Eton Range Realignment Project

ATTACHMENT 2 to EPBC Ref: 2015/7552 Preliminary Documentation Residual Impact Assessment and Offset Proposal

December 2015

Queensland Government

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Glossary

Term	Description
CQU	Central Queensland University
DAF	Department of Agriculture and Fisheries
DEHP	Department of Environment and Heritage Protection
DERM (former)	Department of Environment and Resource Management
DNRM	Department of Natural Resources and Mines
DoE	Department of the Environment
EMP(C)	Environment Management Plan (Construction)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FMP	Fauna Management Plan (Koala)
FRW	Fauna Rescue Whitsunday
KSAT	Koala Spot Assessment Technique
MNES	Matters of National Environmental Significance
NC Act	*Nature Conservation Act 1992*
NRM	Department of Natural Resources and Mines
QPWS	Queensland Parks and Wildlife Service
RE	Regional Ecosystem
REF	Review of Environmental Factors
RFI	Request for Additional Information
SPRAT	Species Profile and Threats Database
TMR	Department of Transport and Main Roads
VMA	*Vegetation Management Act 1999*

1. Introduction

1.1 Purpose

This Residual Impact Assessment and Offset Proposal for the Koala has been prepared to respond to the request for additional information (RFI) issued by the Department of the Environment (DoE) for *Environmental Protection and Biodiversity Act 1999* (EPBC Act) referral 2015/7552. The residual impact assessment is based on the impact to the Koala following the implementation of mitigation measures included in the FMP. The offset proposal described in this report is proposed to counterbalance the residual impacts that remain after avoidance and mitigation measures. The proposal aims to provide conservation benefit and environmental value for the Koala, placing a particular focus on the regional context of the population of Koalas.

The 'Project area' in this Report is defined as the area within the resumption boundary that is required to accommodate the construction of two dual lane carriageways, split carriageways, and general road construction for 3.756 km of the 'Eton Range crossing' on the Peak Downs Highway between Mackay and Nebo.

1.2 Objectives

This Report:

- Identifies the anticipated residual impacts to Matters of National Environmental Significance (MNES), specifically the Koala (*Phascolarctos cinereus*), resulting from the construction and operation of the Eton Range Realignment Project – 'the Project'.
- Outlines the Department of Transport and Main Road's (TMR) commitment to provide offsets in accordance with the EPBC Act and the *EPBC Act Environmental Offsets Policy 2012* (the 'EPBC Act Offsets Policy'), in response to the residual impact generated as a result of construction and operation of the Project.
- Is to be read in conjunction with the Preliminary Documentation Main Report and the Fauna Management Plan - Koala (FMP), included as Attachment 1 to the Preliminary Documentation, which document the mitigation and management measures included in the assessment of residual impacts.

The EPBC Act Offsets Policy and Offsets Assessment Guide have been used to determine the offset requirements for the Project.

Error! Reference source not found. provides a summary of the structure of the Offsets Proposal, identifying where specific aspects of Item 1.1, 4.1, 4.2, 4.3, 4.4 and 4.5 of the RFI are addressed.

Table 1: RFI Requirements Specific to the Offset Proposal

Item no	Item requirement	Reference in the Offsets Proposal	Demonstration of how the Offsets Proposal addresses the item requirements in the RFI
1.1	**The preliminary documentation must provide:**		
(i)	Updated maps detailing areas of disturbance overlaid with known populations and habitat for Koala, including known movement corridors within and in the vicinity of the site.	Section 2.3	This report identifies known Koala movement corridors along the Eton – Nebo stretch of the Peak Downs Highway.

Item no	Item requirement	Reference in the Offsets Proposal	Demonstration of how the Offsets Proposal addresses the item requirements in the RFI
4	**Proposed Offsets**		
4.1	The preliminary documentation must include an assessment of the likelihood of residual impacts occurring, after mitigation and management measures relating to the project have been applied. Based on information provided in the referral, the Department considers that residual significant impacts to Koalas are likely. In the light of this, please provide an offset management plan or proposal to be implemented to compensate for the residual significant impacts on Koalas.	Entire document	The offset proposals have been developed to compensate for the residual significant impact of the Project on the Koala. The preferred option is the option that has been deemed to provide a greater conservation gain for the species.
4.2	The offset management plan/proposal must comply with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (October 2012) and accompanying Offsets assessment guide, accessible from: www .environment.qov.au/epbc/publications/environmental-offsets-policy.html	Section 4.2 and 5.8	Compliance of the two offset proposals with the Offsets Policy is tabulated.
4.3	If you wish to propose indirect offsets instead of direct offsets you must address requirements at section 4.2.1 of the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy. Discussions about the benefits of the proposed indirect offsets must consider the conservation advice for the Koala. You must also compare the anticipated cost (financial and other) of delivering the indirect offset(s) against the anticipated cost of delivering direct offsets.	Section 4 and 6	The added conservation gain of the hybrid offsets package has been discussed, including consideration of the relevant Conservation Advice. Anticipated costs of each proposal has been estimated.
4.4	Offsets should compensate for an impact for the full duration of the impact.	Entire document	Both offset proposals compensate for the full duration of the impact
4.5	Offsets must directly contribute to the ongoing viability of the Koala and deliver an overall conservation outcome that improves or maintains the viability of habitat for the Koala, as compared to what is likely to have occurred under the status quo, i.e., if neither the action nor the offset had taken place.	Section 6	An analysis of each option's ability to provide a conservation outcome for the Koala has been provided.

2. Residual Impact Assessment

2.1 Impact Area

The FMP identified that a total of 30.867 ha of potential Koala habitat will be impacted as a result of the Project. This is slightly reduced from the 31.192 ha included in the original EPBC Referral documentation.

It should be re-noted that approximately 12.728 ha of vegetation was previously removed for the Project. This was undertaken to accommodate survey, geotechnical works, access, and trial embankment works undertaken in 2014 and 2015. This trial area was subject to significant previous disturbance from the installation of Telstra and Ergon infrastructure, geotechnical investigations and survey. A Significant Impact Assessment for the Koala was carried out in December 2013 (EcoSM, 2013) which identified that the Project was unlikely to have a significant impact on any Matters of National Environmental Significance (MNES). Due the publication of the 'EPBC Act referral guidelines for the Vulnerable Koala' in late 2014, an additional environment assessment was conducted by TMR, and the decision was made to refer the Project for consideration.

These previously cleared areas have been included within the Project area described within this document. Further information is provided in Attachment 1 Fauna Management Plan – Koala (FMP).

2.2 Description of the Project

The Project area is composed of four (4) mapped Regional Ecosystems (REs), and non-remnant vegetation. All vegetation in the area provides suitable habitat for the Koala, except for the vine thicket community represented by RE 8.12.3. Refer to the Preliminary Documentation Main Report and the FMP for further information regarding the Project

2.3 Significant Impact Assessment

The potential impacts of the Project to the Koala were identified in the FMP to be as follows:

- Habitat removal and degradation;
- Habitat fragmentation and loss of connectivity;
- Disease and pathogens;
- Vehicle strike; and
- Predation by wild dogs.

The potential impacts have been assessed against the Significant Impact Criteria for Vulnerable species in accordance with *the Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* to determine whether the impacts on matters of national environmental significance are likely to be significant. The outcome of this assessment, with reference to the proposed mitigation and management measures contained within the FMP, is provided in Table 2.

Table 2: Significant Impact Assessment of the Project on the Koala

EPBC Significant Impact Assessment - Criteria	Impacts of the Project on the Koala	Residual Impact to be addressed?
Lead to a long-term decrease in the size of an important population of a species?	The Project will result in the maximum removal of 30.867 ha of suitable Koala habitat along a 3.756 km stretch. Fragmentation has been minimised by designing the new road adjacent to the existing Peak Downs Highway to utilise existing disturbed areas. Habitat removal has been identified as an impact, with indirect impacts also noted. With the implementation of mitigation measures including Koala fencing, a fauna crossing and sequential clearing, and noting the availability of suitable existing habitat on the Eton Range, and the wider Clarke-Connors Ranges bioregion, the Project is not expected to cause a long-term decrease in the size of the existing population.	No
Reduce the area of occupancy of an important population?	The Project will directly reduce the area of occupancy of the Koala by 30.867 ha. The vegetation communities removed to facilitate the Project are mapped as 'Least Concern' and occur extensively throughout the Clarke-Connors Ranges sub-bioregion. It should also be noted that this vegetation exists directly adjacent to the existing Peak Downs Highway, which is a known threat to Koalas. Although the removal of 30.867 ha of habitat will reduce the area of occupancy within a contiguous habitat landscape of more than 600,000 ha by a very small percentage, it will still 'reduce' the area of occupancy of the population. The provision of offsets will be required to mitigate this residual impact.	Yes
Fragment an existing important population into two or more populations?	Original construction of the Peak Downs Highway fragmented the Eton Range habitat and created a potential barrier to movement. Construction of a split carriageway will further fragment the habitat and, depending on the success of the fauna under passage, may provide a further impediment to localised Koala movement. A potential north-south movement corridor has been identified approximately 10 km south-west of the Project on the Peak Downs Highway from historic Department of Environment and Heritage Protection (DEHP) and Central Queensland University (CQU) Koala sighting records (Figure 1). It is however unknown why this location is utilised as a crossing point by the local population. The important crossing points within the Project area are expected to be in the flatter sections of the Highway at the top of the range (CH 49,800 – 51,200 m), where Koala activity levels were highest. A fauna crossing has been incorporated into the design at this location to maintain connectivity at this location. In a regional context, and with consideration of the extent of suitable habitat on the Eton Range and the wider Clarke-Connors Ranges, while the Project will potentially exacerbate the current movement obstruction, it is not expected to fragment the population of Koalas that resides in the wider area. The provision of offsets will be required to mitigate this possible residual impact.	Possibly
Adversely affect habitat critical to the survival of a species?	The Project area has been identified as containing habitat critical to the survival of the Koala, in accordance with DoE's Koala Habitat Assessment Tool included in the FMP. The project will directly impact 30.867 ha of critical Koala habitat. Surveys undertaken within the Project impact area and within surrounding habitat show moderate and high Koala activity along the flatter parts of the study area and low and no activity along the steep slopes. It is expected that this is not unique to the area surveyed, but typical of the broader Eton Range, and Clarke-Connors Ranges sub-bioregion. It should also be noted that this vegetation exists directly adjacent to the existing Peak Downs Highway, which is a known threat to Koalas.	Yes

EPBC Significant Impact Assessment - Criteria	Impacts of the Project on the Koala	Residual Impact to be addressed?
	The provision of offsets will be required to mitigate this residual impact.	
Disrupt the breeding cycle of an important population?	The Koala breeding season is generally between September and March, with females giving birth to a single young between October and May. As described in the FMP, the construction phase of the project will be carried out in a way that minimises direct impacts to individuals. During the breeding season, males actively seek female Koalas and Koala movement is more extensive. An unmitigated Project could lead to an increase risk of vehicle strike. Traffic volume, speed and visibility influence the Koala collision rate. Prevett et al. (1995) found that road kills occurred where vehicle speeds exceeded 80km/hr and where wider habitat corridors or linear forests occurred on both sides of the road. It is noted that a large majority of the proposed road (Ch. 50,900 – 53,000 m northbound, Ch. 51,500 – 53,000 m southbound) will be restricted to 60km/hr due to the steep and winding nature of the alignment. The Project location is not a known corridor for movement along the Range. Figure 1 identifies a potential north-south movement corridor approximately 10 km south-west of the Project, which is more likely to be used as a crossing point for the Koala. The expected crossing points with the Project are expected to be in the flatter sections of the highway at the top of the range, where Koala activity levels were highest on either side of the existing highway. The Project is not expected to disrupt the breeding cycle of the existing population. Impacts of habitat fragmentation will be mitigated through the construction of a fauna crossing and furniture, while stress impacts will be managed through best practice sequential clearing, as detailed in the FMP.	No
Modify, destroy, remove or isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The project will directly impact 30.867 ha of Koala habitat adjacent to the existing Peak Downs Highway, which accounts for only a small area of suitable habitat in the broader landscape. Although clearing will cause minor additional fragmentation of habitat on the Eton Range and reduce the area of available habitat, the extent of linear habitat disturbance is not likely to decrease the availability or quality of habitat available to the local population to the extent that the species will decline.	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat?	Invasive species, including feral animals such as the fox (*Vulpes vulpes*) and wild dog are likely to occur throughout the Eton Range, and Clarke - Connors Range sub-bioregion, including within and adjacent to the Project area These types of predatory species are drawn to areas of disturbance to prey upon mammals and reptiles that are moving away from the disturbance area, therefore, predation by feral animals is a risk to this species during and immediately after clearing activities. Predatory species are also attracted to the prey opportunities presented by cleared linear corridors, although it is recognised that in this location, the linear corridor is already present in the form of the existing Peak Downs Highway. There is potential for the spread of invasive weeds, such as Lantana, to occur during construction, degrading the habitat of the Koala through the suppression of sapling growth. The implementation of weed management measures during the construction and maintenance phase will minimise impact of weed species on Koala habitat quality of adjoining habitat areas. The Project is considered unlikely to result in any new invasive species becoming established in habitat areas adjacent to the impact area, as these invasive and predatory species are already established throughout the wider	No

EPBC Significant Impact Assessment - Criteria	Impacts of the Project on the Koala	Residual Impact to be addressed?
	landscape. There is evidence of wild dogs on the Eton Range, however given the location, no data regarding dog attacks is available.	
Introduce disease that may cause the species to decline?	Vegetation clearing and resultant stress have the potential to increase the expression of chlamydia in koalas, however the implementation of mitigation measures such as sequential clearing will reduce the risk of disease. The Project is not anticipated to introduce disease that may cause the species to decline.	No
Interfere substantially with the recovery of the species?	The implementation of a fauna crossing structure and Koala fencing, in addition to offsets, will remove the potential for the Project to interfere with the recovery of the Koala.	No

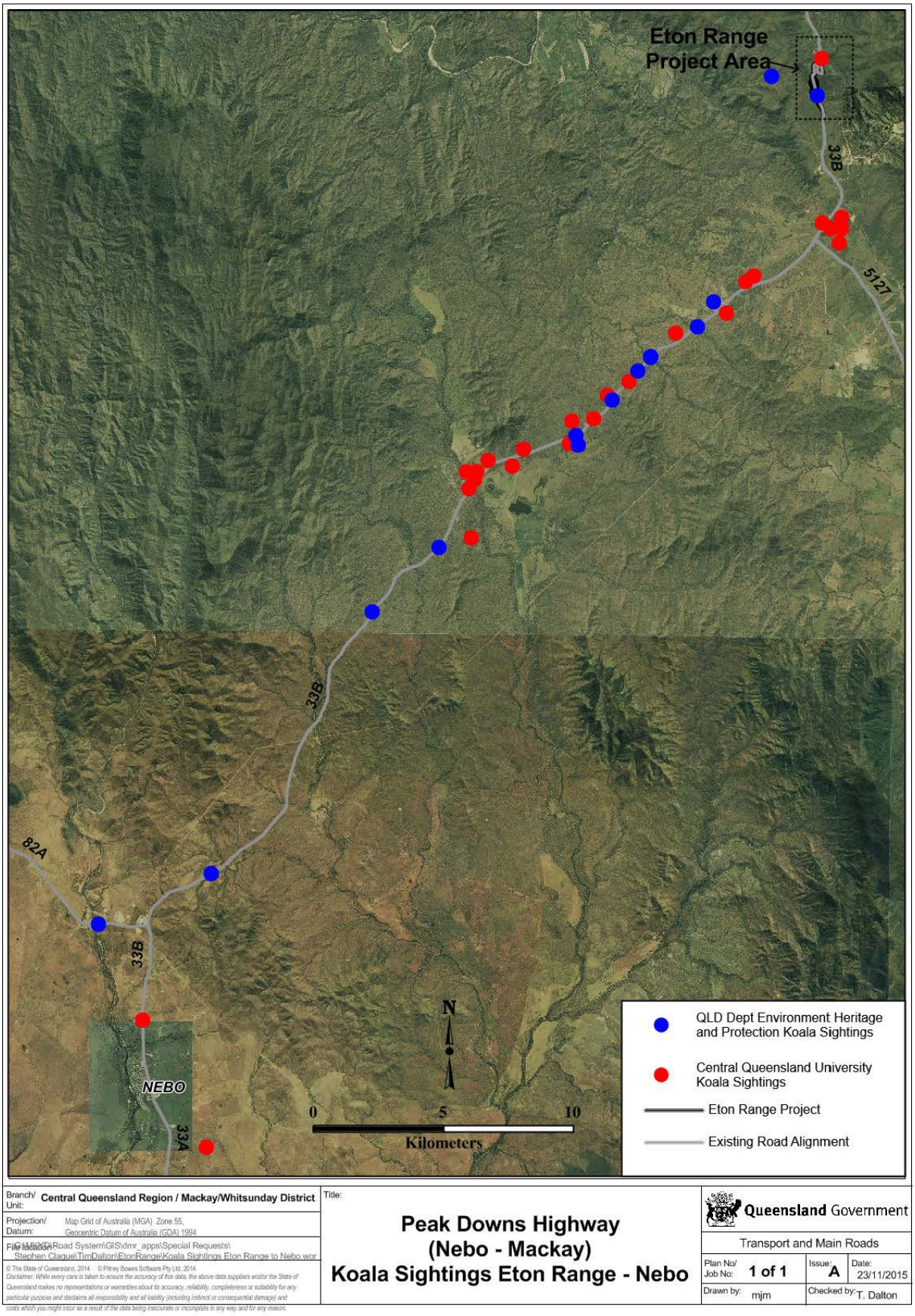


Figure 1: CQU/DEHP Koala Sightings along the Peak Downs Highway from Eton to Nebo (up to September 2015)

The FMP identified **habitat removal** and the potential of **further habitat fragmentation and a decrease in connectivity** as the residual risks of the Project. Table 2 identified the following residual impacts associated with the Project:

- Reducing the area of occupancy of an important population;
- Adversely affecting habitat critical to the survival of a species; and
- Further decreasing connectivity of habitat, potentially causing additional fragmentation of the existing Koala population.

As this impact cannot be completely mitigated through the measures defined in the FMP, offsets are proposed in accordance with the EPBC Act Offsets Policy.

3. Determining Offset Options

3.1 Development of Options

In determining the most suitable offset proposal for the Project, TMR has taken consideration of the residual impacts identified in Section 2 as well as a number of additional aspects, including the following:

- Availability of suitable data with regard to the existing habitat and population dynamics of the Koala within the Project impact area and immediate surrounding areas.
- Availability of suitable data with regard to existing threats to the Koala within the Project and immediate surrounding areas.
- The characteristics of the Project and immediate surrounding areas and its suitability for providing offsets for the ongoing protection of the Koala with respect to suitable habitat, existing land uses and tenure, and presence of existing linear road infrastructure.

Consideration of these aspects identified a number of factors to be considered in the development of the offsets proposal. These are outlined in Table 3 below.

Table 3: Aspects considered in development of the Project Offset Proposal Options

Aspect	Comments
Availability of suitable data with regard to the existing habitat and population dynamics of the Koala within and immediately adjacent to the Project.	• Data on the Koala within the vicinity of the Project impact area is limited to historic DEHP and CQU sighting/roadkill records (Figure 1) as well as the Project field investigation results. • The Clarke – Connors range population has been little studied apart from some preliminary audits near St Lawrence, Nebo and Collinsville. • There is no known data relating to the dynamics of the population. • There is very little known data relating to the size of the population. • Desktop and field verification of suitable habitat for the Koala was completed for the Project area. • The occurrence of Koalas within the vicinity of the Project area was initially identified during a Fauna Assessment undertaken in December 2013 (EcoSM, 2013). Direct visual sightings of the Koala were noted during the survey. • A subsequent Commonwealth listed threatened fauna species assessment was undertaken in July 2015 as per the newly introduced EPBC Act referral guidelines for the vulnerable Koala (SMEC, 2015). The study indicated low Koala activity levels along the steep slopes within the northern end of the project and medium – high activity levels at the southern lower grade end of the impact area.
Availability of suitable data with regard to existing threats to the Koala within the Project and immediate surrounding areas.	• There have been historical increases in mining traffic along the Peak Downs Highway due to the development of the Bowen Basin. • It is expected that the development of the Galilee Basin will result in significant future increases in mining traffic along the Peak Downs Highway. • Government agencies, local community groups and scientific bodies concur that roadkill along the Peak Downs Highway is a major threatening process to the continued existence of the Koala in the region. Considerable community sentiment now exists in the region around the issue. • Data on existing threats to the Koala within the vicinity of the Project area is limited to historic DEHP and CQU roadkill records along the Peak Downs Highway (Figure 1). These records identify that the majority of Koala sightings are further south along the Peak Downs Highway. • EcoSM (2013) identified the presence of wild dogs in the Project area. • SMEC (2015) identified that the presence of Lantana in and adjacent to the Project area has the potential to inhibit Koala access to the base of a tree.

