Other Notes: minimise impacts – fairly large intact remnant patch

Width of community: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Width of total remnant: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear (mapping)
Total community area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha
Total remnant area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha

50m X 10m Plot Information   Canopy Stratum Form: Tree Shrub; Herb; Grass; Aquatic

Stratum	Median Height (m)	Visual Cover Est (%)	Other Structural Notes
Emergent			<5% Bare ground
Canopy	15m	50%	
Mid	1.5m	30%	
Ground	0.5m	50%	

All woody species present within 50m x 10m plot (plus dominant and threatened non-woody species)

Species	Rel. Dom.	Form	E	Ht (m) T1	T2	T3	S1	S2	G
E. propinqua	A	Tree		15m					
E. umbra	A	Tree			12m				
E. siderophloia	O	Tree			12m				
Exocarpus cupressiformis	O	Tree				5m			
Ozothamnus diosmifolius (s)	D	Shrub					1.5m		
Acacia ulicifolia	F	Shrub					1m		
Pultenaea villosa (s) (Photo 2634-6)	F	Shrub					1m		
Entolasia stricta (s)	A								0.5
Pratia purpurascens (s)	F								0.1
Hardenbergia violacea	O								0.2
* Senecio madagascariensis (s)	R								0.3
* (Thistle) Cirsium vulgare	R								0.3
+ E. microcorys	R								
+ Bursaria spinosa	R								
+ Acacia falcata	R								

(*) KEITH - NSW 21 - NORTHERN HINTERLAND SEMI MESIC FOREST
(1) CRA - FE 134 - SOUTH COAST SHRUBBY GREY GUM

Species annotations: S = Specimen Collected; * = Exotic Species; ** = Declared Species; + = Outside but adjoining 50m x 10m plot
Height categories: E = Emergent; T1 = Tree 1 stratum, T2 = Tree 2, T3 = Tree 3, S1 = Shrub 1 stratum, S2 = Shrub 2, G = Ground stratum
Form: V = Vine, E = Epiphyte; A = Aquatic; Seed = Seedling; Sap = Sapling;
Ab = Abundance within Stratum (D = dominant; A = Abundant; F = Frequent; O = Occasional, R = Rare)

Vegetation Monitoring Data Sheet

Job Number: S60665

Site Number: FL02 Assessor: JB + CL Date: 29/08/2008

Location: Large remnant – Gas Fields

GPS Projection: Lat-Long; UTM Datum: GDA94; WGS84; AGD84 Zone: 56

Latitude / Easting: .... Longitude / Northing: .... Waypoint #: 002

Photo: 2637 / 2638

Soil Colour	Soil Secondary Texture	Soil Primary Texture	Other Soil Notes
Whitish	Clayey	Clay	
Pale	~~Silty~~	Silt	
Yellow	Sandy	Loam	
Orange	Gravely	~~Sand~~	
Brown	Stony	Gravel	
Red			
Dark		Saline Mud	
Black			
Mottled			

Altitude: 133 m Slope: .... Aspect: N; NE; E; SE; S; SW; W; NW

Landform: Undulating Plain

Table 25 CORVEG landform situation codes

Landform situation	Code	Landform situation	Code
PLAIN		HILLS, MOUNTAINS, TABLELANDS	
Not otherwise specified, flat gentle slopes, undulating terrain	A	Slope or hill not specified	I
Downs, open downs, rolling downs, stony downs, pebbly downs		Cliff (steep rocky face), rocky ledge, rocky outcrop, scarp, crack in rock, crevices	L
Alluvial plain or flat, alluvium, flood plain	Q	Coastal rocky headland	N
Inland clay pan, salt flat or pan (inland)	U	Top, crest of mountain or ridge	K
Tidal flat, salt flat (coastal)	V	Jump up, mesa, tableland, plateau	O
STREAMS		OTHER	
Lakes, banks of lake, river, stream, water course, levees + permanent water	C	Foredune coastal dune, high dune	S
Gully, drainage line, ravine gorge, outwash + intermittently wet	D	Unspecified coastal dune, beach dune, inland (coastal) dune, low dune, coastal sandhill	R
Bed of channel — distributaries of inland streams, beds + intermittently flooded	I	Inland dune, inland sandhill	T
		WATER	
		Freshwater lake, lagoon, spring, stream	X
		Freshwater swamp, marsh, soak, brackish edge	W
		Gilgai, melon hole, sinkhole	Z
		Saltwater, sea, saltwater swamp	Y