Aspect	Comments
The characteristics of the Project and immediate surrounding areas and its suitability for providing offsets for the ongoing protection of the Koala with respect to suitable habitat, existing land uses and tenure, and presence of existing linear road infrastructure.	• Land use immediately adjacent to the Project is restricted to limited to cattle grazing and nature conservation. • The terrain and geology of the Clarke-Connors Range has largely precluded clearing for agriculture. • A substantial portion of the range lies within protected areas, including the adjacent Spencer's Gap State Forest and the nearby Ben Mohr State Forest. • The Clarke-Connors Range encompasses a huge area of approximately 631,980 hectares, most of which is remnant vegetation.

3.2 Offset Proposal Options

On the basis of the aspects outlined above, two offset options have been developed

- **Option 1** – A hybrid offset package comprising the following:
  - Part a – Funding a study by Koala Research CQ entitled 'Managing the Clarke Connors Range Koala Population' (refer to Appendix A).
  - Part b – A commitment towards funding the implementation of fauna sensitive design along the Peak Downs Highway as recommended by the study.
- **Option 2** – Implementation of a direct land offset.

Details of both options are provided in Sections 4 and 5 respectively.

4. Option 1 – Hybrid Offset Package

4.1 Details of Proposal

4.1.1 Part 1a – Study entitled 'Managing the Clarke Connors Range Koala Population'

As previously noted, the Clarke Connors Range encompasses a huge area of approximately 631,980 hectares, most of which is remnant vegetation. The dominant land use of the range is nature conservation and cattle grazing (DEHP, 2015b). A substantial part of the Clarke Connors Range lies within protected areas, State Forests or Leased Land. Notably these include Eungella and Homevale National Parks, and Spencer's Gap and Ben Mohr State Forests which are in close proximity to the Project. In addition, a number of smaller areas of freehold land have been gazetted as Nature Refuges via voluntary conservation agreements (Reef Catchments, 2015). The terrain and geology of the range has also largely precluded clearing for agriculture.

Following the Koala's recent listing of 'Vulnerable' in the entirety of the Queensland State, it is of the utmost importance for data to exist on the population within the Clarke Connors Range. The study proposes to determine population dynamics of the Clarke Connors Range Koala population through a number of discrete projects.

Although as not prevalent in the Project location, it is known that a significant number of Koalas fatalities occur further south along the Peak Downs Highway (Figure 1). This is an issue that has been heightened with the historic increases in mining traffic along the road and has led to considerable community interest. Understanding of local Koala movements on the stretch of the Peak Downs Highway between Eton and Nebo is low. The proposal will aim to provide valuable data for informed future investment in fauna sensitive road infrastructure along the Peak Downs Highway. It will also provide assistance in justifying any future funding allocations for this investment.

Specifically, the proposal seeks to increase knowledge of the Clarke-Connors Range Koala population, and facilitate improved conservation management for the species along the Peak Downs Highway, between Eton and Nebo. This will include:

1.0 Defining koala population management units across the Clarke-Connors Range;
2.0 Understanding koala habitat use, and diet, as well as ranging behaviour in the vicinity of the Eton to Nebo stretch of the Peak Downs Highway;
3.0 Habitat analysis and modelling to predict future koala-road kill hotspots on the Eton to Nebo stretch of the Peak Downs Highway; and
4.0 Investment planning for installation of wildlife barriers and underpasses on the Peak Downs Highway between Eton and Nebo.

The entire proposal can be viewed in Appendix A. TMR proposes to provide **$287,442** towards this section of the package.

4.1.2 Part 1b – Investment towards the implementation of Koala sensitive infrastructure along the Peak Downs Highway

While TMR considers that identifying areas where the Peak Downs Highway abuts Koala activity is essential for addressing knowledge gaps in the area, it also acknowledges the importance of timely implementation of the study's recommendations. Currently, wildlife signage has been installed along the stretch of Peak Down Highway between Eton and Nebo. It is expected that the study will provide recommendations for investment in the following additional wildlife protection and/or diversion infrastructure at identified Koala crossing points:

- Additional Koala road signage;
- Koala exclusion fencing; and
- Retrofitting of existing drainage structures with Koala underpasses.

This monetary commitment will ensure that a pool of funding (provided through the Project) is immediately available for the implementation of the study's recommendations. TMR proposes to provide **$200,000** towards this element of the package.

4.2 Compliance with EPBC Act Offsets Policy

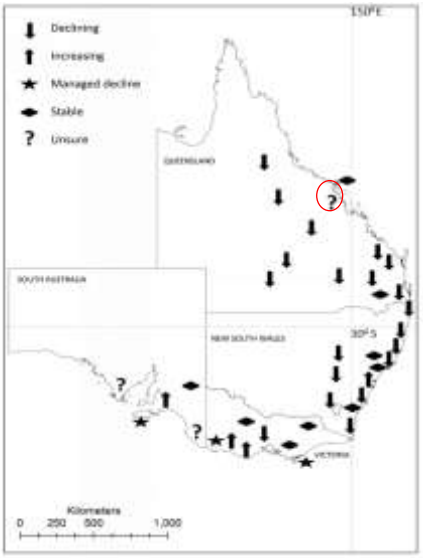
Section 4.2.1 of the EPBC Act Offsets Policy outlines that deviation from the 90% direct offset requirements will only be considered where:

- It can be demonstrated that a greater benefit to the protected matter is likely to be achieved through increasing the proportion of other compensatory measures in an offsets package, or
- Scientific uncertainty is so high that it isn't possible to determine a direct offset that is likely to benefit the protected matter.

Furthermore the study is required to comply with the criteria outlined in Appendix A of the EPBC Act Environmental Offsets Policy. Compliance with these criteria have been documented in Table 4 below.

Table 4: Compliance with Section 2.4.1 and Appendix A of the Environmental Offsets Policy

EPBC Offset Guideline Reference	Criteria	Details
Section 4.2.1	*It can be demonstrated that a greater benefit to the protected matter is likely to be achieved through increasing the proportion of other compensatory measures in an offsets package*	It was determined in the residual impact assessment that the residual threats posed to the Koala as a result of the Project are a reduction in the area of occupancy of an important population, effecting habitat critical to the survival of the species, and a decrease in connectivity of habitat potentially fragmenting the existing Koala population. The Clarke Connors Range encompasses a huge area of approximately 631,980 hectares, most of which is remnant vegetation. As previously described, most of this is in relatively secure land tenure and is not immediately threated by land clearing. It is therefore considered unlikely that the implementation of a small direct land offset will significantly benefit the local population of Koalas. Roadkill and reduced connectivity along the Peak Downs Highway is known to be a majority threatening process to viability of this population of Koalas. Fauna Rescue Whitsundays identified that of the 26 Koalas in their recent database, 11 (42%) were injured along the Peak Downs Highway (FRW, 2015). This confirms the impact that the existing highway has on the viability of the local Koala population. Considering the wider intact landscape of the Clarke – Connors Range, the hybrid package mentioned above is considered an appropriate approach to offset a significant threat to the local Koala population.
	Scientific uncertainty is so high that it isn't possible to determine a direct offset that is likely to benefit the protected matter. For example, this can be the case in some poorly understood ecosystems in the Commonwealth marine environment	As previously described, there are critical knowledge gaps around the density, dynamics, health, and conservation biology of the Koala population in the Clarke-Connors Range. This regional population has been little studied apart from some preliminary audits near St Lawrence and further west at Nebo and Collinsville. It is therefore difficult to provide an effective direct land offset when it is not known (a) the nature of the population, (b) the home range/movements of the population, and (c) the successfulness of Koalas crossings in the region. As identified by the Department of Environment on the Koala Species Profile and Threats database, the population range of Koalas in the Central Mackay Coast is relatively unknown and confidence in the 10,000 population estimate is low (DoE, 2015b). This is further demonstrated by McAlpine et al (2015) in Figure 2.

EPBC Offset Guideline Reference	Criteria	Details
		 **Figure 2: Estimated status of Australian Koala populations** (McAlpine et al, 2015)
Appendix A	(1) *The research program will improve the viability of the impacted protected matter*	As described in the 'Managing the Clarke Connors Range Koala Population' proposal (Appendix A), the data would help assist in firstly confirming the viability of the Clarke-Connors Range population, and will also provide scientifically robust data to inform decisions on future investment on fauna sensitive design on the Peak Downs Highway. Koala fatalities along the Highway not only cause disproportionate effects on the population, but also lead to community concern and distress. The commitment towards investment in Koala sensitive infrastructure in the identified high risk areas along the Peak Downs Highway will directly improve the viability of the population by helping to reduce a significant threat.
	(2) *The research program will be targeted toward key research education activities as identified in the relevant Commonwealth approved recovery plan, threat abatement plan, conservation advice, ecological character description, management plan or listing document.*	The EPBC 'Approved Conservation Advice for *Phascolarctos cinereus*' identifies a number of research priorities that the Commonwealth considers to contribute to effective management of the species. The following priorities included in the 'Approved Listing Advice (DoE, 2015b)' have been considered in the development of the study: • *Development and implementation of an integrated program of Koala population monitoring and abundance estimates across the Koala's range, **with particular focus on those regions for which population size and trends are currently least known**. Targeting regions where there were previous surveys but where there are no recent estimates will enable trends to be determined over a broader range of the species;* • *Develop landscape-scale population models, to provide a framework for the assessment of relative threat risk and management intervention cost-effectiveness.* • *Develop understanding of gene flow and landscape connectivity* • *Identify and delineate key populations; and* • *Maintain or enhance research programs directed at the assessment of the incidence and consequences to populations of Koala mortality or injury due to dogs and traffic, and of mechanisms to reduce the impacts of these threatening factors (DOE, 2015b).* The Koala was officially listed as Vulnerable under Queensland legislation in August 2015. It is likely the new listing of the Koala will eventuate in the development in a number of Recovery Plans and Management Strategies for State-wide introduction. Outputs of this study have the potential to assist in the development of such documentation.
	(3) *The research program will be undertaken in a transparent, scientifically robust and timely manner*	The study's methodology undertaken is described in 'Managing the Clarke Connors Range koala Population' (Appendix A). The methodology has been prepared to ensure the data sets produce robust scientific

EPBC Offset Guideline Reference	Criteria	Details
		conclusions. It is proposed that the study will be approximately two years in duration.
	(4) *The research program will be undertaken by a suitably qualified individual or organisation in a manner approved by the department*	The study will be led by Dr Alistair Melzer (PhD UQ, BSc (Hons), CBLT) who works for Koala Research - CQ. Alistair's project team is described in 'Managing the Clarke Connors Range Koala Population' (Appendix A). Koala Research – CQ is a community funded research program hosted by CQ University. The research will be completed in accordance with the university procedures and as described in Appendix A. All papers resulting from the research will undergo peer review prior to publication. The work will be made publically available once finalised. CV's of expected key team members of the study are included in Appendix C.
	(5) *The research program will consider best practice research approaches.*	Alistair Melzer has been researching Koalas and their habitat since 1988 and has provided expert advice to the Commonwealth and state agencies. He leads the research program at the Koala Research Centre of Central Queensland and is an executive member of the National Koala Research Network. All papers resulting from the research will be required to undergo peer review prior to publication. All specific research approaches are described in detail in Appendix A

5. Option 2 – Direct Land Offset Proposal

5.1 Introduction

A direct land-based offset prepared in accordance with the EPBC Act Offsets Policy has been proposed as Option 2. TMR has identified a parcel of land that will be legally secured as a direct offset for the maximum loss of 30.867 ha of Koala habitat as a result of the Project. A range of other areas were assessed but were not considered in the offset proposal as they provided limited conservation gain to the species.

5.2 Assessment of Potential Direct Offset Areas

5.2.1 Desktop Assessment

A desktop assessment and gap analysis was undertaken to identify potential offset sites for the Project. This included a review of local, state and federal government planning instruments and databases to assist in determining the ecological attributes of both impact areas and offset sites. The review included the following databases, maps and reports:

- Aerial photography;
- DEHP Regional Ecosystem and Essential Habitat Mapping, under the *Vegetation Management Act 1999* and Regional Ecosystem Description Database;
- DEHP Wildlife Online Database;
- Atlas of Living Australia;
- Department of the Environment's Protected Matters Search Tool ; and
- CQU Koala Record Database.

The results of the desktop assessment of the offset site are in Appendix E.

5.2.2 Site Assessments and Surveys Undertaken

A number of field surveys/assessments have been completed for the Project area and potential offset areas. The specific documents utilised in the offset proposal are identified below:

- Fauna/flora surveys of the impact area conducted by EcoSM in 2009, 2011, and 2013 to support the preparation of the Environmental Assessment Report; and
- A survey undertaken by SMEC in 2015 targeting Commonwealth listed threatened species (specifically the Koala) at the impact area.

Each of these surveys are summarised in Section 2.2.2 of the Preliminary Documentation Main Report. Collected data that has been utilised in this Offset Proposal to determine the Koala habitat quality of the Project area (Figure 3 and Figure 4).

In addition, a desktop determination was undertaken of the Project area in October 2015 by Koala Research – CQ. Koala Research – CQ was able to assign a Koala habitat ranking for each regional ecosystem within the Project area. These rankings are based on the publication 'Ranking koala habitat using Queensland mapped regional ecosystems' (Melzer, 2014). The results of the desktop assessment indicated that, apart from the vine thicket community (RE 8.12.3a), the three RE's ranked as high value Koala habitat.

An ecological survey undertaken by Kleinfelder (2015) focussed on a TMR owned property approximately 10km south of the Project. The site was identified as a potential direct offset location. The survey is included in Appendix D and has been summarised in Section 5.5.

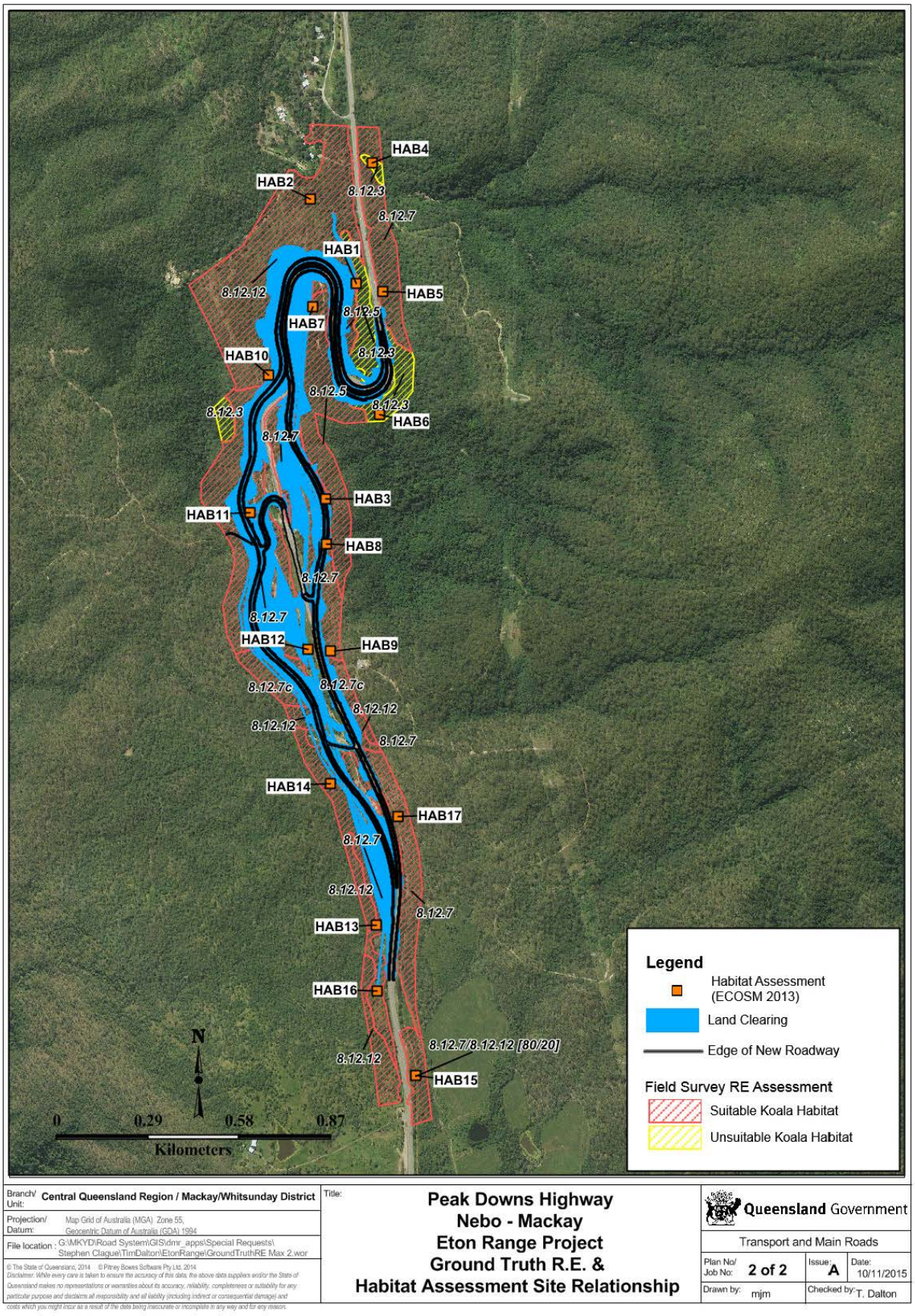


Figure 3: Relationship between field verified Regional Ecosystems and Habitat Assessment Sites at the Project Area

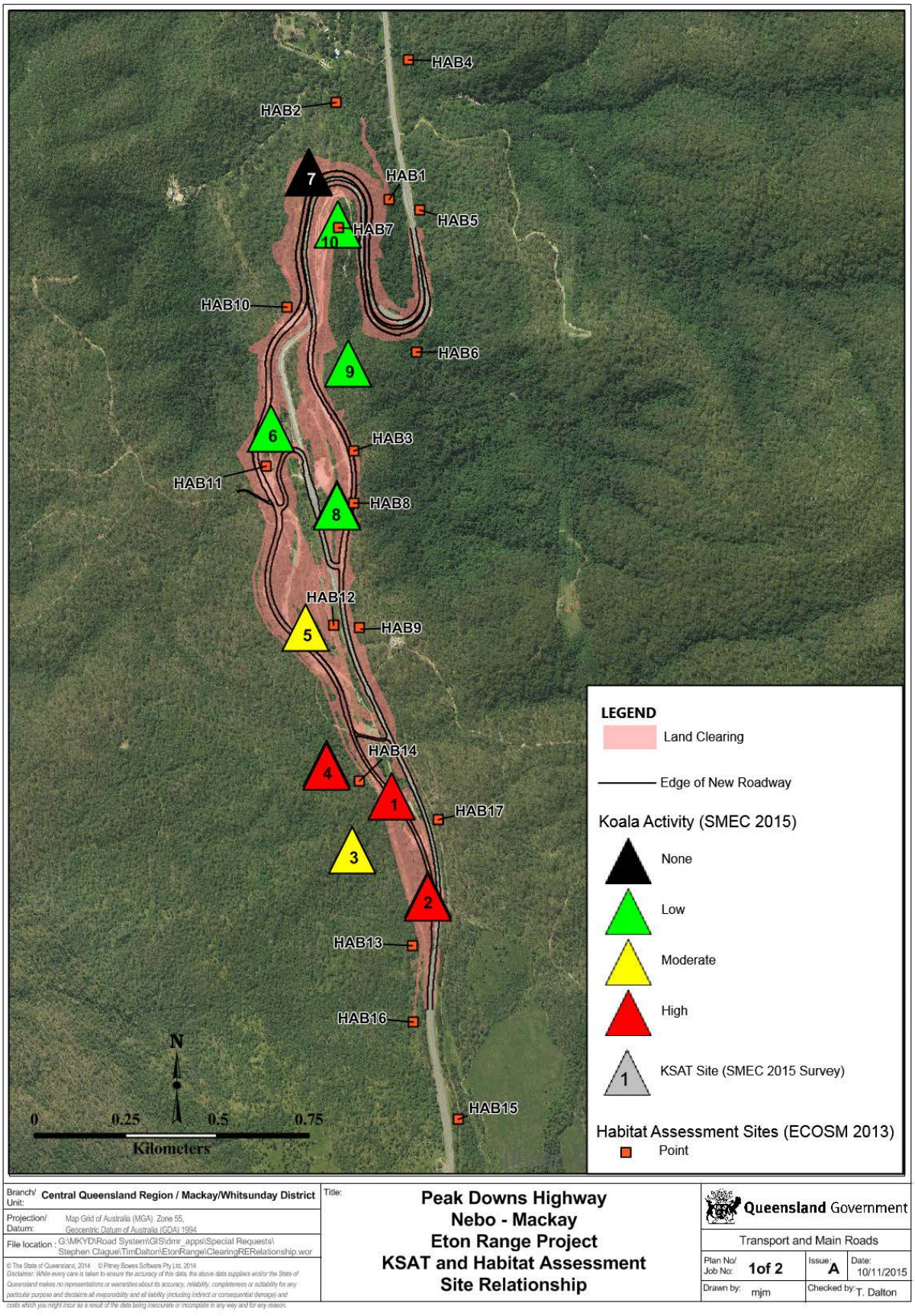


Figure 4: Relationship between Habitat Assessment Sites and KSAT Sites at the Project area

5.3 Offsets Assessment Guide Criteria

The Offsets Assessment Guide requires the proponent to establish criteria to assess the habitat quality of the impact and proposed offset site, including site condition, site context and species stocking rate distribution. Due to the varying quality of Koala habitat within both the Project area and proposed offset site, an approach has been developed that averages the quality in each case.

As shown in Figure 3 and Figure 4, individual habitat assessment sites were utilised in EcoSM's (2013) assessment of the Project area. For consistency purposes, Kleinfelder (2015) utilised a similar approach in the assessment of the offset site. Results from these habitat assessment sites were then used to assist in determining the overall Koala habitat quality of the sites in line with the approach described below.

5.3.1 Site Condition

The Offsets Assessment Guide identifies the need to consider three characteristics when determining site condition in relation to the Koala:

- What is the structure and condition of the vegetation on the site?
- What is the diversity of relevant habitat species present (including both endemic and non-endemic)?
- What relevant habitat features are on the site?

An assessment of each of these characteristics can be determined using a matrix that considers both Koala Research – CQ's (2015) Koala Habitat Rankings and Modified BioCondition scores for both the Project area (EcoSM, 2013) and offset site (Kleinfelder, 2015). Table 5 has been developed as the Project specific tool to determine the site condition score out of ten.

Table 5: Site Condition Scoring Matrix

Assessment Criteria	Assessment Score
Koala Habitat Rank score of 0, Modified BioCondition Score of 1-4	1
Koala Habitat Rank score of 1, Modified BioCondition Score of 1-4	2
Koala Habitat Rank score of 2, Modified BioCondition Score of 3-4	3
Koala Habitat Rank score of 2, Modified BioCondition Score of 1-2	4
Koala Habitat Rank score of 3, Modified BioCondition Score of 3-4	5
Koala Habitat Rank score of 3, Modified BioCondition Score of 1-2	6
Koala Habitat Rank score of 4, Modified BioCondition Score of 3-4	7
Koala Habitat Quality score of 4, Modified BioCondition Score of 1-2	8
Koala Habitat Quality score of 5, Modified BioCondition Score of 3-4	9
Koala Habitat Quality score of 5, Modified BioCondition Score of 1-2	10

5.3.2 Site Context

The Offsets Assessment Guide identifies the need to consider three characteristics when determining site context in relation to the Koala:

- What is the connectivity with other suitable/known habitat or remnants?
- What is the importance of the site in relation to the overall species population or the occurrence of the community?
- What threats occur on or near site?

It should be noted that a determination of the importance of site in relation to the overall population is difficult to ascertain due to the lack of scientific data on the Clarke-Connors Range Koala population.

As per the Queensland BioCondition Assessment Manual (2015), landscape attributes for the assessment site's patch size, connectivity, and context have been scored in EcoSM's (2013) and Kleinfelder's (2015) reports utilising GIS mapping.

Existing threats to the Koala at the impact and offset sites need to also be considered to determine an accurate site context score. The EPBC Koala Conservation Advice (DoE, 2015b) identifies four main threats to the continued survival of the Koala.

- fragmentation of habitat;
- vehicle strike;
- disease; and
- predation by dogs.

These components need to be considered when determining the 'threat' component of each assessment site's context score.

A specific equation to determine the total context score out of ten for each habitat assessment site has been developed considering each of the site context components.

$$\textbf{Assessment Site Context Score} = \frac{(\textbf{Size of Patch}+\textbf{Connectivity}+\textbf{Context}+\textbf{Lack of Threats})_{\textbf{measured}}}{(\textbf{Size of Patch}+\textbf{Connectivity}+\textbf{Context}+\textbf{Lack of Threats})_{\textbf{max}}} \times \mathbf{10}$$

5.3.3 Species Stocking Rate Distribution

The Offsets Assessment Guide identifies the need to consider three characteristics when determining species stocking rate in relation to the Koala:

- What is the presence of the species on the site? (i.e. confirmed / modelled).
- What is the density of species known to utilise the site?
- What is the role of the site population in regards to the overall species population?

The application of the metrics from the KSAT Methodology was applied to score for the Koala's species stocking rate. The east coast (med - high) activity category from Phillips and Callaghan (2011) was applied to the Koala population to provide an appropriate score from a regional perspective. The scoring matrix for the species stocking rate is provided in Table 6. The maximum species stocking rate score is ten

Table 6: Species Stocking Rate Scoring Matrix

Assessment Criteria (KSAT Results)	Assessment Score
No Scats Recorded	1
East coast med - high (low use) less than 10%	2
East coast med - high (low use) 10% or greater but less than 22.52%	3
East coast med - high (medium use) 22.52% or greater but less than 25%	4
East coast med - high (medium use) 25% or greater but lower than 28%	5
East coast med - high (medium use) 28% or greater but less than 30.5%	6
East coast med - high (medium use) 30.5% or greater but less than 32.84%	7
East coast med - high (high use) greater than 32.84% but less than or equal to 38%	8
East coast med - high (high use) greater than 38% but less than or equal to 45%	9
East coast med - high (high use) greater than 45%	10

5.4 Koala Habitat Quality of Project area

The Koala habitat quality of the Project area was determined utilising EcoSM (2013), SMEC (2015), and Koala Research – CQ's (2015) raw data.

The habitat quality scores for each habitat assessment site within the Project area is outlined in Table 7. It should be noted that a number of EcoSM's (2013) habitat assessment sites have since been disturbed as a result of the trial embankment activities previously described in Section 2.1. The habitat quality assessment calculation considers the original quality of the Koala habitat prior to these disturbances.

It should also be noted that habitat assessment sites 2, 4, 5, 6 and 15 have been omitted from the calculation as they are not located within or immediately adjacent to the finalised Project area (refer to Figure 3).

The habitat quality for the Project area, calculated as a combined score of all the habitat assessment sites, is 7. As expected, the Koala habitat quality increases towards the southern extents of the Project area.

Table 7: Koala Habitat Scoring Criteria for Project area

Habitat Site Assessment Unit	Site Condition	Site Context	Species Stocking Rate	Total Habitat Quality Score
HAB1	10	7.33	1	6.11
HAB3	8	7.33	3	6.11
HAB7	8	7.33	3	6.11
HAB8	8	7.33	3	6.11
HAB9	8	7.33	4	6.44
HAB10	9	7.33	3	6.44
HAB11	8	7.33	1	5.44
HAB12	8	7.33	4	6.44
HAB13	7	7.33	8	7.44
HAB14	7	7.33	9	7.78
HAB16	7	6.67	8	7.22
HAB17	8	7.33	10	8.44

Habitat Site Assessment Unit	Site Condition	Site Context	Species Stocking Rate	Total Habitat Quality Score
			Average	**6.68**
			Total Averaged Habitat Quality Score	**7**

5.5 Potential Direct Offset Site

5.5.1 Desktop Assessment

Based on the results of the desktop and field investigations, a proposed offset site (herein referred to as 'the Site') has been identified approximately 10km to the south of the Project. The Site lies on the western side of the Clarke-Connors Range approximately 350 meters west of the unpaved Blue Mountain Road. Current connectivity of remnant vegetation between the Project and the Site is relatively high. The Site also connects to Epsom State Forest 1 on its southern edge (refer to Figure 5). The Site is located on TMR owned land formally described as Lot 1 on RL5001.

The Site comprises of the southern section of Lot 1 RL5001 and is 75.17 hectares in area. It contains mostly remnant vegetation and field verified mapping indicates four field verified regional ecosystems – Least Concern RE's 11.12.3, 11.3.9, 11.3.25 and 11.3.4. Each of these are dominated by Koala food trees in the form of *Eucalyptus* spp and *Corymbia* spp. Currently the Site is grazed by cattle by means of a road license.

5.5.2 Field Assessment

An ecological assessment was undertaken by Kleinfelder in November 2015 to evaluate the Site and its suitability as an offset for the Project (refer to Appendix D). The assessment collected field data relating to the condition of the existing habitat, the importance of the Site within the landscape, and the current Koala activity levels. It should be noted that the Site is only a portion of the total study area assessed (refer to Figure 6 and Figure 7).

As identified in Appendix D, the survey found:

- Moderate to poor habitat as identified by an overall Modified BioCondition Class Score of 3;
- Good site context in relation to the landscape in which the site is situated;
- Medium to high levels of Koala activity; and
- Mild to moderate levels of external threats.

Photos of the Site are included in Plate 1 and Plate 2.

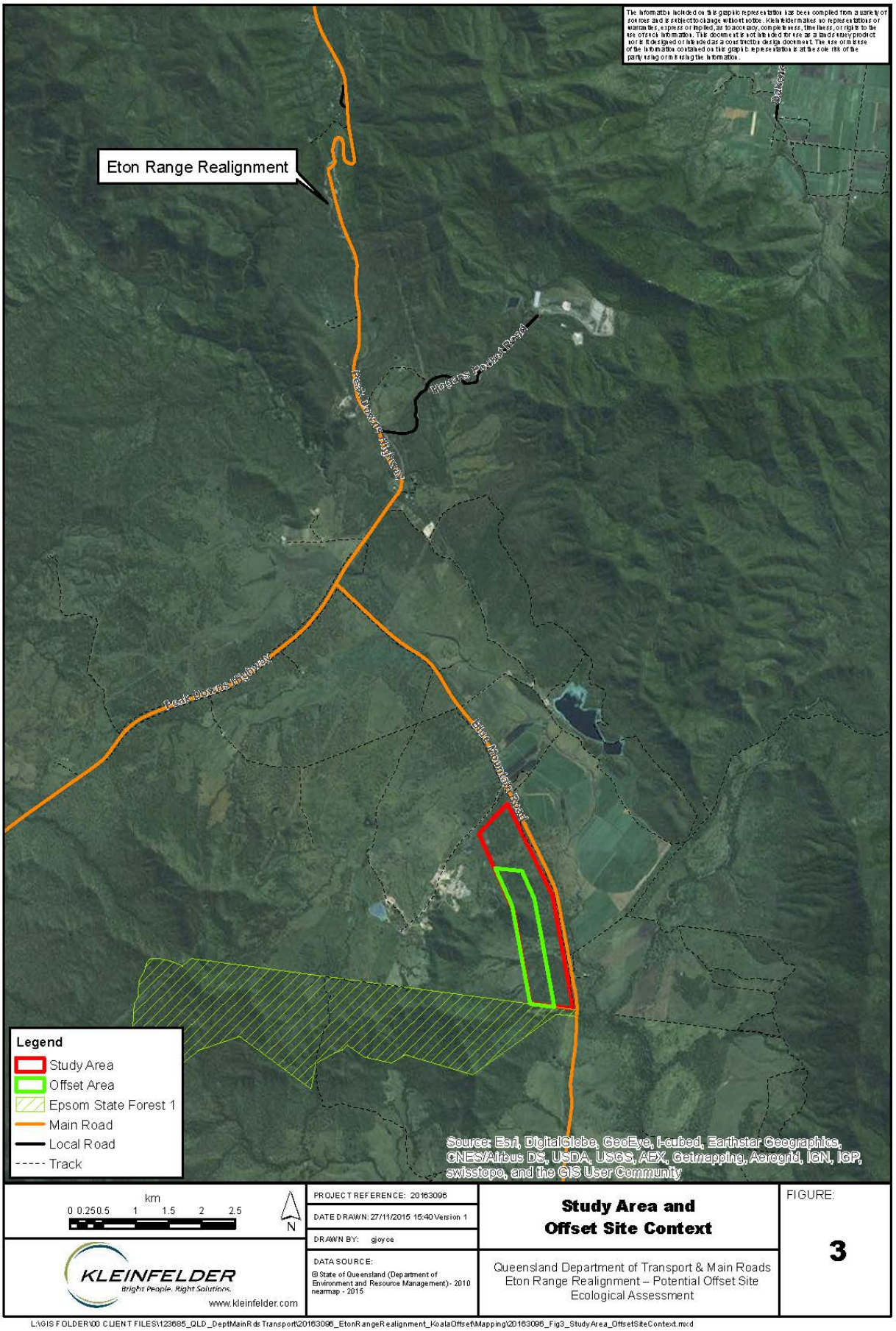


Figure 5 - Location of Site in relation to adjacent State Forest and the Project area

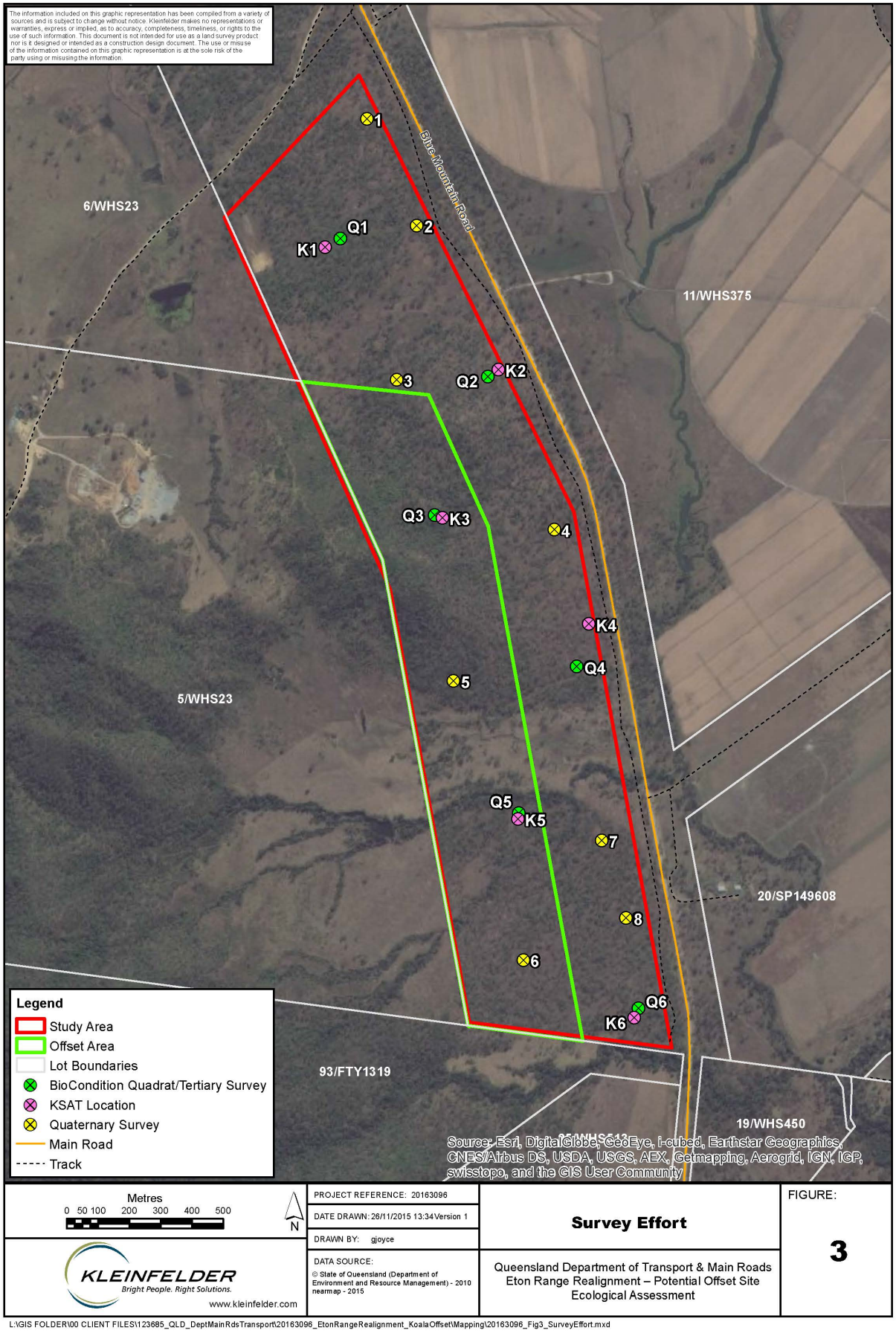


Figure 6: Survey Efforts conducted at the Site

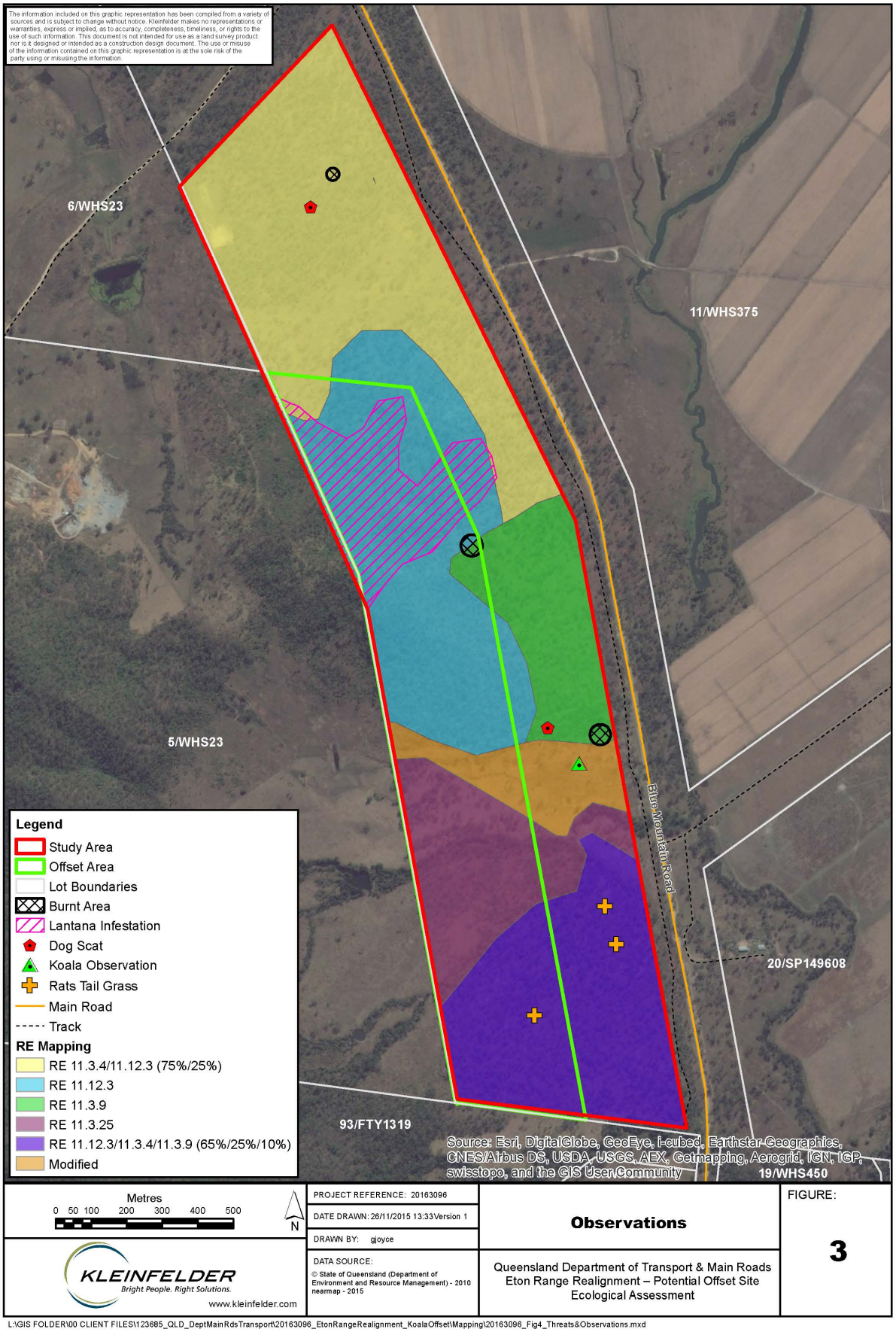


Figure 7: Field Verified Regional Ecosystems and Observations of the Site

Plate 1: Site photos from BioCondition quadrat 3

Plate 2: Site photos from BioCondition quadrat 6

The offset site has been assessed in accordance with the criteria outlined in Section 5.2 to determine the direct offset requirements for the Project (Table 8).