Table 26 CORVEG types of erosional landform patterns by slope and relief class codes

Slope class							
Class	LE Level	VG Very gently inclined	GE Gently inclined	MO Moderately inclined	ST Steep	VS Very steep	PR Precipitous
Percentage	<1	1–3	3–10	10–32	32–56	56–100	>100
Degrees (rounded to nearest whole number)	0	1–2	2–6	7–18	19–29	30–45	>45
Relief class	Erosional landform pattern						
M Very high >300 m (about 500 m)	–	–		RM Rolling mountains	SM Steep mountains	VM Very steep mountains	PM Precipitous mountains
H High 90–300 m (about 150 m)	–	–	UH Undulating hills	RH Rolling hills	SH Steep hills	VH Very steep hills	PH Precipitous hills
L Low 30–90 m (about 50 m)			UL Undulating low hills	RL Rolling low hills	SL Steep low hills	VL Very steep low hills	B Badlands
R Very low 9–30 m (about 15 m)	–	GR Gently undulating rises	UR Undulating rises	RR Rolling rises	SR Steep rises	B Badlands	B Badlands
P Extremely low <9 m	LP Level plain	GP Gently undulating plain	UP Undulating plain	RP Rolling plain	B Badlands	B Badlands	B Badlands

Disturbance

Fire scars: slight / old – 3m scar <%5

Feral animal: Hare / Canid %

Weeds: <%5

Other: Track / excavator diggings 5m × 5m nearby / logging nearby %

Health: Pristine / Excellent / Very Good / Good / Average / Degraded / Completely Degraded (almost without natives)

Special significance

Cultural: –

Recreational:

Conservation: Last large remnant in area

Commercial: –

Other Notes: Minimise impacts – fairly large intact remnant veg. patch

Width of community: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Width of total remnant: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Total community area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha
Total remnant area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha

50m X 10m Plot Information

Canopy Stratum Form: Tree; Shrub; Herb; Grass; Aquatic

Stratum	Median Height (m)	Visual Cover Est (%)	Other Structural Notes
Emergent			* Bare ground <5%
Canopy	16m	30%	
Mid	1.5m	10%.	
Ground	0.5m	50%	

All woody species present within 50m x 10m plot (plus dominant and threatened non-woody species)

	Species	Rel. Dom.	Form	E	Ht (m) T1	T2	T3	S1	S2	G
	E moluccana	D	Tree		16m					
	E siderophloia	O	Tree		16m					
	E. umbra	O	Tree		16m					
	Eyocarpus cupressaformis	F	Tree		6m					
	Acacia ulifolia	F	Shrub					1.5m		
	Ozothamnus diosmifolius	F	Shrub					1.5m		
	Hardenbergia violacea	O	Vine							0.20
	Bursaria spinosa	F	Shrub					1m		
	Pratia purpurascens	O	Herb							0.10
*	Centaury spp. (S)	O	Herb							0.2
	Lomandra longifolia	O	Herb							0.5
	Hibbertia aspera	F	Herb							0.5
	Themeda triandra	A	grass							0.3
	Poa sieberiana var sieberiana (S)	F	grass							0.3
	Imperata cylindrica (blady grass)	F	grass							0.6
	Jacksonia scoparia	R	Tree		5m					
*	Senecio madagascariensis	O	Herb							0.2
*	Hypochaeris radicata	O	Herb							0.1
	+ Clematis aristata		V							
	+ Alectryon tomentosum	R	Tree		5m					
	+ Notelaea venosa (S)									
	(*) KCTH - NSWAl - Northern Hinterland Semi-Mesic Forest									
	(*) CRA - ?									