Table 8: Proposed Offset Site

Offset Site	Lot 1 RL5001 North of Epsom State Forest 1, Blue Mountain Road, Hazledean	
Total area of property	Lot 1 RL5001 is 166.2124 ha in size. In compliance with the outputs of the finalised EPBC Environmental Offsets Calculator, only the southern portion of the property is proposed as the Site.	166.2124 ha
Total area of Site	The southern portion of Lot 1 RL5001 is proposed as the Site.	75.17 ha
Habitat Quality[1]	*Condition*: Mapped as predominantly RE 11.12.3 and 11.3.25 which contain known Koala habitat. Moderate to Poor Modified BioCondition Class Scores.	8.25
	Context: Good site condition and is connected to Epsom State Forest 1 to the south. Mild – Moderate level of threats, including weed incursion, potential of bushfires and wild dogs.	7.67
	Species Stocking Rate: Medium to High levels of Koala activity identified from KSATs.	6.25
	Habitat Quality Score:	**7** (7.39)
Time over which loss is averted	A 20 year period has been applied as the Site will be legally secured.	20 years
Time until ecological benefit	A 0 year period has been applied as the habitat value is already present at the Site.	0 years
Risk of loss without offset	If the Site is not used as an offset it is at a moderate risk of being sold and potentially cleared for cattle grazing or mining, consistent with the surrounding land uses.	50%
Future quality without offset	Without protection and application the habitat quality is considered likely to reduce due to the existing threats of additional weed incursion and bushfires.	6
Risk of loss with offset	The Site will be legally secured.	0%
Future quality with offset	As the Site will be legally secured the habitat integrity will remain and will not be at risk of future clearing for agricultural/mining purposes. The management measures detailed below are expected to maintain the habitat quality of the Site.	7
Time over which loss is averted (max 20 years)	A 20 year period has been applied as the land will be legally secured.	20 years
Confidence in result	A high degree of confidence can be applied as the site is located adjacent to State Forest and contains existing Koala habitat	80%

[1] Quadrat sites 1 and 2 have been omitted from the calculation as they are located north of the Site and were undertaken within RE 11.3.4/11.12.3 (75/25) which is predominately located outside the Site (Figure 6 and Figure 7).

5.6 Results of Offsets Assessment Guide

The habitat scoring criteria developed for the Project has been based on the outcome of the site assessment of the Project area and offset Site (with summaries provided in Table 7 and Table 8 respectively). The full results are provided in Appendix I.

The results indicate that:

- The total impact area of the Project is 30.867 ha. The impact site has a Koala habitat quality score of 7.
- The Site is 75.17 ha with a current Koala habitat quality of 7. The expected future Koala habitat quality is also 7.
- Assuming that the Site was not legally secured the risk of averting the loss of the Site is 50% and the quality of the land will decrease to a habitat quality score of 6. The Site provides a 107.51% direct offset.

5.7 Management of Offset Site

An offsets area management plan (OAMP) will be prepared for this Site if DoE conditions this option, and will detail areas where management actions are to be implemented, with clear timeframes and performance objectives. This OAMP will be applied over a five year period.

In order to maintain the habitat quality of the proposed offset site at 7, a number of management measures are required, including the following:

- Moderating vehicle and machinery access;
- Removal of Lantana thickets, Giant Rats Tail Grass and other weeds over a five year period where required; and
- Management of fire risks.

There is also expected to be costs associated with ensuring that the potential site is legally secured, as well as ongoing monitoring of the site in line with the EPBC Approval.

The estimated total cost of these measures is approximately **$195,000**. This cost has been determined using best judgement, considering all the information available at the time of the valuation. It has been assumed that no land purchase is required for this offset site.

5.8 Compliance with the EPBC Act Offsets Policy

Option 2 has been developed in accordance with the principles and aims of the EPBC Act and EPBC Act Offsets Policy, as outlined in Table 9.

Table 9: Offset Proposal compliance with the EPBC Act Offsets Policy

Suitable offsets must:	Proposed offsets
(1) Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	This offset proposal provides a legally secured parcel of land with suitable habitat and connectivity for the koala.
(2) Be built around direct offsets but may include other compensatory measures	A 107.51% direct offset is identified in this offset proposal option.
(3) Be in proportion to the level of statutory protection that applies to the protected matter	The offset proposal has been defined based on the Offsets Assessment Guide, and therefore is considered consistent with the statutory protection afforded to the protected matters.
(4) Be of a size and scale proportionate to the residual impacts on the protected matter	The offset proposal has been defined based on the Offsets Assessment Guide, and therefore is considered consistent with the statutory protection afforded to the protected matters.

Suitable offsets must:	Proposed offsets
(5) Effectively account for and manage the risks of the offset not succeeding	The offset site is already owned by TMR and will be legally secured as part of this Offsets Proposal.
(6) Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)	There are no Queensland State approvals for the Koala for the Project. There are no State Offsets required as works do not involve an activity prescribed under Section 9(c) of *Environmental Offsets Act 2014*.
(7) Be efficient, effective, timely, transparent, scientifically robust and reasonable	The offset proposal includes clearly documented frameworks with an appropriate level of scientific rigour applied, relevant to the level of risk posed to the protected matters.
(8) Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	The offset proposal includes the commitment to develop a detailed OAMP for the Project, by TMR to be applied for a five year period.

6. Offset Option Analysis

A comparison of estimated outcomes and costs of Option 1 and 2 is provided in Table 10.

Table 10: Comparison of Estimated Costs for Option 1 and 2

Aspect	Option 1 – Hybrid Offset Package	Option 2 – Direct Land Offset Proposal
Long-term conservation value for the Koala	An initial study will be undertaken to help determine the population dynamics and movement patterns of Koalas within the vicinity of the Peak Downs Highway (Eton - Nebo). Future investment on Koala sensitive infrastructure along the Peak Downs Highway will then focus on increasing connectivity between the large amount of intact Koala habitat between Eton and Nebo. This option will aim at increasing scientific knowledge of the local Koala population. It will also lead to increases in Koala connectivity and reduce Koala fatalities along the Highway.	A portion of land containing identified habitat for the Koala will be legally secured, and management measures will be employed to ensure that the existing Koala habitat is maintained at its current habitat value. It is unknown whether the area that will be offset will make a long-term contribution to regional conservation of the Koala. This is due to the vastness of existing intact Koala habitat within the Clarke-Connors Range, of which most occurs in relatively secure land tenure.
Koala Research – CQ Study	$287,442	N/A
Investment in Koala sensitive infrastructure along the Peak Downs Highway	$200,000	N/A
Direct land offset and management measures	N/A	$195,000
Estimated Funding value	**$487,442**	**$195,000**

6.1 Stakeholder Consultation

TMR have been actively engaging with a number of government and community organisations regarding the Project and the offset proposal. Initial consultation with DEHP was undertaken for the development of the proposals. Discussions have been ongoing between TMR and Fauna Rescue Whitsundays (FRW) – a not for profit volunteer organisation that cares for the region's wildlife and habitat. A meeting was held on the 25/11/15 between representatives from TMR, FRW, and Ipswich's Moggill Koala Hospital. Feedback was received from the groups and considered in the offset proposal and the FMP. A letter of support from FRW towards Option 1 of this proposal is included in Appendix B.

6.2 Preferred Option

TMR considers that by directly studying and managing a major known threat to the Koala in the region (the Peak Downs Highway between Eton and Nebo), considerable improvements can be made towards Koala conservation in the region. Currently it is not known how significant the impacts of the Peak Down Highway are to the conservation of the regional population, nor how significance the loss of north-south connectivity is. The study will not only address large knowledge gaps in relation to the regional Koala population, but will aid in eventually increasing connectivity and decreasing vehicle strike through strategic investment on the Peak Downs Highway. Furthermore, it is intended that the results of the research program will be used by TMR to assist in the future upgrading of linear infrastructure projects in the region.

Despite the capacity of the direct land offset (Option 2) to continue to support Koalas, the size of the required offset is relatively small when considering the home range of an individual Koala, as well as the vastness of intact Koala

habitat along the Clarke–Connors Range and adjacent lowlands (Reef Catchments, 2015). Although habitat removal is identified as a residual risk of the Project, it is not considered as major of a threatening process in the region.

By targeting known knowledge gaps of the population, and developing and implementing strategic future investment for Koala sensitive infrastructure on the Peak Downs Highway, measureable environmental outcomes can be achieved that will have a long-term conservation value for the species in the region. Option 1 has greater potential to also leave a lasting legacy that is likely to be well supported by the local media, community, and relevant stakeholders.

7. References

Atlas of Living Australia (2015). *Atlas of Living Australia Online Search,* Canberra. Available at: http://biocache.ala.org.au/explore/your-area

DEHP (2015a). *Wildlife Online Extract*. Department of Environment and Heritage Protection, Brisbane. Available at: https://environment.ehp.qld.gov.au/report-request/species-list/

DEHP (2015b). *Clarke - Connors Ranges IBRA subregion — facts and maps*, WetlandInfo, Department of Environment and Heritage Protection, Brisbane. Available at: http://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/ibra-subregion-clarke-connors-ranges/

DoE (2013). *Significant Impact Guidelines 1.1: Matters of National Environmental Significance*. Department of Environment, Canberra. Available at: http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance

DoE (2015a). *EPBC Act Protected Matters Search Report*. Department of Environment, Canberra. Available at: http://www.environment.gov.au/epbc/pmst/index.html.

DoE (2015b). *Species Profile and Threats Database*. Department of Environment, Canberra. Available at: http://www.environment.gov.au/sprat.

DoE (2015c). *EPBC Act Environmental Offsets Policy*, Department of Environment, Canberra. Available at: http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy

DoE (2015d). *How to use the Offsets Assessment Guide*, Department of Environment, Canberra. Available at: http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy

DTMR (2013). *Technical Manual – Environmental Process Manual August 2013.* Department of Transport and Main Roads, Brisbane. Available from: http://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Environmental-processes-manual.aspx

Ellis, W., Melzer, A., and Bercovitch, F. (2009). *Spatiotemporal dynamics of habitat use by koalas: the checkerboard model.* Behavioral Ecology and Sociobiology, Pp. 1181-88.

Eyre, T., Kelly, A., Neldner, V., Wilson, B., Ferguson, D., Laidlaw, M., and Franks, A. (2015). *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

EcoSM (2011). *Eton Range Upgrade Project – Options W1A-W2A and X1A-X2A.* Report prepared for Department of Transport and Main Roads. Ecological Survey & Management, Brendale

EcoSM (2009). *Ecological Assessment Report Peak Downs Highway Realignment Eton Range Crossing.* Report prepared for Department of Transport and Main Roads. Ecological Survey & Management, Brendale.

EcoSM (2013). *Eton Range Realignment Project Fauna Assessment Report*. Report prepared for Department of Transport and Main Roads. Ecological Survey & Management, Brendale.

FRW (2015). Personal communication, Fauna Rescue Whitsundays Association, 26 November 2015.

McAlpine, C., Lunney, D., Melzer, A., Menkhorst, P., Phillips, S., Phalen, D., Ellis. W., et al. (2015). *Conserving Koalas: A Review of the Contrasting Regional Trends, Outlooks and Policy Challenges.* Biological Conservation v192 Pp. 226–36.

Melzer, A., (2015a). *Importance of koala habitat associated with the Eton Range Realignment Project.* Report prepared for the Department of Transport and Main Roads. Koala Research – CQ, Rockhampton.

Melzer, A., (2015b). *Comments on the proposed direct offset for cleared koala habitat associated with the Eton Range highway upgrade*. Report prepared for the Department of Transport and Main Roads. Koala Research – CQ, Rockhampton.

Melzer, A., (2014). *Ranking koala habitat using Queensland's mapped regional ecosystems*, Koala Research – CQ, Rockhampton.

Phillips, S. and Callaghan, J. (2011). *The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus,* Zoologist v35(3). Pp. 774-780

Prevett, P., Pope, R., Callaghan, J., and Bailey, L. (1995). *The Management and Research of Non-urban Koala Populations.* Central Queensland University, Pp. 94-97.

Reef Catchments (2015). *Clarke Connors Range – State of Region Report*, Reef Catchments, Mackay. Available at: http://reefcatchments.com.au/files/2014/09/3.1-Clarke-Connors-Range.pdf.

SMEC (2015). *Eton Range Realignment Project, Field Survey Report for Matters of National Environmental Significance.* Report prepared for the Department of Transport and Main Roads.

Appendix A: Koala Research – CQ Proposed Study 'Managing the Clarke Connors Range Koala Population'

Koala Research – CQ
a community funded research program
hosted by CQUniversity

Proposal: Managing the Clarke-Connors Range koala population

This study aims to address critical knowledge gaps around conservation biology and population dynamics of koalas in Central Queensland's hinterland ranges. There is a particular focus on the Clarke-Connors Range as these hills and ranges are considered to support one of the most extensive contiguous koala populations in Queensland, and are also considered likely to be a major area of refuge under both expected climate changes and the nation's expanding human footprint.

A lack of regional knowledge is providing uncertainty around the application of suitable conservation management measures around current and future upgrading and modification of major road corridors along the Peak Downs Highway. Consequently, the study will directly address koala connectivity issues associated with the existing Peak Downs Highway between Nebo and Eton.

The study is expected to run over two years and involves a number of discrete projects. These are:

1.0 Defining koala population management units across the Clarke-Connors Range;
2.0 Understanding koala habitat use, and diet, as well as ranging behaviour in the vicinity of the Eton to Nebo stretch of the Peak Downs Highway;
3.0 Habitat analysis and modelling to predict future koala-road kill hotspots on the Eton to Nebo stretch of the Peak Downs Highway; and
4.0 Investment planning for installation of wildlife barriers and underpasses on the Peak Downs Highway between Eton and Nebo.

It is understood that monitoring of the Eton Range koala underpass and fauna exclusion fencing will be undertaken by TMR post construction. These results, if available and where relevant, will be included within the reporting aspect of the study.

Key research team members include:

Dr Alistair Melzer, CQUniversity, a terrestrial ecologist specialising in koalas and koala habitat;

Dr William Ellis, a koala zoologist with broad experience in koala genetic studies, koala social interactions and habitat use, as well as GPS radio tracking of koalas;

Dr Sean FitzGibbon, a zoologist experienced in koala capture and VHF and GPS koala tracking;

Dr Ben Bath, a field zoologist with particular expertise in koala capture and tracking;

Mr Rolf Schlagloth, CQUniversity, currently developing koala road-kill hotspot modelling for Victorian highways.

CQUniversity will provide GIS technicians and field assistants as required to assist the principal research team.

CV's for the key team members are provided separately.

The cost (excluding GST) associated with this study is $287,442, including:

1.0 Defining koala population management units across the Clarke-Connors Range $47,300

2.0 Habitat analysis and modelling to predict future koala-road kill hotspots $64,468

3.0 Understanding koala habitat use, and diet, as well as ranging behaviour in the vicinity of highways $138,014

4.0 Investment planning for installation of wildlife barriers and underpasses on the Peak Downs Highway between Nebo and Eton. $21,160

5.0 Integrated reporting, workshop and project management $16,500

Please note that this study has been developed as a research activity with the expectation that the principal researchers and associated institutions will be able to publish the findings in appropriate peer reviewed journals as well as use the work to facilitate student studies and teaching.

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a.melzer@cqu.edu.au; a.melzer@cqes.com.au (preferred)

Context: Queensland's coastal ranges – centred on the Clarke-Connors range, have been identified as significant refugia in the past (Smith 2013), and have been proposed as future koala climate refugia identified in modelling by Adam-Hoskings *et al*. (2011), and, more broadly, as a biodiversity refugia in modelling by NSCAFF (Reside *et al.* 2013).

Recently, a contraction in the northern and western extent of the koala's range (Gordon *et al*. 2006, Seabrook *et al*. 2011) together with widespread declines in abundance across the central and northern parts of its range (McAlpine *et al*. 2015) have prompted national concern for the fate of the species (ECRC 2011), and the Commonwealth listing of the koala as *vulnerable* in New South Wales (NSW), Australian Capital Territory (ACT) and Queensland (Qld) (TSSC 2012). Range contractions are expected to continue with predicted increases in climate variability as well as increased frequency and intensity of extreme weather events impacting on koalas (Adam-Hoskings *et al*. 2011), and their habitat (Adam-Hoskings *et al*. 2012). These declines, and predicted climatic changes, have been associated with human-induced increases in greenhouse gasses – especially carbon dioxide, methane and nitrous oxide (IPCC 2013). There are expectations of an increase in maximum and minimum temperatures, increased frequency and duration of heat waves, as well as an increased severity and duration of droughts (Hughes and Steffen 2013, IPCC 2013). Consequently, there are widespread concerns about the continued survival of the koala.

Despite range contractions, koalas have persisted and maintain a widespread, but largely fragmented distribution across Queensland. We consider that current localities supporting koalas reflect refugia from the environmental challenges encountered over the last 25 years (Melzer *et al*. 2013). In broad terms these refugia are associated with the mountains, hills and scarps associated with the coastal ranges (including Kroombit Tops, Clarke-Connors Range), the precipice sandstones of the Carnarvon and associated ranges (including Blackdown Tableland), and the hills and ranges of the Einasleigh Uplands.

The coastal ranges from about Collinsville, south through the Clarke-Connors ranges, to the commencement of the Marlborough Hills (some 300 km), represents the most extensive regional koala population. Generally the koalas are located in the drier woodlands or open forests – mostly on the western aspect of these ranges, although populations still extend to the coast around St Lawrence and Clairview, as well as Sarina. In the latter case, however, these coastal populations are being fragmented as coastal development expands. This regional population has been little studied apart from some preliminary audits near St Lawrence (Melzer and Tucker 2011). This study estimated a population of some thousands of koalas in and around St Lawrence. A recent field inspection of properties near Nebo (Mt Spencer, adjacent to Mt Adder and Pinnacles) returned a moderate number of koala sightings, suggesting that the regional population there will also be quite high. Preliminary work at Sonoma State Forest, north of Collinsville, identified a low density population.

The terrain and geology of these coastal ranges has largely precluded their clearing for agriculture and their development for large-scale resource extraction. In addition, the dominant land uses of the ranges (nature conservation and intermittent cattle grazing) are largely able to coincide with the existing landscape without the need for modification.

However, there are some key threatening processes acting on this landscape. These include inappropriate land management (*e.g*. fire), increasing climate variability with impacts exacerbated by poor land management, development of the coastal lowlands, and ongoing road and rail kills associated with the Bruce Highway (Clairview/St Lawrence/Waverley Creek) and the Peak Downs Highway (Nebo to Eton), as well as the Nebo to Mackay rail link. Critically there is little known of the full extent, connectivity or ecology of this koala population or of the habitat upon which it is based. Consequently, it is difficult to make conclusions of the significance of any discrete impacts on either the local koala population or on the regional population.

Specifically, progressive upgrades of the Peak Downs Highway that cuts across this landscape results in small incremental losses of known koala habitat and connectivity, and have the potential to increase the road kill rate or the extent to which the highway provides an ecological barrier to koala dispersal. Potential further increases in mining traffic along the Highway resulting from development of the Galilee Basin will exacerbate this existing threat.

This proposal seeks to increase knowledge of the Clarke-Connors Range koala population, and facilitate improved conservation management for the species and its habitat. The project will include:

(a) A consideration of the effective koala-management units across the Clarke-Connors, and associated ranges;
(b) Habitat analysis and modelling to predict future koala-road kill hotspots on the Nebo – Eton stretch of the Peak Downs Highway; and
(c) Investment planning for installation of wildlife barriers and underpasses on the Peak Downs Highway between Nebo and Eton.

Basic studies of koala habitat use and movement patterns in the vicinity of the Nebo – Eton stretch of the Peak Downs Highway. The expected outputs are:

1. Increased knowledge of koala habitat use and diet, as well as the significance of the greater Clarke-Connors Range koala population, together with recommendations for future management.
2. A framework for predicting the occurrence of koala-hotspots on road corridors; and
3. Identification of koala-hotspots along the extent of the Nebo-Eton stretch of the Peak Downs Highway, together with recommendations on investment in wildlife barriers and associated mitigation works.

1.0 Effective management units across the Clarke-Connors and associated ranges

The aim of this project is to determine whether the koalas along the Clarke-Connors Range are a single management unit or form discrete management units. Understanding this will shed light on population connectedness (and hence the significance of any impacts in any one part of the range), and gene exchange across the area, and informs conservation management.

Methods: This project will examine the genetic relatedness of koalas across the extent of the ranges. Up to 30 tissue samples from at least two, and up to four widely distributed sites will be analysed. We currently hold samples archived from the DTMR St Lawrence/Waverley Creek study (Melzer and Tucker 2011). Further samples can be collected from road kills along the Peak Downs Highway in the ranges to the east of Nebo. (We understand that frozen bodies have been archived by local community members). Samples from two other sites (e.g. Collinsville, Lotus Creek - Collaroy district, or Croydon Road) will be collected from wild-caught koalas. Small tissue samples (approx. 5mm diameter) will be taken from each koala's ear and placed in 70% ethanol. Samples will be transported to the University of Queensland for analysis. *Note: Team members working on roadways will be provided with appropriate training and personal protective equipment, and will complete suitable risk assessment. Vehicles will be equipped with identification and flashing lights.*

Genetic analysis of these samples will rely on a 20 microsatellite panel developed at The University of Queensland, and based on previous markers identified by Houlden *et al*. (1999), and Cristescu *et al*. (2009), as well as unique markers identified by the University of Queensland research team (Ellis unpublished data). Single nucleotide polymorphic markers will not be used for this study as they are still under development. The 20 microsatellite panel will be sufficient to interpret the local and regional (as well as state wide and national) patterns of genetic connectivity amongst the study groups in this project. All DNA extraction and amplification will be undertaken in the laboratory at The University of Queensland.