Species annotations: S = Specimen Collected; * = Exotic Species; ** = Declared Species; + = Outside but adjoining 50m x 10m plot
Height categories: E = Emergent; T1 = Tree 1 stratum, T2 = Tree 2, T3 = Tree 3, S1 = Shrub 1 stratum, S2 = Shrub 2, G = Ground stratum
Form; V = Vine; E = Epiphyte; A = Aquatic; Seed = Seedling; Sap = Sapling;
Ab = Abundance within Stratum (D = dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare)

Vegetation Monitoring Data Sheet

Job Number: S60665

Site Number: FL03 Assessor: JB + CL Date: 29 / 08 /2008

Location: Avon River & Dog Track Creek (Coal Fields)

GPS Projection: Lat-Long / UTM Datum: GDA94; WGS84; AGD84 Zone: 56

Latitude / Easting: 0401948 Longitude / Northing: 6449276 Waypoint #: 003

Photo: 2639 / 2640

Soil Colour	Soil Secondary Texture	Soil Primary Texture	Other Soil Notes
Whitish	Clayey	Clay	
Pale	Silty	Silt	
Yellow	Sandy	Loam	
Orange	Gravely	Sand	
Brown	Stony	Gravel	
Red			
Dark		Saline Mud	
Black			
Mottled			

Altitude: 116 m Slope: .... Aspect: N; NE; E; SE; S; SW; W; NW

Landform: Creek bank moderate slope (4-5m to water)

Table 24 CORVEG landform situation codes

Landform situation	Code	Landform situation	Code
PLAIN		HILLS, MOUNTAINS, TABLELANDS	
Not otherwise specified, flat gentle slopes, undulating terrain	A	Slope of hill and open [illegible]	[illegible]
Downs, open downs, rolling downs, [illegible] downs	[illegible]	Cliff (steep rocky faces), rocky ledge, rocky outcrop, scarp, crack in rock, crevice	[illegible]
Alluvial plain or flat, outwash, flood plain	B	Coastal rocky headland	N
Inland clay pan, salt pan or pan (claypan)	D	Top, crest of mountain or ridge	K
Tidal flat, salt flat (coastal)	Y	Jump-up, mesa, tableland, plateau	Q
STREAMS		DUNE	
Creek, banks of lake, river, stream, water course, levees + permanent water	C	Frontal coastal dune, high dune	X
Gully, drainage line, ravine, gorge, [illegible] + intermittently wet	G	Unexposed coastal dune, beach dune, second coastal dune, low dune, coastal sandhill	R
Bed of channels – distributaries of inland streams, beds – intermittently flooding	F	Inland dune, inland sandhill	T
		WATER	
		Freshwater lake, lagoon, spring, stream	S
		Freshwater swamp, marsh, soak, [illegible] area	W
		Gilgai, melon hole, sinkhole	Z
		Saltwater, sea, saltwater swamp	Y

Table 25 CORVEG types of erosional landform patterns by slope and relief class codes

Slope class							
Class	LE Level	VG Very gently inclined	GE Gently inclined	MO Moderately inclined	ST Steep	VS Very steep	PR Precipitous
Percentage	<1	1–3	3–10	10–32	32–56	56–100	100
Degrees (rounded to nearest whole number)	0	1–2	3–6	7–18	19–29	30–45	>45
Relief class	Physical landform pattern						
M Very high >300 m (about 500 m)	–			RM Rolling mountains	SM Steep mountains	VM Very steep mountains	PM Precipitous
H High 90–300 m (about 150 m)	–	–	UH Undulating hills	RH Rolling hills	SH Steep hills	VH Very steep hills	PH Precipitous hills
L Low 30–90 m (about 50 m)	–	–	UL Undulating low hills	RL Rolling low hills	SL Steep low hills	VL Very steep low hills	B Badlands
R Very low 9–30 m (about 15 m)		GR Gently undulating rises	UR Undulating rises	RR Rolling rises	SR Steep rises	B Badlands	B Badlands
P Extremely low <9 m	LP Level plain	GP Gently undulating plain	UP Undulating plain	RP Rolling plain	B Badlands	B Badlands	B Badlands