Genetic diversity will be estimated separately for each group, or regional population, and compared to currently available datasets by locus – matching between studies where identical primers have been used. The mean number of alleles per locus, an unbiased estimate of heterozygosity (He) and observed heterozygosity (Ho) will be calculated using GENALEXversion 6.5 (Peakall and Smouse 2012). FSTAT (Goudet 2001) will be employed to calculate allelic richness, which uses rarefaction to correct the mean number of alleles/locus for sample size and FIS. We will test for deviations from Hardy Weinberg equilibrium using Markov chain analysis in Genepop on the Web (http://genepop.curtin.edu.au/; Raymond and Rousset1995).

It may also be possible to examine the stability of the population-based genetic diversity by comparing samples of different age, or from animals of different age. This will allow comment on the significance of variation in the genetic profile among local populations, hence informing management decisions. Over the course of our study, and with reference to archived samples, we would seek to detect temporal changes in expected heterozygosity and mean number of alleles per locus by combining koalas into groups according to age, and applying the Queller and Goodnight relatedness estimator as calculated in GENALEX version 6.5 (Peakall and Smouse 2012). We will use Wilcoxon signed rank test with GraphPad Prism version 6.0a for MacOSX GraphPad Software, La Jolla, California, USA, www.graphpad.com) to determine median relatedness values and significant departures from zero (unrelated).

Output: A technical report will be prepared describing the genetic diversity across the Clarke-Connors Range, drawing conclusions with regard to the regional relatedness and significance of the greater populations as well as providing management recommendations, where appropriate.

Costs: $47,300

2.0 Landscape analysis and modelling to predict future koala-road kill hotspots along the Eton – Nebo stretch of the Peak Downs Highway

Methods: This project extends research currently underway at CQUniversity. Currently, the koala team are analysing koala black-spots along a highway near Ballarat (Victoria). The aims are to understand what constitutes a black spot, understand what road conditions contribute to the likelihood of a koala strike, and develop a framework for predicting koala black spots more generally. This work is scheduled for completion in mid-2016 – although major conclusions should be available much earlier. Our intent is to apply the findings of this project to koala problem areas around the Peak Downs Highway between Eton and Nebo. The work will attempt to predict likely black spots. In broad terms the relationship between koala habitat attributes, topography and the pattern of road kills are analysed to identify associations with frequency of koala road deaths. Results will be tested against: (a) current DEHP and CQU records of koala road kills in this area; and (b) areas of known high value koala habitat. The project will produce a framework for predicting koala hotspots along the road, and provide input to decisions regarding investment in wildlife protection measures.

Effort: Desktop habitat quality – highway alignment analysis; ground-truthing and revision of analysis; predicting hotspots; field testing predictions on the Peak Downs Highway.

Output: ARC GIS compatible digital maps and hard copy maps will be prepared describing the koala-road-collision risk zones along the Eton to Nebo stretch of the Peak Downs Highway.

Costs: $64,468

3.0 Koala habitat use and movement patterns in the vicinity of the Eton – Nebo stretch of the Peak Downs Highway

Methods:

Koala ranging and habitat use: Ten koalas will be caught and fitted with GPS and VHF enabled collars. These animals will be caught in the ranges on the Nebo side of the range from habitat adjacent to the highway road reserve. The animals will be collared and tracked. Routine tracking using the VHF transmitters will be undertaken to develop a data base on tree use and animal behaviour during the breeding and non-breeding seasons. The project will run over two years. Every 3 to 4 months, the animals will be caught, and GPS data down loaded. At the end of the study all animals will be re-caught and collars removed. *Note: All collars are fitted with weak links. These perish over time. At that point the link breaks and the collars fall off. This ensures that no koala is left with a permanent collar.* Koala activity and habitat use will be mapped by relating GPS tracks and logged sighting coordinates to habitat maps and highway infrastructure maps.

Koalas will also be individually microchipped in order to successfully identify the animals if they are injured post study and taken in care. This is consistent with current practices by local wildlife carers when rehabilitated Koalas are released.

Roadkill: Carcasses will be logged, noting the species, location, and frequency of kill as well as date. The logging will utilise a geo-referenced, mobile devise deployed by local field assistants. The monitoring will extend the entire length of the highway from Eton to Nebo. Field workers will also stop (when safe to do so) and collect tissue samples for genetic analysis and also identify gender of the carcasses. Collected data will inform this project, and the modelling of koala hotspots. Data will be collected in four three-day campaigns, scheduled within the spring-summer months to coincide with the time of greatest koala activity. *Note: Surveyors will be provided with appropriate training and personal protective equipment and will complete suitable risk assessment. Vehicles will be equipped with identification and flashing lights.*

Diet: Although typical food species of the koala are broadly known (Melzer *et al*. 2014), local diet varies in association with plant leaf chemistry and landscape conditions (nutrients, moisture). To ascertain the regional importance of koala food tree species, koala diet will be determined through analysis of the content of fresh faecal pellets that will be collected from a range of habitat types. Traditionally, diet studies have relied on the manual identification and counting of known cuticle fragments in a large number of samples. Here, however, we intend to apply an analysis of eucalypt DNA within the faeces. The method has been used in other species, so suitable primers are available for a large number of organisms. We will use this method for analysing koala diets because it could provide a more efficient means to determine koala diets. The concept is straight forward: koala faeces are collected, DNA is extracted and a small fragment of DNA is amplified using suitable primers. Thereafter, Next generation sequencing is used to generate a large number of copies of each fragment, which are, in turn, used to determine number and proportion of each *Eucalyptus* species found in the sample.

Typical diet species for koalas across Queensland have been identified through previous work (Melzer *et al*., 2014), thus enabling us to generate a reference database of the key diet species for the region. Leaves from three trees of each prospective species will be collected and stored (silica gel) at ambient room temperature until DNA extraction.

As DNA fragments in faeces are typically small, target regions have to be short, variable and flanked by conserved genomic regions to allow solid primer design. This permits reliable amplification of a region where fixed, species-specific variations exist. Literature searches indicate that several possible chloroplast regions that have been used for species identification for diet analysis in herbivores, for example the trnL region (Valentini *et al*., 2009) can be used. This gene, which contains a small (36bp) P6 loop region, was found suitable for diet analysis in a number of small

herbivores (Soininen *et al*., 2009). However, the (generally) single-genus diet of koalas (*Eucalyptus*) has proved more challenging. Alignment of this region in publically available eucalypt chloroplast genomes indicated that this region was not variable enough to distinguish species for this genus. Based on this finding, a more *Eucalyptus*-focussed DNA-specific search was conducted.

A thorough analysis of the chloroplast genome of Australian *Myrtacea* revealed several hypervariable regions, including the intragenic spacers between the rpl 2 – tRNA –His and psbA (Bayly *et al*., 2013). Based on this finding, sample sequences spanning this region, from *E. microcorys, E. calmadulensis, E. elata, E. grandis, E. microcorys, E. obliqua* and *E. umbra* were downloaded from the National Centre for Biotechnical Information webpage (www.**ncbi**.nlm.nih.gov) and aligned manually using BioEdit. Both intragenic regions were considered suitably variable for the purpose of species identification. A set of already published primers (Vaillancourt and Jackson, 2000) to amplify these two regions are available.

DNA extraction and amplification: Approximately 5mg of dry leaf will be placed in a 1.5 ml microfuge snap lock tube along with metal beads and placed in a bead beater for 5 minutes, or until ground to a fine powder. DNA will be extracted using the Qiagen DNEasy plant mini kit according to the manufacturer's instructions, resulting in good quality, 10-20 ng DNA/µl extractions. DNA quality and quantity will be verified on a 1% agarose gel.

A polymerase chain reaction (PRC) will be conducted using the trnH primer as forward primer and rpl2 or psbA as reverse primer. PCRs will be conducted in 20µ reactions.

Resulting sequences will be imported into BioEdit and aligned manually to show clusters of identifiable units. In our work to date, *Eucalyptus grandis, E. microcorys* and *Lophostemon confertus* can be identified to species level, while the two *Corymbia* species, the two ironbarks (*E. melanophloia* and *E. crebra*), and *E. major* and *E. tereticornis* form three distinct pairs, where the pair cannot be told apart from each other, but have a unique sequence compared to the other five units.

This method will be applied across the sites (estimate based on four sites) and will include:

- Sampling prospective species and generating specific target sequences;
- Collecting and analysing scats (Storage, DNA extraction, PCR, report).

The results will be related to the local floristics to decide dietary species where species groups cannot be separated. For example, although *E. major* and *E. tereticornis* cannot be distinguished through this method, *E. major* does not occur in the region.

Output: (1) A report on koala ranging behaviour, tree use and relationship to the highway and associated infrastructure; including a consideration of gender and seasonal influences as well as statistics on highway crossings. Digital GPS track logs relating koala activity to other relevant GIS layers.(2) An analysis of the distribution of koala and other wildlife road kills along the highway and in relation to habitat and infrastructure characteristics. Data will be available as GIS compatible digital files. (3) A report on local koala diet and a discussion in relation to observed tree use reported in output 1 above.

Costs: $138,014

4.0 Investment planning for installation of wildlife barriers and underpasses

This project will incorporate the distribution of contemporary and recorded DEHP and CQ University road kills, modelling of potential hotspots, as well as the results of the tracking relating to tree use and movements in relation to the Peak Downs Highway. The project will focus on the Eton to Nebo stretch of the Peak Downs Highway. Initially, mapped vegetation along the highway route will be ground truthed. At the same time, surveys of koala activity will be undertaken. The surveys will use

scat distribution and frequency of occurrence, as well as direct sightings of koalas and mapped recent historical records. The results will be used to identify areas where the highway abuts high koala activity. This work will be mapped against the known characteristics of likely koala black spots. The results of the koala ranging and associated habitat will be considered in interpreting the likelihood of koala road interactions.

Output: A report and associated mapping will be prepared that identifies likely high risk areas and provides recommendations for future investment in wildlife protection and/or diversion infrastructure. The output will be related to topographical and road design features to identify likely locations for installation of protective/diversion fences, new underpasses, and/or retrofitting existing bridges and culverts.

Costs: $21,160

5.0 Integrated reporting, and project management

Dr Alistair Melzer will oversee the separate project elements and manage logistical support and field coordination. CQUniversity will provide contract management and regulatory oversight.

An integrated report and associated workshop with DTMR and other key stakeholders will be held upon project commencement, annually, and within three months of the completion of all elements of the study. Stakeholder meetings to report progress will be held every 6 months.

Cost: $16,500

Note: *All activities are subject to: (a) risk assessment and job safety analyses as appropriate, (b) appropriate permits from the DEHP (c) CQUniversity animal ethics approvals, and (d) approval to access both private and public owned land. There will be an experienced first-aider present with each catch team. Only experienced persons are used in these catch teams. Teams working along highways will be provided with additional training and risk assessment. They will be required to wear reflective clothing, have vehicles fitted with flashing lights, and to apply a road protocol to ensure that traffic flows are not interrupted and that other drivers are not put at risk.*

References

Adam-Hoskings, C., Grantham, H.S., Rhodes, J.R. McAlpine, C.A. and Moss, P.T. (2011). Modelling climate change-induced shifts in the distribution of the koala. *Wildlife Research* **38**, 122 – 130.

Adams-Hosking, C., McAlpine, C.A., Rhodes, J.R., Grantham, H.S. and Moss, P.T. (2012). Modelling changes in the distribution of the critical food resourses of a specialist folivore in response to climate change. Diversity and Distributions **18**, 847 – 860.

Bayly, M. J., Rigault, P., Spokevicius, A., Ladiges, P. Y., Ades, P. K., Anderson, C., Bossinger, G., Merchant, A., Udovicic, F., Woodrow, I. E. & Tibbits, J. (2013). Chloroplast genome analysis of Australian eucalypts – Eucalyptus, Corymbia, Angophora, Allosyncarpia and Stockwellia (Myrtaceae). *Molecular Phylogenetics and Evolution***, 69**, 704-716.

ECRC (2011) The koala-saving our national icon. *A report of the Environment and Communications Reference Committee*, The Senate. Commonwealth of Australia, Australian Capital Territory, Canberra.

Gordon, G., Hrdine, F. and Patterson, R. (2006). Decline in the distribution of the koala *Phascolarctos cinereus* in Queensland. *Australian Zoologist* **33(3),** 345 – 358.

Goudet, J. (2001). FSTAT, a program to estimate and test gene diversities and fixation indices (version 2.9.3).

Houlden, B. A., Costello, B.H., Sharkey, D., Fowler, E.V., Melzer, A., Ellis, W., Carrick, F., Baverstock, P.R. and Elphinstone, M.S. (1999) Phylogeographic differentiation in the mitochondrial control region in the koala *Phascolarctos cinereus* (Goldfuss, 1817). *Molecular Ecology* **8**, 999-1011.

Hughes, L. and Steffen, W. (2013) *Be prepared: Climate change and the Australian bushfire threat*. Climate Council of Australia Ltd.

IPCC (2013) Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the IPCC 5th Assessment Report. Intergovernmental Panel on Climate Change.

McAlpine, C., Lunney, D., Melzer, A., Menkhorst, P., Phillips, S., Phalen, D., Ellis, W., Foley, W., Baxter, G., de Villers, D., Kavanagh, R., Adams-Hosking, C., Todd, C., Whisson, D., Molsher, R., Walter, M., Lawler, I. and Close, R. (2015) Conserving Koalas in the 21st Century: Regional trends, challenges and prognoses. *Biological Conservation.* DX.DOI.ORG/10.1016/j.biocon.2015.09.020

Melzer, A., Ellis, W., FitzGibbon, S. and Carrick, F. (2013) 'Drought and the koala: two case studies from the central highlands' in Flint, N. and Melzer, A. (eds), *Conserving central Queensland's koalas*. Pp. 95-99, Koala Research Centre of Central Queensland, CQUniversity Australia, Rockhampton, Queensland.

Melzer, A., Ellis, W., FitzGibbon, S., Cristescu, R and Manno, G. (2014) The habitat and diet of koalas *Phascolarctos cinereus* in Queensland. *Australian Mammalogy* http://dx.doi.org/10.1071/AM13032.

Melzer, A. and Tucker, G. (2011) *Koalas of the St Lawrence Region of Central Queensland. A report to the Department of Transport and Main Roads*. Central Queensland Environmental Surveys. Cawarral, Queensland.

Peakall, R. and P. Smouse (2006). "GENALEX6: genetic analysis in Excel. Population genetic software for teaching and research. ." Molecular Ecology Notes(6): 288-295.

Raymond, M. and F. Rousset (1995). "GENEPOP (version 1.2): population genetics software for exact tests and ecumenicism." Journal of Heredity 86: 248-249.

Reside, AE, Van Der Wal, J, Phillips, BL, Shoo, LP, Rosauer, DF, Anderson, BJ, Welbergen, JA, Moritz, C, Ferrier, S, Harwood, TD, Williams, KJ, Mackey, B, Hugh, S, Williams, YM & Williams, SE (2013) *Climate change refugia for terrestrial biodiversity: Defining areas that promote species persistence and ecosystem resilience in the face of global climate change*, National Climate Change Adaptation Research Facility, Gold Coast, 216 pp.

Seabrook, L., McAlpine, C. Baxter, G., Rhodes, J. Bradley, A. and Lunney, D. (2011) Drought-driven change in wildlife distribution and numbers: a case study of koalas in south west Queensland. *Wildlife Research* **38**, 509 – 524.

Smith, M. (2013) *The Archaeology of Australia's Deserts*. Cambridge University Press, New York.

Soininen, E., Valentini, A., Coissac, E., Miquel, C., Gielly, L., Brochmann, C., Brysting, A., Sonstebo, J. H., Ims, R., Yoccoz, N. & Taberlet, P. 2009. Analysing diet of small herbivores: the efficiency of DNA barcoding coupled with high-throughput pyrosequencing for deciphering the composition of complex plant mixtures. *Frontiers in Zoology*, **6, 16**.

TSSC (2012) *Advice to the Minister for Sustainability, Environment, Water, Population and Communities from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (Threatened Species Scientific Committee, .Department of Environment, Australian Capital Territory, Canberra).

Valentini, A., Miquel, C., Nawaz, M. A., Bellemain, E. V. A., Coissac, E., Pompanon, F., Gielly, L., Cruaud, C., Nascetti, G., Wincker, P., Swenson, J. E. and Taberlet, P. (2009) New perspectives in diet analysis based on DNA barcoding and parallel pyrosequencing: the trnL approach. *Molecular Ecology Resources*, **9**, 51-60.

Appendix B: Correspondence with Fauna Rescue Whitsundays

Fauna Rescue Whitsundays Association Inc.
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PO Box 806 Cannonvale, QLD 4802
24/7 HOTLINE: (07) 4947 3389
Email: frwsecretary@gmail.com
Website : www.frw.org.au

26 November 2015

To: **Tim Dalton**
Environmental Officer | Mackay / Whitsunday District
Program Delivery And Operations | Department of Transport and Main Roads

Subject: Letter of Support for Eton Range EPBC Offset Research Proposal

Fauna Rescue Whitsundays would like to thank you for the opportunity to meet and comment on the Eton Range EPBC Offset Research Proposal.

As one of the local volunteer care providers for the regions wildlife, Fauna Rescue Whitsundays (FRW) has seen a dramatic increase in injured and orphaned koalas coming into care from the Peak Downs Highway in the last two years. FRW has been actively mapping koala sightings and rescues for the last 12mths and the data is showing we have a dramatic number of vehicle related injuries and deaths to koalas on the Peak Downs Highway between the Eton range and Nebo.

Fauna Rescue Whitsundays has been running community and industry awareness sessions about the plight of the local koala populations and we believe the EPBC offset research proposal including mapping and rehabilitation support, coupled with the addition of future wildlife crossings will have a positive effect in mitigating the number of vehicle related injuries and deaths we are documenting.

Yours sincerely,
Jan Gottke

Secretary

Fauna Rescue Whitsundays Association Inc

Appendix C: CVs (Koala Research – CQ)

Curriculum Vitae

Name: Alistair John Melzer

Contact details: 376 Coorooman Creek Road
Cawarral Qld 4072
0458246600 (Central Queensland Environmental Surveys)
0749 309944 (CQUniversity)

Date of birth: 29 March 1953
Citizenship: Australian
Marital status: married

Dr Alistair Melzer PhD Ecology (University of Queensland) has been working in the dry tropical environment of Queensland since 1989. Dr Melzer has worked with Queensland's industry, government and community since 1995 to resolve environmental problems associated with project development and subsequent management. These include:

- flora and fauna surveys associated with formal impact assessment,
- environmental management plans and associated ecosystem health monitoring,
- bush fire management strategies,
- weed management plans, and
- revegetation strategies and associated restoration success monitoring

in coastal, estuarine and inland Queensland.

Alistair Melzer also pursues applied research projects in partnership with state agencies, universities and the community. Currently these include:

- Koala conservation biology,
- Restoration of koala habitat under climate change, and
- Management of environmental weeds and the recovery of fire sensitive ecosystems.

He has provided impartial, expert advice to community, industry, state (New South Wales, South Australia and Queensland) federal agencies and local governments on a variety of environmental issues associated with conservation biology, biodiversity management, environmental risks associated with water management and coastal industrial development as well as environmental policy interpretation. He has been formally and informally involved in the recovery planning processes for the Bridled nailtail wallaby, Hairy-nosed wombat and the Yellow chat as well as conservation planning for the Koala and some ecosystems.

Dr Melzer was Director of the Centre for Environmental Management, CQUniversity, Rockhampton from 2001 to 31 December 2006 where he managed a multi disciplinary team of about 30 resource economists, marine, aquatic and terrestrial ecologists, ecotoxicologists and technical staff focused on industrial and resource management issues.

From March 2008, Dr Melzer has pursued an independent program of research, contract research and consulting through Central Queensland Environmental Surveys. He has authored or co-authored over 30 scientific papers and more than 60 technical reports. He also continues to supervise postgraduate students and international interns at CQUniversity.

Dr Melzer works on regional conservation biology and biodiversity management issues in protected, industrial and developing landscapes and considers the complex issues associated with achieving conservation outcomes within increasingly developed regional landscapes and

coastlines. He continues to publish scientific and ecological management papers. He is an Adjunct Research Fellow at CQUniversity.

Qualifications

Tertiary education

Doctorate of Philosophy – Botany, University of Queensland 1995.
Bachelor of Science (Honours) – Botany, University of Queensland 1988.
Bachelor of Science – Botany, University of Queensland 1986.
Certificate in Biological Laboratory Techniques - Queensland Institute of Technology (now Queensland University of Technology) 1976.

Secondary education

Senior Certificate - Nambour State High School 1970.
Junior Certificate - Nambour State High School 1968.

Training

Open water diving certificate - Professional Association of Diving Instructors 1979.
Senior first aid and cardiopulmonary resuscitation certificates.
Chainsaw operations (Level 1 and 2).

Memberships & affiliations

Member of Ecological Society of Australia.
Member of Royal Society of Queensland.
Member of Queensland Naturalists' Club Inc.
Member of the Koala Research Network.
Member of the Central Queensland Koala Volunteers.