Disturbance

Fire scars: – %

Feral animal: – %

Weeds: ✓ %5

Other: Grazing cows. %

Health: Pristine / Excellent / Very Good / Good / Average / Degraded / Completely Degraded (almost without natives)

Special significance

Cultural: –

Recreational: –

Conservation: Habitat corridor / veg only extends 5-10m from channel

Commercial: –

Other Notes: –

Width of community: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Width of total remnant: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Total community area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha
Total remnant area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha

50m X 10m Plot Information

Canopy Stratum Form: Tree; Shrub; Herb; Grass; Aquatic

Stratum	Median Height (m)	Visual Cover Est (%)	Other Structural Notes
Emergent			some bare cut around exposed banks
Canopy	14m	70	* some erosion.
Mid	8m	50	
Ground	0.20m	60	

All woody species present within 50m x 10m plot (plus dominant and threatened non-woody species)

	Species	Rel. Dom.	Form	E	T1	T2	T3	S1	S2	G
	Angophora subvelutina	O	Tree		14					
	Acacia irrorata	O	Tree			8				
	Callistemon salignus. (S)	O	Tree			8				
	Hymenanthera dentata (S)	O	Shrub					2		
	Casuarina cunninghamiana	D	Tree		14					
*	Solanum mauritianum (tobacco)	O						2		
	Lomandra hystrix.	F	Herb							0.6
**	Ligustrum sinense (privet)	F	Shrub			6				
*	Prunus persica (Peach tree)	F	Tree					4		
	Cynodon dactylon	D	Grass							0.2
+	E. tereticornis	O								

(*) KEITH - NSW21 - NORTHERN HINTERLAND SEMI-MESIC FOREST
(*) CRA - FC 17 - REDGUM - APPLE

Species annotations: S = Specimen Collected; * = Exotic Species; ** = Declared Species; + = Outside but adjoining 50m x 10m plot
Height categories: E = Emergent; T1 = Tree 1 stratum, T2 = Tree 2, T3 = Tree 3, S1 = Shrub 1 stratum, S2 = Shrub 2, G = Ground stratum
Form; V = Vine; E = Epiphyte; A = Aquatic; Seed = Seedling; Sap = Sapling;
Ab = Abundance within Stratum (D = dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare)

Vegetation Monitoring Data Sheet

Job Number: S60665

Site Number: FL 04 Assessor: [illegible] Date: 01/09/2008

Location: buffer zone (surrounded by pasture lands) (KP4)

GPS Projection: Lat-Long; UTM Datum: GDA94; WGS84; AGD84 Zone: 56

Latitude / Easting: 399745 Longitude / Northing: 6445 489 Waypoint #: 026

Photo: 2699 / 2700

Soil Colour	Soil Secondary Texture	Soil Primary Texture	Other Soil Notes
Whitish	Clayey	Clay	–
Pale	Silty	Silt	
Yellow	Sandy	Loam	
Orange	Gravelly	Sand	
Brown	Stony	Gravel	
Red			
Dark		Saline Mud	
Black			
Mottled			

Altitude: 121 m Slope: Aspect: N; NE; E; SE; S; SW; W; NW

Landform: Very gently inclined

Table 24 CORVEG landform situation codes

Landform situation	Code	Landform situation	Code
PLAIN		HILLS, MOUNTAINS, TABLELANDS	
Not otherwise specified, flat gentle slopes, undulating terrain; Downs, open downs, rolling downs, stony downs, pebbly downs	A	Slope of hill not specified	P
		Cliff (steep rocky faces), rocky ledge, rocky outcrop, scarp, crack in rock, crevices	L
Alluvial plain or flat, alluvium, flood plain	B	Coastal rocky headland	N
Inland clay pan, salt flat or pan (inland)	U	Top, crest of mountain or ridge	K
Tidal flat, salt flat (coastal)	V	Mesa, butte, tableland, plateau	Q
STREAMS		DUNE	
Lakes, banks of lake, river, stream, water course, levees – permanent water	C	Fixed coastal dune, high dune	S
Gully, drainage line, ravine gorge, watershed – intermittently wet	D	Unstabilised coastal dune, beach dune, recent coastal dune, fore dune, coastal sandhill	R
Bed of channel, distributaries of inland streams, beds – intermittency needed	F	Inland dune, inland sandhill	T
		WATER	
		Freshwater lake, lagoon, spring, swamp	V
		Freshwater swamp, marsh, soak, soakage area	W
		Gilgai, melon hole, sinkhole	Z
		Saltwater, pan, saltwater swamp	Y

Table 26 CORVEG types of erosional landform patterns by slope and relief class codes

Slope class

Class	LE Level	VG Very gently inclined	GE Gently inclined	MO Moderately inclined	ST Steep	VS Very steep	PR Precipitous
Percentage	<1	1–3	3–10	10–32	32–56	56–100	100
Degrees (rounded to nearest whole number)	0	1–2	2–6	6–18	18–29	30–45	>45

Relief class	Erosional landform pattern						
M Very high >300 m (about 500 m)			–	RM Rolling mountains	SM Steep mountains	VM Very steep mountains	PM Precipitous
H High 90–300 m (about 150 m)			UH Undulating hills	RH Rolling hills	SH Steep hills	VH Very steep hills	PH Precipitous hills
L Low 30–90 m (about 50 m)		–	UL Undulating low hills	RL Rolling low hills	SL Steep low hills	VL Very steep low hills	B Badlands
R Very low 9–30 m (about 15 m)		GR Gently undulating rises	UR Undulating rises	RR Rolling rises	SR Steep rises	B Badlands	B Badlands
P Extremely low <9 m	LP Level plain	GP Gently undulating plain	UP Undulating plain	RP Rolling plain	B Badlands	B Badlands	B Badlands

Disturbance

Fire scars: moderate 2-4m %5

Feral animal: – %

Weeds: – %

Other: Evidence of previous logging / tracks %5

Health: Pristine / Excellent / Very Good / Good / Average / Degraded / Completely Degraded (almost without natives)

Special significance

Cultural: –

Recreational: –

Conservation: Remaining last large patch remnant vegetation

Commercial: –

Other Notes: Roads to be positioned E of remnant boundary i.e. already cleared pasture land.

Width of community: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Width of total remnant: <35m wide ; 35-75m ; 75-150m ; 150-300m ; >300 ; not linear
Total community area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha
Total remnant area: Does not extend beyond site; <1ha ; 1-5ha; 5-20ha ; 20-50ha ; >50ha

50m X 10m Plot Information

Canopy Stratum Form: Tree; Shrub; Herb; Grass; Aquatic

Stratum	Median Height (m)	Visual Cover Est (%)	Other Structural Notes
Emergent			Bare ground = 0 mostly leaf litter/organic debris
Canopy	16	50	
Mid	4	10	
Ground	0.4	60	

All woody species present within 50m x 10m plot (plus dominant and threatened non-woody species)

Species	Rel. Dom.	Form	E	Ht (m) T1	T2	T3	S1	S2	G
E. moluccana	O	T		16					
E. sideroxphloia	D	T		16					
E. umbra	A	T		16					
Callistemon salignus	A	sm T				4			
Exocarpus cupressiformis Native cherry	R	sm T				2			
Acacia ulicifolia	O	sh				1			
Bursaria spinosa	O	Sh				1.5			
Leucopogon juniperinus	F	sh						0.5	
Pultenaea villosa	F	sh				1			
Dianella caerulea	O								0.3
Themeda triandra	A	G							0.4
Entolasia stricta	A	G							0.4

(*) KEITH - NSW69 - HUNTER MACLEAY DRY SCLEROPHYLL FOREST
(*) CRA - FE71 - IRONBARK

Species annotations: S = Specimen Collected; * = Exotic Species; ** = Declared Species; + = Outside but adjoining 50m x 10m plot
Height categories: L = Emergent; T1 = Tree 1 stratum, T2 = Tree 2, T3 = Tree 3, S1 = Shrub 1 stratum, S2 = Shrub 2, G = Ground stratum
Form: V = Vine; E = Epiphyte; A = Aquatic; Seed = Seedling; Sap = Sapling;
Ab = Abundance within Stratum (D = dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare)