Employment details

March 2008 to present	Principal, Central Queensland Environmental Surveys
January 2007 to March 2008	*Senior Research Fellow*
July 2001 to 31 December 2006	*Director*, Centre for Environmental Management (Formally Centre for Land and Water Resource Management).
Nov. 1999-July 2001	Interim Director, Centre for Environmental Management (Gladstone).
1996-1999	*Senior Research Officer*, Central Queensland University. Leader of the Industrial Land Management Programme within the Centre for Environmental Management in the Faculty of Arts, Health and Sciences.
1994-1996	*Research Fellow*, Central Queensland University, Rockhampton.
1984-94	Full time study through the Botany Department, University of Queensland.
1983	Travelled overseas for 12 months.
1975-82	*Technician* - Queensland Institute of Medical Research, Herston, Brisbane.
1972-74	*Cadet Technician* - Animal Research Institute, Yeerongpilly, Brisbane.

Post-graduate student supervision

Candidate: Mr Richard Knight
Degree: MSc
General topic: Rehabilitation success in Bowen Basin coal mines
Completed: 2002

Candidate: Ms Margaret Stanek
Degree: MSc
General topic: Habitat requirements for Bridled Nailtail Wallaby
Completed: 2000

Candidate: Ms Delma Clifton
Degree: part time PhD
General topic: Water turnover and field metabolic rate in koalas
Completed: 2008

Candidate: Ms Gail Tucker
Degree: Part time MSc
General topic: Habitat utilisation and survivorship of sub-adult koalas
Completed: 2010

Candidate: Ms Leonie Andersen
Degree: MSc
General topic: Eco toxicology and shell disease in mud crabs
Completed: 2003

Candidate: Ms Samantha Fox
Degree: Part time PhD
General topic: Conceptualisation of integrated environmental monitoring systems
Completed: 2009

Candidate: Mr John Clarke

Degree: Part time MSc
General topic: Ecology of the Kroombit Tinker Frog
Completed: 2007

Candidate: Ms Tina Ball
Degree: Part time MSc
General topic: Nature refuges as habitat for arboreal marsupials
Completed : 2008

Candidate: Mr Wayne Boyd
Degree: Full time PhD
General topic: Assessing rehabilitation success in Bowen Basin open cut coal mines
Completed: 2012

Candidate: Mrs Dixe Knott
Degree: Part time PhD
General topic: Influence of vegetation management on native flora and fauna
Completion expected: 2016

Candidate: Mr Rolf Schlagloth
Degree:PhD
General topic: Modelling koala road kill blackspots
Completion expected: 2016

Scientific Publications

1. McAlpine, C., Lunney, D., **Melzer, A**., Menkhorst, P., Phillips, S., Phalen, D., Ellis, W., Foley, W., Baxter, G., de Villers, D., Kavanagh, R., Adams-Hosking, C., Todd, C., Whisson, D., Molsher, R., Walter, M., Lawler, I. and Close, R. (in press 2015) Conserving Koalas in the 21st Century: Regional trends, challenges and prognoses.*Biological Conservation.*DX.DOI.ORG/10.1016/j.biocon.2015.09.020
2. Ellis, W., FitzGibbon, S., Pye, G., Whipple, B., Barth, B., Johnston, S., Seddon, J., **Melzer, A**., Higgins, D. and Bercovitch, F. (2015) The role of bioacoustics signals in koala sexual selection: insights from seasonal patterns of associations revealed with GPS-proximity units. *Plos One* doi:10,1371/journal.pone.0130657.
3. Kjeldsen, S.R., Zenger, K.R., Leigh, K., Ellis, W., Tobey, J., Phalen, D., Higgins, D., **Melzer, A**., FitzGibbon, S., Raadsma, H. W. (2015) Genome-wide SNP loci reveal novel insights into koala (*Phascolarctos cinereus*) population variability across its range. *Conservation Genetics* DOI 10.1007/s10592-015-0784-3
4. **Melzer, A.,** Ellis, W., FitzGibbon, S., Cristescu, R and Manno, G. (2014) The habitat and diet of koalas *Phascolarctos cinereus* in Queensland. *Australian Mammalogy* http://dx.doi.org/10.1071/AM13032.
5. **Melzer, A.**, Melzer, R, Dinwoodie, A, and Beard, D (2014) Recovery of herbaceous species richness following herbicide treatment of *Cenchrus ciliaris* (buffel grass) - a pilot study in *Onychogalea fraenata* (bridled nailtail wallaby) habitat restoration. *Proceedings of the Royal Society of Queensland.* **119**: 7-20.
6. Ellis, W., FitzGibbon, S., **Melzer, A.,** Wilson, R., Johnston, S., Bercovitch, F. Dique, D. And Carrick, F. (2013) Koala habitat use and population density: using field data to test the assumptions of ecological models. *Australian Mammalogy* dx.doi.org/10.1071/AM12023
7. Kollipara, A., Polkinghorne, A., Wan, C., Kanyoka, P. Hanger, J., Loader, J., Callaghan, J., Bell, A., Elis, W., FitzGibbon, S., **Melzer, A**., Beagley, K. and Timms, P. (2013) Genetic diversity of *Chlamydia pecorum* strains in wild koala locations across Australia and the implications for a recombinant *C. pecorum* major outer membrane protein based vaccine. *Veterinary Microbiology* **167 (3-4)**: 513 – 522.
8. Lee, K.E., Seddon, J.M., Johnston, S., FitzGibbon, S.I., Carrick, F., **Melzer, A.**, Bercovitch, F. and Ellis, W. (2013) Genetic diversity in natural and introduced island populations of koalas in Queensland. *Australian Journal of Zoology* http://dx.doi.org/10.1071/ZO12075.
9. Houston, W. A. and **Melzer, A**. (2012) Dry rainforests have a distinct and more diverse assemblage of epigaeic invertebrates than eucalypt woodlands: implications for ecosystem health monitoring. *Pacific Conservation Biology* **18 (2)**: 133 – 145.
10. Ellis, W., Bercovitch, F., Fitzgibbon, S., Roe, P., Wimmer, J., **Melzer, A.** and Wilson, R. (2011) Koala bellows and their association with the spatial dynamics of free-ranging koalas. *Behavioural Ecology* doi:10.1093/arq216
11. **Melzer, A**., Baudry, C., Kadiri, M, and Ellis, W. (2011) Tree use, feeding activity and diet of koalas on St Bees Island, Queensland. *Australian Zoologist* **35 (3):** 870-875.
12. **Melzer, A.**, Ellis, W., Gordon, G., Tucker, G., Kindness, R. And Carrick, F. (2011) Unusual patterns of tooth wear among koalas (*Phascolarctos cinereus*) from St Bees Island, Queensland, require re-evaluation of criteria for aging koalas by tooth-wear class. *Australian Zoologist* 35 **(3)**: 550-554.
13. Ellis, W., Bercovitch, F., Fitzgibbon, S., **Melzer, A**., de Villiers, D. and Dique, D. (2010) Koala birth seasonality and sex ratio across multiple sites in Queensland, Australia. *Journal of Mammalogy*, **91 (1)** 177 – 182.

14. Ellis, W., **Melzer, A**., Clifton, I.D. and Carrick, F. (2010) Climate change and the koala *Phascolarctos cinereus*: water use and energy. *Australian Zoologist* **35 (2)**: 369 – 377.
15. **Melzer A**, Ellis WA and Bercovitch F. (2010) Observations of male-on-male aggression among Queensland koalas (*Phascolarctos cinereus*) from central Queensland. *Queensland Naturalist* **48(1-3):**36-44.
16. Ellis. W. A. H., **Melzer, A**., and Bercovitch, F. B. (2009) Spatiotemporal dynamics of habitat use by koalas: the checkerboard model. *Behavioral Ecology and Sociobiology* **63 (8)** 1181-1188.
17. **Melzer, A**. and Ellis, W.A. (2009) Integrating research and conservation land management – a case study from koala research in St Bees Island national park. *Australian Journal of Environmental Management* **16**: 45-50.
18. Clifton, I.D., Ellis, W. A. H., **Melzer, A**. and Tucker, G. (2007) Water turnover and the northern range of the koala (*Phascolarctos cinereus*). *Australian Mammalogy* **29** 85 – 88.
19. Tucker, G., **Melzer, A**. and Ellis, W. (2007) The development of habitat selection by subadult koalas. *Australian Journal of Zoology*. **55** 1-5.
20. Augusteyn, J., **Melzer, A**., Porter, G., Houston, W., Clarke, J. (2005) Terrestrial vertebrate fauna of the serpentine communities near Marlborough. In: *Marlborough Serpentine Landscape Management and Conservation*. (editors Exelby, A., Wormington, K., and Melzer, A) Centre for Environmental Management, Central Queensland University, Gladstone, Qld
21. Exelby, A., Wormington, K., and **Melzer, A**. Eds (2005) *Marlborough Serpentine Landscape Management and Conservation*. Centre for Environmental Management, Central Queensland University, Gladstone, Qld
22. Exelby, A., Wormington, K., and **Melzer, A**. Eds (2005) *The State of Port Curtis*. Centre for Environmental Management, Central Queensland University, Gladstone, Qld.
23. Houston, W. and **Melzer, A**. (2005) Distinguishing effects of natural disturbances such as droughts on natural vegetation from potential industrial influence in the Port Curtis area using regional reference sites and the differential response of closed and open canopy vegetation.. In *The State of Port Curtis*. (Editors Exelby, A., Wormington, K., and Melzer, A) Centre for Environmental Management, Central Queensland University, Gladstone, Qld
24. **Melzer, A.** (2005) Towards a sustainable industrialised coastline. In *The State of Port Curtis*. (Editors Exelby, A., Wormington, K., and Melzer, A) Centre for Environmental Management, Central Queensland University, Gladstone, Qld.
25. **Melzer, A.** (2005) Introduction. In *Marlborough Serpentine Landscape Management and Conservation*. (editors Exelby, A., Wormington, K., and Melzer, A) Centre for Environmental Management, Central Queensland University, Gladstone, Qld.
26. Pfeiffer, A. **Melzer, A**., Tucker, G., Clifton, D. and Ellis, W. (2005) Tree use by koalas (*Phascolarctos cinereus*) on St Bees Island, Queensland – report of a pilot study. *Proceedings of the Royal Society of Queensland* **112**: 47-51.
27. Houston, W., **Melzer, A.**, Van Dyk. S. and Tucker, G. (2004) Range extension and additional habitat type for *Planigale tenuirostris* (Marsupialia: Dasyuridae) in Central Queensland. *Memoirs of the Queensland Museum* **49**: 649-652.
28. Taylor, J., Lloyd, L., **Melzer, A**., Faithful, J. (2004) Conserving ecosystems and managing biodiversity in industrial land and seascapes – Yabulu Nickel Refinery Experience. Partnerships and Pathways to implementation. Inaugural Global Sustainable Development Conference, 25-29 October Melbourne Vic. Mining Council of Australia.

29. **Melzer. A**., Tucker, G., Hodgon, J. and Elliott, B. (2003) A note on predation on koalas *Phascolarctos cinereus* by raptors, including Wedge-tailed eagles *Aquila audax*, in Queensland. *The Queensland Naturalist 41(1-3)*, 38-40.
30. Ellis, W.A.H., **Melzer, A**., Carrick, F.N. and Hasegawa M. (2002) Tree use and home range of the koala (*Phascolarctos cinereus*) at Blair Athol, central Queensland. *Wildlife Research* **29 (3)** 303-312.
31. Lyons K., **Melzer A.**, Carrick F. and Lamb D. Eds (2001) *The research and management of non-urban koala populations*. Koala Research Centre of Central Queensland. Central Queensland University, Rockhampton.
32. **Melzer A**. and Houston W. (2001) An overview of the understanding of koala ecology: how much more do we need to know? In: *The research and management of non-urban koala populations* (eds K. Lyons, A. Melzer, F. Carrick and D. Lamb). Koala Research Centre of Central Queensland. Central Queensland University, Rockhampton.
33. **Melzer A**., Carrick F., Menkhorst P., Lunney D. and St John B. (2000) Overview, critical assessment and conservation implications of koala distribution and abundance. *Conservation Biology* **14 (3)** 619-628.
34. Penn, A.M., Sherwin, W.B., Gordon, G., Lunney, D., **Melzer, A**., and Lacy, R.C. (2000) Demographic forecasting in Koala Conservation. *Conservation Biology* **14 (3)**, 629-638.
35. Houlden, B. A., Costello, B.H., Sharkey, D., Fowler, E.V., **Melzer, A**., Ellis, W., Carrick, F., Baverstock, P.R. and Elphinstone, M.S. (1999) Phylogeographic differentiation in the mitochondrial control region in the koala *Phascolarctos cinereus* (Goldfuss, 1817). *Molecular Ecology* **8**, 999-1011.
36. Evans R, Johnstone R., **Melzer A.** and Wade L. (1997) Any future for nature conservation within the industrial landscape - case studies from Central Queensland. In: *Proceedings - Conservation outside nature reserves*. Centre for Conservation Biology, University of Queensland, Brisbane.
37. Carrick F.N., Girjes A.A., **Melzer A.** and Ellis W.A. (1996) Prevalence of chlamydial infection in a relatively undisturbed koala population. In: *Koalas - Research for management* (editor G. Gordon). Proceedings of the Brisbane Koala Symposium, 22-23 September 1990. World Koala Research Incorporated, Brisbane.
38. **Melzer A.** (1996) Terrestrial Monitoring. In (editor J. Piorewicz) *Proceedings of the Workshop on the Boyne River estuary*, pages 76-83. Centre for Land and Water Resources and Queensland Alumina Ltd. Central Queensland University Press, Rockhampton, Qld.
39. **Melzer A**. and Lamb D. (1996) Habitat utilisation by central Queensland koala colony. In: *Koalas - Research for management* (editor G. Gordon). Proceedings of the Brisbane Koala Symposium, 22-23 September 1990. World Koala Research Incorporated, Brisbane.
40. **Melzer A**., Maclennan D. and Lamb D. (1996) Twenty-four hour activity and roost tree use: a guide to fodder selection by Central Queensland koalas. In: *Proceedings from a Conference on the Status of the Koala in 1995.* Pp. 138-144. Australian Koala Foundation, Brisbane.
41. Ellis W.A.H., **Melzer A.**, Green B., Newgrain K., Hindell M.A. and Carrick F.N. (1995) Seasonal variation in water flux, field metabolic rate and food consumption of free-ranging koalas (*Phascolarctos cinereus*). *Aust. J. Zool*. **43**, 59-68.
42. **Melzer A**. and Lamb D. (1994) Low density populations of the koala (*Phascolarctos cinereus*) in Central Queensland. *Proc. R. Soc. Qld*, **104**, 89-93.

43. **Melzer A**., Schneider M.A. and Lamb D. (1994) Insects associated with the faecal pellets of the koala, *Phascolarctos cinereus* Goldfuss. *Australian Entomologist* **21(3)**, 69-70.
44. Ellis W.A.H., Girjes A.A., Carrick F.N. and **Melzer A.** (1993) Chlamydial infection in koalas under relatively little alienation pressure. *Aust. Vet. J*. **70** (11) 427-428.
45. Worthington Wilmer J.M., **Melzer A**., Carrick F. and Moritz C. (1993) Low genetic diversity and inbreeding depression in Queensland koalas: implications for conservation. *Wildlife Research*, **20**, 177-188.
46. **Melzer A**. and Lamb D. (1992) Koala habitat in Central Queensland: Implications for management. In: *Fitzroy Catchment Symposium* Proceedings (eds L.J. Duivenvoorden, D.F. Yule, L.E. Fairweather and A.G. Lawrie), Central Queensland University, Rockhampton.

Book reviews

Melzer A. (2008) Koalas: Historical, Cultural and Social Context for Research and Management. A review of Koala; Origin of an Icon, Stephen Jackson Alan and Unwin. Journal of Mammalian Evolution. In Press.

Theses

Melzer A. (1988) *An investigation of some attributes of eucalypt forest and koala population density in southeast Queensland.* Honours Thesis, Botany Department, University of Queensland.

Melzer A. (1995) *Aspects of the ecology of the koala Phascolarctos cinereus (Goldfuss, 1817) in the sub-humid woodlands of Central Queensland.* PhD Thesis, University of Queensland, Brisbane, Qld.

Technical Reports

1. **Melzer, A**., Melzer, R. and Brushe, J. (2011) *Vegetation of Gawula (110SP178490) and the Recreation Reserve (109SP178490 State of Queensland NRM).* A report for the Gawula Aboriginal Land Trust. Central Queensland Environmental Surveys, Rockhampton.

2. **Melzer, A.** (2010) *Bajool Marble Quarry* Cycas megacarpa *recovery plan*. A report for Omya Australia. Central Queensland Environmental Surveys, Rockhampton.

3. **Melzer, A**. and Kopittke, L. (2010) Stanwell Fire Management Plan. A report for Stanwell Corporation Pty Ltd. Central Queensland Environmental Surveys, Rockhampton in association with Lloyd Consulting, Brisbane.

4. Lloyd Consulting (2009) *Neerkol Industrial Precinct Flora and Fauna Study.* Central Queensland Environmental Surveys, Lloyd Consulting and CQUniversity Australia's Centre for Environmental Management, Lloyd Consulting, Wilston, Brisbane.

5. **Melzer, A.** (2009) Weed Management Plan, Bajool Marble Quarry. A report for Omya Australia. Central Queensland Environmental Surveys, Rockhampton.

6. **Melzer, A.** (2008) *Environmental values, potential impacts and remediation strategies of a rock dump within MLA80145, Bajool Marble Quarry, Omya Australia.* Central Queensland Environmental Surveys, Rockhampton.

7. **Melzer, A.,** Melzer, R. Hearn, R. (2007) *Natural values of lands proposed to extend the Stanwell Power Station nature refuge*. Centre for Environmental Management, CQUniversity, Rockhampton, Qld.

8. Connolly, R. M., Currie, D. R., Danaher, K. F., Dunning, M., **Melzer, A**., Platten, J. R., Shearer, D., Stratford, P. J., Teasdale, P. R., Vandergradt, M. (2006) Intertidal wetlands of Port Curtis; Ecological patterns and processes and their implications. Technical Report 43 Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, Brisbane, Qld.

9. Houston, W., **Melzer, A**. and Black, B. (2006) *Faunal indicators of rehabilitation success at Callide coal mine – a pilot study*. A report to Anglo Coal (Callide Management) Pty Ltd. Centre for Environmental Management, Central Queensland University, Rockhampton, Qld.

10. **Melzer, A**. (2006) *An external reference site for the Yabulu Nickel Refinery EH&M programme.* Centre for Environmental Management, Central Queensland University, Rockhampton, Qld.

11. **Melzer, A.** (2006) *Managing buffel grass (*Cenchrus ciliaris*) within a fire prone environment at Nairana National Park.* Centre for Environmental Management, Central Queensland University, Rockhampton, Qld.

12. **Melzer, A.**, Hendry, R., Black, B. and Wormington, K. (2006) Hummock Hill Island
13. flora and fauna, survey. A report for East Wing Corporation. Centre for Environmental Management, Central Queensland University, Gladstone, Qld.

14. **Melzer, A.**, Houston, W. and Black, B. (2006) *Monitoring rehabilitation performance at Bajool Quarry*. A report to Omya Australia. Centre for Environmental Management, Central Queensland University, Rockhampton, Qld.

15. Wormington, K., **Melzer, A**., Stratford, P., Alquezar, R., Jacobs, K., and Wragg, G. (2006) *Flora and fauna of the Yabulu Coastal Sands. Report 10: Spring 2005 and Autumn 2006 monitoring*. A report to Yabulu Refinery, QNI Resources Pty Ltd. Centre for Environmental Management, Central Queensland University, Rockhampton, Qld.

16. Rogers, V., **Melzer, A**., Bamberg, B. (2005) *Pap2.1/2.2 Burnett Basin Regional Community Water Quality Networks and Rivercare. A report for the Burnett Mary Regional Group.* Centre for Environmental Management, Central Queensland University, Gladstone.

17. **Melzer, A**. (2004) *A proposal for the characterisation of marine habitats of Corio Bay, design of a baseline monitoring programme and the development of a community reporting framework for Corio Bay health.* Prepared for the Livingstone Shire Council. Centre for Environmental Management, Central Queensland University.

18. **Melzer, A**. (2004) *Potential consequences of reducing freshwater flow in Sandy Creek.* A report to Livingstone Shire Council. Centre for Environmental Management, Central Queensland University.

19. Rogers, V., Johnson, R. and **Melzer, A**. (2004) *Gladstone Area Water Board environmental monitoring programme, Aquatic ecosystem monitoring 2002: Habitat, biota and vegetation assessment*. A report to Gladstone Area Water Board. Centre for Environmental Management, Central Queensland University, Gladstone.

20. Rogers, V. and **Melzer, A.** (2004) *Gladstone Area Water Board environmental monitoring programme, Aquatic ecosystem monitoring 2004: Fish and habitat assessment.* A report to Gladstone Area Water Board. Centre for Environmental Management, Central Queensland University, Gladstone.

21. Wormington, K. Houston, W., **Melzer, A**., Shearer, D., Rogers, V. and Price, M. (2004) *Flora and fauna of the Yabulu Coastal Sands: technical report 8, Spring 2003 monitoring.* Report to Yabulu Refinery QNI Resources Pty Ltd. Centre for Environmental Management, Central Queensland University, Rockhampton.

22. Andersen, L E, Boundy, K, and **Melzer, A**, (2003) *Intertidal crabs as potential biomonitors in Port Curtis.* Centre for Environmental Management, Central Queensland University. Gladstone. Report to CRC.

23. Houston, W, **Melzer, A**, Price, M, McKenna, L, Lowry, R, and Tucker, G, (2003) *Seasonal Fauna Survey of Newlands Coal Mine (Surface).* Report to Newlands Coal. Terrestrial Ecology Programme, Centre for Environmental Management, Central Queensland University. Rockhampton.

24. Houston, W, **Melzer, A**, Wormington, K, Lowry, R, Price, M, McKenna, L, and Tucker, G, (2003) *Fauna Survey of the Mount Morgan Mine MM104*. Report to the Department of Natural Resources and Mines. Centre for Environmental Management, Central Queensland University. Rockhampton.

25. Wake, J, Houston, W, and **Melzer, A**, (2003) *Assessment of Proposed Development Site at East Point Mackay.* Report to Mackay City Council. Centre for Environmental Management, Central Queensland University. Mackay.

26. Currie, D., Small, K., Johnson, R., Shearer, D., Campbell, J., Boundy, K. and **Melzer, A**. (2002). *Halifax Bay marine monitoring programme – QNI, Yabulu monitoring: October 2001*. Centre for Environmental Management, Central Queensland University, Gladstone.

27. Houston, W. and **Melzer, A.** (2002) *Baseline biological monitoring of Gladstone airshed influences on regional woodlands and forests*. State of Port Curtis Conference, 23-25th October 2002, Central Queensland University, Gladstone.

28. Houston, W., **Melzer, A**., Price, M., McKenna, L. and Lowry, R. (2002) *Fauna Survey of Newlands Coal Mine (surface), Winter 2002.* Interim Report to Newlands Coal. Industrial Land Management Programme, Centre for Environmental Management, Central Queensland University, Rockhampton.

29. Houston, W., **Melzer, A**., Price, M. and Rogers, V. (2002*) Fauna Survey of Oldman South ML, May 2002.* Report to Queensland Magnesia Inc (QMAG). Industrial Land

Management Programme, Centre for Environmental Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

30. Houston, W., Wormington, K. and **Melzer, A**. (2002) *Fauna Survey of Mt Morgan Mine, Dry Season (July)*, 2002. Interim Report to Department of Natural Resources and Mines. Industrial Land Management Programme, Centre for Environmental Management, Central Queensland University, Rockhampton.

31. **Melzer, A**., Houston, W., Johnson, R., Cooper, A., Rogers, V., Price, M., Hamilton, D., Lowry, R., Tucker, G., Yates, E. and Mitchell, C. (2002) *Flora and Fauna of the Yabulu Coastal Sands: Report 6. Spring 2001 Monitoring.* Report to Yabulu Refinery, QNI Resources Pty Ltd. Industrial Land Management Programme, Centre for Environmental Management, Central Queensland University, Rockhampton.

32. Rogers, V., **Melzer, A**., Price, M., Shearer, D. and Wormington. K. (2002) *Shale Oil Project: Terrestrial flora and fauna studies; Report 15: Biological monitoring of aquatic environments – winter 2001.* Industrial Land Management & Planning, Centre for Environmental Management, Central Queensland University, Rockhampton.

33. Houston, W., Cooper, A., Hamilton, D., Augusteyn, J., Attard, T., Mitchell, C., Champion, I., Hendry, R., Lobergeiger, V., Rayner, D. and **Melzer, A**. (2001) *Ecological monitoring in the Calliope and Boyne rivers as well as Baffle creek: terrestrial riparian monitoring.* A report for the Gladstone Area Water Board. Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

34. Kasel, S., **Melzer, A**., Elliott, B., Cai, L. and Scriffignano, J. (2000) *Conservation Management strategy for the Awoonga Dam area: Fauna. Classification of habitat types*. A report to the Gladstone Area Water Board. Industrial Land Management Programme, Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

35. Kasel, S., Elliott, B. and **Melzer, A.** (2000) *Code of Practice: Wildlife rescue within the Awoonga Dam area.* A report to the Gladstone Area Water Board. Industrial Land Management Programme, Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

36. Houston, W. and **Melzer, A.** (2000) *Environmental assessment of the lands associated with the Neerkol Orphanage*. A report to Stanwell Corporation. Industrial Land Management Programme, Centre for Land and Water Resource Management, faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

37. Melzer A., Hendry, R., Rideout, J., Lewis, S., Aspland, S. and Gallacher, D. (2000) *Buffer zone impacts at the Australian Magnesium Corporation research and development plant at Gladstone: Report 2.* Industrial Land Management Programme, Centre for Land and Water Resource Management, Central Queensland University.

38. Houston W., **Melzer A**., Aspland S. and Scriffignano. J. (1999) *Stuart Oil Shale Project: terrestrial and aquatic flora and fauna studies: Report5-Terestrial monitoring March - April 1998.* Industrial Land Management Programme, Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University.

39. Houston W., **Melzer A**., Elliott B., Lowry R. and Scriffignano (1999) *Stuart Oil Shale Project: terrestrial and aquatic flora and fauna studies: Report 3a-Audit of the vertebrate fauna of the Targinie area north of Gladstone, January 1998*. Industrial Land Management Programme, Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University.

40. Houston W., **Melzer A**., Scriffignano J., Elliot B., Lowry R., Radic P. and Heinrich B. (1999) *Terrestrial fauna of the Stanwell Power Station*. A report to Stanwell Corporation. Industrial Land Management Programme, Centre for Land and Water Resource Management, faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

41. **Melzer A**. (1999*) Environment and conservation management strategy: Yabulu Refinery, QNI Resources Pty Ltd.* Centre for Land and Water Resource Management. Central Queensland University, Rockhampton.

42. **Melzer, A**., Porter, G., Houston, W., Clarke, J., Whereat, C., Tangey, B. and Augusteyn, J. (1999) *Investigation of the habitat of* Diplodactylus *spp.* nova *in the serpentine hills near Marlborough*. Central Queensland University, Rockhampton.

43. **Melzer, A**., Rayner, D., Hendry, R., Knight, R., Orr, J., Scriffignano, J. Hamilton, D. and Attard, T. (1999) *Flora and fauna of the inundation areas associated with the raising of the Awoonga Dam.* Centre for Land and Resource Management, Central Queensland University, Rockhampton, in association with Sinclair Knight Merz, Rockhampton.

44. **Melzer A**., Walker, M., Roberts, D., Tucker, G., Elliott, B., Aspland, S., Hendry, R., Heinrich, B., Augusteyn, J., Lowry, R., Price, M., Knight, R. and Radic, P. (1999) *Flora and fauna of MDL 177 – Southern Pacific Petroleum (Development)*. Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

45. Tucker G., Rayner D., Elliott B., Lowry R. and **Melzer A**. (1999) *Terrestrial fauna and flora of the South Walker Creek proposed coalmine extension (ML 4750) near Nebo, Queensland.* Industrial land Management Programme, Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

46. Yates E. and **Melzer A**. (1999) *Monitoring mangroves: a review with reference to the mangroves of Yabulu sands.* Yabulu Nickel refinery, QNI Resources Pty Ltd. Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

47. Clarke J., Pickering G. and **Melzer A.** (1998) *Habitat assessment of proposed diversion of South Walker Creek near Nebo in Central Queensland*. A report to BHP Coal. Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

48. Houston W., Brushe J. and **Melzer A**. (1998*) Flora and fauna of the Yabulu coastal sands. A report to Queensland Nickel Ltd.* Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

49. Houston W., Brushe J. and **Melzer A**. (1998*) Flora and fauna of the Yabulu coastal sands II: after the 1997 floods. A report to Queensland Nickel Ltd.* Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

50. **Melzer, A.**, Houston, W., Rayner, D., and Lowrey, R. (1998) *Terrestrial fauna of the serpentine communities associated with the proposed Marlborough Nickel Project*. Central Queensland University, Rockhampton.

51. **Melzer A**. and Pickering G. (1998) *Vegetation of the Suttor Creek Project (ML4761) Glenden (Nebo Shire).* A report to Newlands Coal Pty Ltd. Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

52. **Melzer A**., Pickering G. and Scriffignano J. (1998) *Vegetation of Stanwell Power Station*. A report to Stanwell Corporation. Industrial Land Management Programme, Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

53. Florence R., **Melzer A**. and Smith A. (1997*) Recommendations for management of koalas in Pine Creek State Forest and the formulation of a koala management plan*. A report on the Scientific Working Party workshops. Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton.

54. Houston W. and **Melzer A**. (1997) Pre-*site disturbance audit of targeted fauna associated with Stage 1 dams on the Stuart Mining Lease, Gladstone.* Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

55. **Melzer A**. and Brushe J. (1997) *Remnant vegetation conservation and management strategy.* A report to the Livingstone Shire Remnant Vegetation Committee. Centre for Land and Water Resource Management. Central Queensland University, Rockhampton.

56. **Melzer A**. and Houston W. (1997) *Distribution and ecology of the koala.* Koala Research Centre of Central Queensland. Faculty of Applied Science, Central Queensland University, Rockhampton.

57. Melzer R., Pickering G. and **Melzer A**. (1997) *Surveys for rare and threatened flora on selected State Forests.* Centre for Land and Water Resource Management, Central Queensland University, Rockhampton.

58. Houston W. and **Melzer A**. (1996) spring *survey of the avian fauna of Walker Creek, Nebo, Central Queensland.* Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

59. Houston W. and **Melzer A**. (1996) Impact *of the raising of the dam wall of Mt Morgan Dam No. 7 on terrestrial fauna and flora*. A report to Mt Morgan Shire Council. Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University, Rockhampton.

60. Houston W. and **Melzer A**., Pickering G. and Elliot B. (1996) *Flora and fauna of Poitrel Mining Lease near Moranbah in Central Queensland.* A report to BHP Coal. Centre for Land and Water Resources, Faculty of Applied Science, Central Queensland University, Rockhampton.

61. **Melzer A**. (1996) *Assessment of the significance of a proposed four hectare clearing on habitat utilisation by a population of koalas at the Coolangatta-Tweed Golf Club.* A report to AGC Woodward-Clyde Pty Ltd. Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton.

62. **Melzer A**. (1996) *Assessment of the impact of modifications to the course of the Coolangatta-Tweed Golf Club on a resident population of koalas.* A report to AGC Woodward-Clyde Pty Ltd. Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton.

63. **Melzer A**. (1996) Plan *of management for the koala population within the Coolangatta-Tweed Golf course.* Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton.

64. **Melzer A**., Hendry R. and Pickering G. (1996) *Tramline assessment through SF840 Bingera.* A report to the Isis Central Sugar Mill. Centre for Land and Water Resources, Faculty of Applied Science, Central Queensland University, Rockhampton.

65. **Melzer A**., Houston W. and Porter G. (1996) *Fauna of Curragh Coal Mine, Blackwater, Central Queensland.* Centre for Land and Water Resource Development, Central Queensland University, Rockhampton.

66. **Melzer A**. and Melzer R. (1996) *Flora and fauna assessment of Gregory Mine Remnant - suitability of the remnant for bridled nailtail captive colony/ release site*. Central Queensland Environmental Surveys, Rockhampton.

67. **Melzer A**., Rayner D. and Cox M. (1996) *Flora and fauna on South Walker Creek Mine, Nebo, Central Queensland.* A report to BHP COAL Australia. Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton.

68. **Melzer A**. and Riley S.J. (1996*) Maintenance and management of biodiversity around the Boyne Island Aluminium Smelter*. Centre for Land and Water Resource Management, Faculty of Applied Science, Central Queensland University, Rockhampton.

69. **Melzer A**., Brushe J. and Rey P. (1995) Vegetation *of the Boyne Smelters Ltd buffer zone.* A report to Boyne Smelters Ltd. Centre for Land and Water Resource Management. Central Queensland University, Rockhampton.

70. **Melzer A**. and Childs L. (1995) Terrestrial flora and fauna. In: *Biological and ecological data (excluding fisheries) on the Dawson River system with particular reference to the proposed Nathan Dam* (Author/editor L.J. Duivenvoorden). River and Wetland Ecology Group, Centre for Land and Water Resource Development, Central Queensland University, Rockhampton.

71. **Melzer A.,** Houston W., Clancy N., Childs L. and Rey P. (1995) *Fauna of the Boyne Smelters Ltd buffer zone.* A report to Boyne Smelters Ltd. Centre for Land and Water Resource Development, Central Queensland University, Rockhampton.

72. **Melzer A**. (1994) Evaluation *of the proposed Stanwell Power Station Nature Refuge.* Central Queensland Environmental Surveys, Rockhampton, Qld.

73. **Melzer A**. and Lamb D. (1994) *Koala habitat and its utilisation at Springsure in Central Queensland.* A report to the Australian Koala Foundation.

74. **Melzer A**. and Lamb D. (1994)) Koala *habitat and its utilisation at Springsure in Central Queensland.* A report to BHP Coal Australia.

75. **Melzer A**. and Melzer R. (1993) *Vegetation of Lot 5, Mulambin Beach - recommendations for an environmentally sensitive residential estate*. Central Queensland Environmental Surveys, Rockhampton.

76. **Melzer A**. (1991) The *Stanwell Power Station environs as koala habitat.* A report to the Queensland Electricity Commission.

Posters

Ball, T., Wake, J., **Melzer, A**. and Goldingay, R. (2004) Squirrel gliders in the Mackay area. Poster presentation. Australian Mammal Society Conference. 4th to 7th July 2004. Tanunda, South Australia.

William Ellis PhD

Resume

27 Dudley St Bardon Q 4065 Ph 0428105275 email w.ellis@uq.edu.au

Tertiary Education

Master of Environmental Law: The Australian National University, Canberra ACT. *2003*

Doctor of Philosophy: The University of Queensland, Brisbane, Queensland. *1998.*

Bachelor of Science (Honours): The Australian National University, Canberra, ACT. *1986.*

Employment History

Current **Senior Research Fellow**

School of Agriculture and Food Science, The University of Queensland, Q 4072

Adjunct Research Fellow

Centre for Environmental Management, CQ University, Q 4702

2005 – 2011 **Clarke Endowed Conservation Postdoctoral Research Fellow**

San Diego Zoo Institute for Conservation Research, San Diego, USA

2000-2005 **Senior Research Officer**

School of Integrative Biology, The University of Queensland, Brisbane, 4072

1995-2000 **Research Officer**

School of Integrative Biology, The University of Queensland, Brisbane, 4072

1994-1995 **Research Assistant**

School of Integrative Biology, The University of Queensland, Brisbane, 4072

1992 – 1994 **Curator**

"Cairns Tropical Zoo", via Palm Cove, Cairns, 4870.

In brief

I am a behavioural ecologist specialising in the biology of the koala, with long-term field study sites and projects across peri-urban and rural Queensland. Based at The University of Queensland, I have collaborative research partnerships across a variety of institutions nationally and internationally.

Current Projects

1. Ecology of koalas in central Queensland: St Bees Island. Partners include CQ University, San Diego Zoo Global, The Earthwatch Institute, Queensland Parks and Wildlife Service Mackay Marine Parks, Queensland Department of Environment and Heritage Protection - Central Region, Queensland University of Technology.
2. Spatial dynamics of koalas: pathways of pathogen transfer. Queensland State Government Koala funding grant KRG024. St Bees Island.
3. Climate change and the koala: heat load in the koala. Queensland State Government Koala funding grant KRG022. State – wide. University of Queensland and CQ University (Dr Alistair Melzer)
4. Recolonising former koala habitat. Funded by Queensland Department of Environment and Heritage Protection. University of Queensland and Australia Zoo Wildlife Hospital.
5. Ecology of koalas in the Brisbane Valley, Queensland. Funded by Powerlink. (Principal Investigator).

PhD and M Phil Projects Supervised:

Current

1. Ph.D. Urban koalas-their role in a regional koala population. (Student: Diedre De Villiers, University of Queensland: Awarded 2015)

Recently Completed

1. PhD: Environmental water relationships of the koala, *Phascolarctos cinereus*, and the importance of the microenvironment in tropical habitats. (Student: Delma Clifton, Central Queensland University: PhD awarded 2010)

2. Ph.D. Diseases and the immune system: molecular genetics of koalas (Student: Kristen Lee, University of Queensland: PhD Awarded 2010)

3. M. Phil: The general ecology, growth and survival of sub-adult koalas on St Bees Island. (Student: Gail Tucker, Central Queensland University: M. Phil awarded 2009)

Referees

Dr. Robbie Wislon, Senior Lecturer, School of Biological Sciences, The University of Queensland, Brisbane 4072. Ph. +61 7 33652773 Email: r.wilson@uq.edu.au

Prof. F. B. Bercovitch, Wildlife Research Center, Kyoto University, Inuyama, Aichi 484-8506, Japan. Ph. 18583824157 Email: fbercovitch@gmail.com

Dr. Alistair Melzer, Director, Centre for Environmental Management, Central Queensland University, PO Box 1319, Gladstone, Queensland 4680 Ph. +71 7 49708310, Mob 0439875622, a.melzer@cqu.edu.au

Recent publications (2010 – present: full list available on request)

Ellis, W., S. FitzGibbon, et al. (2015). "The Role of Bioacoustic Signals in Koala Sexual Selection: Insights from Seasonal Patterns of Associations Revealed with GPS-Proximity Units." PLoS ONE **10**(7): e0130657.

Kjeldsen, S., K. Zenger, et al. (2015). "Genome-wide SNP loci reveal novel insights into koala (Phascolarctos cinereus) population variability across its range." Conservation Genetics: 1-17.

McAlpine, C., D. Lunney, et al. (2015). "Conserving koalas: A review of the contrasting regional trends, outlooks and policy challenges." Biological Conservation **192**: 226-236.Craig, A. P., J. Hanger, et al. (2014). "A 5-year Chlamydia vaccination programme could reverse disease-related koala population decline: Predictions from a mathematical model using field data." Vaccine **32**(33): 4163-4170.

Ellis, W., R. Attard, et al. (2014). "Faecal particle size and tooth wear of the koala (Phascolarctos cinereus)." Australian Mammalogy **36**(1): 90-94.

Melzer, A., R. Cristescu, et al. (2014). "The habitat and diet of koalas (*Phascolarctos cinereus*) in Queensland." Australian Mammalogy **36**(2): 189-199.

Seddon, J. M., K. E. Lee, et al. (2014). "Testing the regional genetic representativeness of captive koala populations in South-East Queensland." Wildlife Research **41**(4): 277-286.

Ellis, W., S. FitzGibbon, et al. (2013). "Koala habitat use and population density: using field data to test the assumptions of ecological models." Australian Mammalogy **35**(2): 160-165.

Johnston, S. D., R. A. Booth, et al. (2013). "Is faecal cortisol or corticosterone a reliable index of acute serum cortisol secretion in the koala (*Phascolarctos cinereus*)?" Australian Veterinary Journal **91**(12): 534-537.

Kollipara, A., A. Polkinghorne, et al. (2013). "Genetic diversity of *Chlamydia pecorum* strains in wild koala locations across Australia and the implications for a recombinant *C. pecorum* major outer membrane protein based vaccine." Veterinary Microbiology **167**(3-4): 513-522.

Lee, K., J. Seddon, et al. (2013). "Genetic diversity in natural and introduced island populations of koalas in Queensland." Australian Journal of Zoology **60**(5): 303-310.

Lee, K. E., W. A. H. Ellis, et al. (2013). "Anthropogenic changes to the landscape resulted in colonization of koalas in north-east New South Wales, Australia." Austral Ecology **38**(3): 355-363.

Matthews, A., L. Ruykys, et al. (2013). "The success of GPS collar deployments on mammals in Australia." Australian Mammalogy **35**(1): 65-83.

Melzer, A., W. Ellis, et al. (2013). Central Queensland's Koala Islands. Conserving central Queensland's koalas. N. Flint and A. Melzer. Rockhampton, Queensland, Koala Research Centre of Central Queensland**:** 25-28.

Pye, G. W., W. Ellis, et al. (2013). "Serum vitamin D levels in free-ranging koalas (*Phascolarctos cinereus*)." Journal of zoo and wildlife medicine : official publication of the American Association of Zoo Veterinarians **44**(2): 480-483.

Schmidt, D. A., G. W. Pye, et al. (2013). "Fat-soluble vitamin and mineral comparisons between zoo-based and free-ranging koalas (*Phascolarctos cinereus*)." Journal of Zoo and Wildlife Medicine **44**(4): 1079-1082.

Charlton, B., W. Ellis, et al. (2012). "Perception of size-related formant information in male koalas (*Phascolarctos cinereus*)." Animal Cognition **15**: 999-1006.

Charlton, B. D., W. A. H. Ellis, et al. (2012). "Female koalas prefer bellows in which lower formants indicate larger males." Animal Behaviour(84): 1565-1571.