Vegetation Monitoring Data Sheet

Job Number: S60665

Site Number: FL 05 Assessor: JB/CL Date : 30 / 08 /2008

Location: KP 10.1 (West of Nature Reserve)

GPS Projection: Lat-Long; UTM Datum: GDA94; WGS84; AGD84 Zone: 56

Latitude / Easting: 0398078 Longitude / Northing: 6440431 Waypoint #: 011

Photo: 2662 / 2663

Soil Colour	Soil Secondary Texture	Soil Primary Texture	Other Soil Notes
Whitish	Clayey	Clay	
Pale	Silty	Silt	
Yellow	Sandy	Loam	
Orange	Gravely	Sand	
Brown	Stony	Gravel	
Red			
Dark		Saline Mud	
Black			
Mottled			

Altitude: 156 m Slope: Aspect: N; NE; E; SE; S; SW; W; NW

Landform: Gully w gentle to moderate slope w cleared pasture land to N + S

Table 25 CORVEG landform situation codes

Landform situation	Code	Landform situation	Code
PLAIN		HILLS, MOUNTAINS, TABLELANDS	
Not otherwise specified, flat gentle slopes, undulating terrain	A	Slope or hill not specified	P
Downs, open downs, rolling downs, ashy downs, gilgaied downs	[illegible]	Cliff (steep rocky faces), rocky ledge, rocky outcrop, scarp, crack in rock, crevices	[illegible]
Alluvial plain or flat, alluvium, flood plain	B	Coastal rocky headland	N
Inland clay pan, salt flat or pan (inland)	U	Top, crest of mountain or ridge	K
Tidal flat, salt flats (coastal)	V	Jump-up, mesa, tableland, plateau	Q
STREAMS		DUNE	
Lakes, banks of lake, river, stream, water bodies, levees – permanent water	C	Foredune, coastal dune, high dune	R
Gully, drainage line, ravine gorge, outwash – intermittently wet	D	Unspecified coastal dune, beach dune, recent coastal dune, low dune, coastal sandhill	R
Bed of streams – drainage lines of inland streams, beds – intermittently flooded	F	Inland dune, inland sandhill	T
		WATER	
		Freshwater lake, lagoon, spring, stream	X
		Freshwater swamp, marsh, soak, seepage area	W
		Claypan, melon hole, sinkhole	Z
		Saltwater, sea, saltwater swamp	Y

Table 26 CORVEG types of erosional landform patterns by slope and relief class codes

Slope class							
Class	LE Level	VG Very gently inclined	GE Gently inclined	MO Moderately inclined	ST Steep	VS Very steep	PR Precipitous
Per cent slope	<1	1–3	3–10	10–32	32–56	56–100	100
Degrees (rounded to nearest whole number)	0	1–2	3–6	7–18	18–29	30–45	>45
Relief class	**Erosional landform pattern**						
M Very high >300 m (about 500 m)				RM Rolling mountains	SM Steep mountains	VM Very steep mountains	PM Precipitous mountains
H High 90–300 m (about 150 m)		–	UH Undulating hills	RH Rolling hills	SH Steep hills	VH Very steep hills	PH Precipitous hills
L Low 30–90 m (about 50 m)			UL Undulating low hills	RL Rolling low hills	SL Steep low hills	VL Very steep low hills	B Badlands
R Very low 9–30 m (about 15 m)		GR Gently undulating rises	UR Undulating rises	RR Rolling rises	SR Steep rises	B Badlands	B Badlands
P Extremely low <9 m	LP Level plain	GP Gently undulating plain	UP Undulating plain	RP Rolling plain	B Badlands	B Badlands	B Badlands

Disturbance

Fire scars: – %

Feral animal: Rabbit %

Weeds: Fire weed < %5

Other: Tree chopped down / cow tracks / evidence of past ringbark % < 5%

Health: Pristine / Excellent / Very Good / Good / Average / Degraded / Completely Degraded (almost without natives)

Special significance

Cultural: –

Recreational: –

Conservation: Habitat values

Commercial: –

Other Notes: –