Charlton, B. D., D. Reby, et al. (2012). "Estimating the Active Space of Male Koala Bellows: Propagation of Cues to Size and Identity in a Eucalyptus Forest." Plos One **7**(9): e45420.

Cristescu, R., W. Ellis, et al. (2012). "North Stradbroke Island: an island ark for Queensland's koala population?" Proceedings of the Royal Society of Queensland **2012**: 309-334.

Pye, G., W. Ellis, et al. (2012). "Serum protein electrophoresis values for free-ranging and zoo-based koalas (*Phascolarctos cinereus*)." Journal of Zoo and Wildlife Medicine **43**(1): 177-180.

Woosnam-Merchez, O., R. Cristescu, et al. (2012). "What faecal pellet surveys can and can't reveal about the ecology of koalas *Phascolarctos cinereus*." Australian Zoologist **36**(2): 192-200.

Charlton, B. D., W. A. H. Ellis, et al. (2011). "Perception of Male Caller Identity in Koalas (*Phascolarctos cinereus*): Acoustic Analysis and Playback Experiments." Plos One **6**(5).

Charlton, B. D., W. A. H. Ellis, et al. (2011). "Cues to body size in the formant spacing of male koala (*Phascolarctos cinereus*) bellows: honesty in an exaggerated trait." Journal of Experimental Biology **214**(20): 3414-3422.

Ellis, W., F. Bercovitch, et al. (2011). "Koala bellows and their association with the spatial dynamics of free-ranging koalas." Behavioral Ecology **22**(2): 372-377.

Ellis, W. and F. B. Bercovitch (2011). "Body size and sexual selection in the koala." Behavioral Ecology and Sociobiology **65**(6): 1229-1235.

Melzer, A., C. Baudry, et al. (2011). "Tree use, feeding activity and diet of koalas on St Bees Island, Queensland." Australian Zoologist **35**(3): 870-875.

Melzer, A., W. Ellis, et al. (2011). "Unusual patterns of tooth wear among koalas *Phascolarctos cinereus* from St Bees Island, Queensland, require re-evaluation of criteria for aging koalas by tooth-wear class." Australian Zoologist **35**(3): 550-554.

Ellis, W., F. Bercovitch, et al. (2010). "Koala birth seasonality and sex ratios across multiple sites in Queensland, Australia." Journal of Mammalogy **91**(1): 177-182.

Ellis, W., A. Melzer, et al. (2010). "Climate change and the koala *Phascolarctos cinereus* : water and energy." Australian Zoologist **35**(2): 369-377.

Ellis, W. A., S. I. Fitzgibbon, et al. (2010). "Unraveling the mystery of koala vocalisations: acoustic sensor network and GPS technology reveals males bellow to serenade females." Integrative and Comparative Biology **50**: E49-E49.

Lee, K. E., J. M. Seddon, et al. (2010). "Genetic variation and structuring in the threatened koala populations of Southeast Queensland." Conservation Genetics **11**(6): 2091-2103.

Melzer, A., W. A. Ellis, et al. (2010). "Observations of male-on-male aggression among Queensland koalas (*Phascolarctos cinereus*) from central Queensland." Queensland Naturalist **48**(1-3): 36-44.

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THE UNIVERSITY OF QUEENSLAND

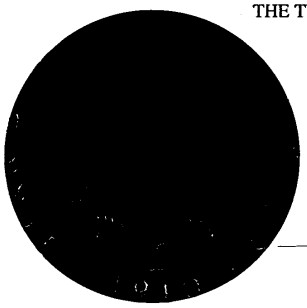
William Anthony Ellis

having fulfilled the conditions
prescribed by the University is this day admitted to
the degree of

DOCTOR OF PHILOSOPHY

in the field of Zoology

GIVEN UNDER THE COMMON SEAL
OF THE UNIVERSITY OF QUEENSLAND
THE TWENTY-THIRD DAY OF DECEMBER, 1997



Chancellor

Vice-Chancellor

Secretary and Registrar

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THE AUSTRALIAN NATIONAL UNIVERSITY

William Anthony Howell Ellis

AFTER DUE EXAMINATION FOLLOWING
THE COMPLETION OF A COURSE OF
STUDY APPROVED BY THE UNIVERSITY HAS
BEEN ADMITTED TO THE DEGREE OF

Master of Environmental Law

GIVEN UNDER THE SEAL OF THE AUSTRALIAN NATIONAL UNIVERSITY
THE SECOND DAY OF MAY 2003

Chancellor

Vice-Chancellor

27 Dudley Street, Bardon Qld. 4065 ◆ Mob.0428 105 275 ◆ w.ellis@uq.edu.au

THE

AUSTRALIAN NATIONAL UNIVERSITY

* * * * *

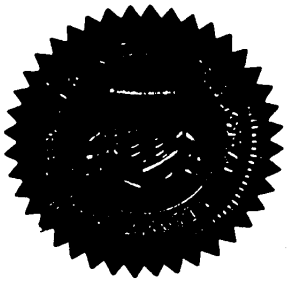
William Anthony Howell Ellis

after due examination following the completion of a course of study approved by the University has this day been admitted to the Degree of

BACHELOR OF SCIENCE

with Honours

Given under the Common Seal of The Australian National University
the *15th.* day of *May* 1986



Peter Karmel
Vice-Chancellor

R V Buts
Registrar

Certified as a true copy of the original
R Baeuer J. P.
13.7.87.

27 Dudley Street, Bardon Qld. 4065 ◆ Mob.0428 105 275 ◆ w.ellis@uq.edu.au

Dr Benjamin J. Barth

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Aroona, QLD, 4551
Phone (m): 0404790 329
E-mail: b.barth@uq.edu.au

Educational qualifications

- PhD (Ecology). Thesis: The effects of urbanisation on wildlife. The University of Queensland, 7 June 2013

- Bachelor of Science Honours (Class 1). University of Queensland, 2007

Current and previous positions

Post-doctoral research fellow (2015-current). School of Agriculture and Food Sciences, University of Queensland.
- Analysis of koala movement data and home range analysis
- Analysis of koala social interactions
- Part time position

Ecological consultant – koala and fauna specialist (2010-current).
Examples of recent work:
- Radio tracking and health monitoring of koalas on the Moreton Bay Rail Link project- personally completing approx. 2000 tracking events
- Safe capture of koalas utilising multiple methods – tree climbing, ground flagging, trapping.
- Koala surveys and scat surveys
- Fauna surveys for bats, mammals, birds, reptiles and amphibians
- Collection and consolidation of survey data for reports

Ecological research assistant (Casual 2013 - 2014). Dr William Ellis, School of Agriculture and Food Sciences, University of Queensland.
- Analysis of koala movement data and home range analysis
- Capture and radio tracking koalas to examining movement, health and population processes

Field research assistant (casual appointments 2009-2013). Dr Robbie Wilson, School of Biological Sciences, University of Queensland.
- Investigating the ecology and movement of the northern quoll using mark recapture and radio tracking techniques

PhD student, (2008-2013) Supervisor: Dr Robbie Wilson. School of Biological Sciences, University of Queensland.

Research from my thesis examined:
- The effectiveness of retaining remnant trees and water courses in new urban housing developments to improve the diversity of bird species
- Changes in ecologically important dung beetle communities in urban landscapes due to

changes in environmental variables
- The effect of species loss on the provision of ecosystem services provided by dung beetle communities
- How changes in resources in urban environments can alter the morphology of sexually selected traits

Ecology tutor, (casual appointments 2009-2013). Dr Robbie Wilson, University of Queensland.
- Organisation and effective communication of teaching material
- Ensuring students follow and understand OH&S procedures for field courses

Postgraduate committee co-ordinator/treasurer, (2010-2011). School of Biological Sciences
- Organisation of postgraduate conference and social functions
- Fund raising and accounting

Professional associations
- Ecological Society of Australia
- Australian mammal society

Publications

- Ellis, W., Fitzgibbon, S., Pye, G., Whipple, B., Barth, B., Johnston, S., Seddon, J., Melzer, A., Higgins, D. and Bercovich, F. (2015). The role of Bioaccoustic Signals in Koala Sexual Selection: Insights from seasonal patterns of associations revealed with GPS-proximity units. PLOS one.

- Barth, B. J., Fitzgibbon, S. and Wilson, R. S. (2015). New urban developments that retain more remnant trees have greater bird diversity. Landscape and Urban Planning. 136.

- Barth, B.J. and Wilson, S, R. (2010). Life in acid: interactive effects of pH and natural organic acids on growth, development and locomotor performance of striped marsh frogs (*Limnodynastes peronii*). Journal of Experimental Biology 213(8) 1293-1300

- Barth, B.J. van Uitregt V. and Wilson, R.S. (submitted to Functional Ecology, currently in review). Male dung beetles from urban forest fragments possess larger sexual signals when competition for resources is lower

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Scientific conferences
- Australian mammal society. 2015. Oral presentation. Titled: How common are physical interspecific interactions between individual wild koalas (*Pascolarctos cinereus*)?
- Australian mammal society. 2014. Oral presentation. Titled: Understanding koala movement and the occurrence of intra-specific interactions within a home range.
- School of biological sciences post graduate conference. 2011. Oral presentation
- SICB, Society for integrative and comparative biology, 2010. Oral presentation
- INTECOL, International congress of ecology, 2009. Oral presentation
- Ecological society of Australia, 2008. Poster

Research grants

- Ecological Society of Australia - student research award $1000
- University of Queensland – student travel awards $1200

Referees

Dr William Ellis
Post-doctoral Research Fellow
The University of Queensland
0428 105 275
w.ellis@uq.edu.au

Dr Sean Fitzgibbon
Post-doctoral Research Fellow/ Environmental consultant
The University of Queensland
0401 336 066
s.fitzgibbon@uq.edu.au

Dr Robbie Wilson
Lecturer/ Researcher
The University of Queensland
07 3365 2773
0458 204 962
r.wilson@uq.edu.au

Personal Details

Address	Work:	School of Food & Agricultural Sciences *and* Centre for Mined Land Rehabilitation (*split appointment*) The University of Queensland St Lucia QLD 4072 Australia Ph: +61 401 336 066
	Postal:	PO Box 6154 St Lucia Post Office St Lucia QLD 4069 Australia
Email		s.fitzgibbon@uq.edu.au
Date & Place of Birth		4th April 1976; Brisbane, Australia
Citizenship & Passports		Australian

Tertiary Education

PhD	2005	Dept. of Zoology & Entomology, The University of Queensland, Australia. Recipient of an Australian Postgraduate Award Scholarship. Thesis title: Life in the suburbs: The survival of the northern brown bandicoot (*Isoodon macrourus*) in bushland of suburban Brisbane, with implications for the conservation of native ground-dwelling mammals.
BSc (Hons)	1998	Dept. of Zoology & Entomology, The University of Queensland, Australia. Awarded First Class Honours. Thesis title: The ecology of a bimodally breathing Australian freshwater turtle (*Elseya* sp.); management and conservation implications.
BSc	1994	The University of Queensland, Australia. Majors in Zoology and Conservation Ecology.

Wildlife Consultancy Experience

December 2006 – current	Ecological Consultant (sole trader), specialising in koala management matters. Contracts have included: Review of Ruthven Quarry koala management program; Coordination of koala monitoring program at Bluesfest site (Tyagarah); Development of the Bluesfest site-specific Koala Plan of Management (in conjunction with another consultancy); Review of numerous development applications to provide expert opinion on koala management matters for local councils in South East Queensland and northern New South Wales.

December 04 – June 2005	Senior Ecologist (contract), AustralAsian Resource Consultants; Brisbane, Australia. Conduct baseline fauna surveys on various mining leases across Queensland; Monitor the environmental rehabilitation of various open-cut mines; Prepare wildlife management reports.
April – Dec 1997	Environment Officer (contract), Dept. Environment & Heritage, Queensland State Government; Brisbane, Australia. Digital mapping of National Park boundaries; Consult experts for information to include in a wildlife database (WildNet); Assist with the formulation of abatement plans for several threatened plant species.

Research & Teaching Experience

December 2005 – current	Research Fellow, The University of Queensland; Brisbane, Australia. Conduct various koala research and monitoring programs in Queensland and New South Wales, including Tyagarah, Clermont, North Stradbroke Island, Mt Byron, Coomera .
August 2006 – 2011	Postdoctoral Research Fellow, School of Biological Sciences, The University of Queensland; Brisbane, Australia. Conduct an urban wildlife research program at new urban developments in South East Queensland (ARC Linkage Project 'Conserving native wildlife during urbanisation').
February 2006 – 2011	Casual lecturer at the School of Biological Sciences, The University of Queensland; Brisbane, Australia. Occasional lecturing to first, second and third year students (mostly BSc) on themes of native wildlife biology, wildlife conservation and urbanisation, and biodiversity and habitat fragmentation.
July – December 2005	Research Officer (contract), Dept. Zoology & Entomology, The University of Queensland; Brisbane, Australia. Conduct laboratory experiments on various species of freshwater fish and crayfish from Fraser and Stradbroke Islands, and Gold Coast Hinterland, Queensland.
October – Nov 2003	Research Assistant (contract), Dept. Zoology & Entomology, The University of Queensland; Brisbane, Australia. Conduct radio-tracking and tag-&-release program on a population of brush-tailed rock wallabies (*Petrogale penicillata*) in dry-rainforest of Warwick, Queensland.
April – May 2003	Research Assistant (contract), Dept. Zoology & Entomology, The University of Queensland; Brisbane, Australia. Assist with radio-tracking and tag-&-release program on a population of koalas (*Phascolarctos cinereus*) in semi-arid woodlands of inland central Queensland.

Selected Publications

FitzGibbon, S. (2015) Reproductive ecology of the northern brown bandicoot (Isoodon macrourus) in habitat fragments of urban Brisbane. *Australian Mammalogy* 37: 253-259.

Kollipara, A., Polkinghorne, A., Wan, C., Kanyoka, P., Hangar, J., Loader, J., Callaghan, J., Bell, A., Ellis, W., **FitzGibbon, S**., Melzer, A., Beagley, K. and Timms, P. (2013) Genetic diversity of *Chlamydia pecorum* strains in wild koala locations across Australia and the implications for a recombinant *C. pecorum* major outer membrane protein based vaccine. *Veterinary Microbiology* 167: 513-522.

FitzGibbon, S., Ellis, W. and Carrick, F. (2013), 'Koala reproduction and the effect of drought in central Queensland; lessons from the Koala Venture project' in Flint, N. and Melzer, A. (eds), *Conserving central Queensland's koalas*. pp. 91-94, Koala Research Centre of Central Queensland, CQUniversity Australia, Rockhampton, Queensland.

Ellis, W., **FitzGibbon,S.**, Melzer, A., Wilson, R., Johnston, S., Bercovitch, F., Dique, D. and Carrick, F. (2013) Koala habitat use and population density: using field data to test the assumptions of ecological models. *Australian Mammalogy* 35: 160-165.

Pye, G., Ellis, W., **FitzGibbon, S.**, Opitz, B., Keener, L. and Hollis, B. (2013) Serum vitamin D levels in free-ranging koalas (*Phascolarctos cinereus*). *Journal of Zoo and Wildlife Medicine* 44: 480-483.

Ellis, W., **FitzGibbon, S.**, and Melzer, A. (2013) 'Regional research: perspectives from the field in central Queensland' in Flint, N. and Melzer, A. (eds), Conserving central Queensland's koalas. pp. 11-15, Koala Research Centre of Central Queensland, CQUniversity Australia, Rockhampton, Queensland.

Lee, K., Seddon, J., Johnston, S., **FitzGibbon, S.**, Carrick,F., Melzer, A., Bercovitch, F. and Ellis, W. (2013). Genetic diversity in natural and introduced island populations of koalas in Queensland. *Australian Journal of Zoology* http://dx.doi.org/10.1071/ZO12075

Matthews, A., Ruykys, L., Ellis, W., **FitzGibbon, S.**, Lunney, D., Crowther, M., Glen, A., Purcell, B., Moseby, K., Stott, J., Fletcher, D., Wimpenny, C., Allen, B., Van Bommel, L., Roberts, M., Davies, N., Green, K., Newsome, T., Ballard, G., Fleming, P., Dickman, C., Eberhart, A., Troy, S., McMahon, C. and Wiggins, N. (2013) The success of GPS collar deployments on mammals in Australia. *Australian Mammalogy* 35: 65-83.

Pye, G., Ellis, W., **FitzGibbon, S.**, Opitz, B., Keener, L., Arheart, K., and Cray, C. (2012). Serum protein electrophoresis values for free-ranging and zoo-based koalas (*Phascolarctos cinereus*). *Journal of Zoo and Wildlife Medicine* 43(1): 177-180.

Campbell, H.A., R.G. Dwyer, **S. FitzGibbon**, C.J. Klein, G. Lauridsen, A. McKeown, A. Olsson, S. Sullivan, M.E. Watts, D. A. Westcott (2012). Prioritising the protection of habitat utilised by southern cassowaries *Casuarius casuarius johnsonii*. *Endangered Species Research* 17:53-61.

Ellis, W., Bercovitch, F., **FitzGibbon S.I.**, Melzer, A., Roe, P., Wimmer, J. and Wilson, R. (2011). Koala bellows and their association with the spatial dynamics of free-ranging koalas. *Behavioral Ecology* 22(2): 372-377.

FitzGibbon, S.I., R.S. Wilson & A.W. Goldizen (2011). The behavioural ecology and population dynamics of a cryptic ground-dwelling mammal in an urban Australian landscape. *Austral Ecology* 36(2): 722-732.

FitzGibbon, S.I. & C.E. Franklin (2010) The importance of the cloacal bursae as the primary site of aquatic respiration in the freshwater turtle, *Elseya albagula*. *Australian Zoologist* 35(2): 276-282.

Barth, B.J., **FitzGibbon, S.I.**, Carter, A.J. and Wilson, R.S. (2010). Effects of resource availability on dung beetle abundance and male horn size in Australian urban forest fragments. *Integrative and Comparative Biology* 50(1).

Ellis, W., Bercovitch, F., **FitzGibbon S.**, Melzer, A., de Villiers, D and Dique, D. (2010). Koala birth seasonality and sex ratios across multiple sites in Queensland, Australia. *Journal of Mammalogy* 91(1): 177-182.

Wilson, R.S., Condon C.H., David G., **FitzGibbon S.I.**, Niehaus A.C. & Pratt K. (2010). Females prefer athletes, males fear the disadvantaged: different signals used in female choice and male competition have varied consequences. *Proceedings of the Royal Society of London Series B* 277(1689): 1923-1928.

Lowe, K., **FitzGibbon, S.**, Seebacher, F. & R.S. Wilson (2010). Physiological and behavioural responses to seasonal changes in environmental temperature in the Australian spiny crayfish *Euastacus sulcatus*. *Journal of Comparative Physiology B* (in press) (published online Feb 2010).

FitzGibbon, S.I., D.A. Putland & A.W. Goldizen (2007) The importance of functional connectivity in the conservation of a ground-dwelling mammal in an urban Australian landscape. *Landscape Ecology* 22 (10): 1513-1525.

FitzGibbon, S.I. & D.N. Jones (2006) A community-based wildlife survey: the knowledge and attitudes of residents of suburban Brisbane, with a focus on bandicoots. *Wildlife Research* 33 (3): 233-241.

Name: Rolf Jakob Schlagloth

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Date of birth: 9 June 1965
Citizenship: Australian

Rolf Schlagloth (PhD candidate Koala Ecology CQU) has been working on many aspects of the Koala in different capacities, in Victoria and Queensland since 1992. Mr Schlagloth has worked with universities, industry, government and community to investigate issues associated with koala ecology and management. These include:

- flora and fauna surveys, some associated with formal impact assessment (e.g. Golden Plains Shire, Ballarat (Vic); St Lawrence, St Bees Is (Qld)),
- Koala management plans (KPoM) and associated monitoring,
- revegetation strategies and restoration projects, restoration of koala habitat (e.g. Ballarat KPoM, Golden Plains Koala Habitat Atlas, Framlingham Koala Habitat Revegetation Project) and,
- Koala conservation biology (e.g. current research on Koala diet and movement in a roadkill blackspot).

He has provided impartial, expert advice to community, industry, state (Victoria) - federal agencies (e.g. National Koala Strategy) and local governments (e. g. Ballarat, Golden Plains, Moorabool, Macedon, Central Goldfields) on a variety of issues associated with koala conservation.

Mr Schlagloth has also worked as a science teacher and consultant *Australian Wildlife & Flora Research*. He has authored a number of technical reports (e.g. Koala Plan of Management for Ballarat) and co-authored scientific papers. He is very skilled in all aspects of koala research, including handling animals and surveying their habitat.

Mr Schlagloth has focused most of his studies and work around the Koala. The thesis for his undergraduate degree was centred on radio-tracking koalas along a highway with a high incidence of koala road-kill, his master's thesis 'Using the Koala as a community education flagship species: For what purposes, with what outcomes?' explored the purposes and outcomes of a community Koala conservation programme in Ballarat (Vic) and his current PhD research 'Modelling koala road-kill black spots' investigates how these animals use the habitat near a black spot but most importantly it aims at determining the parameters that contribute to koalas being killed on our roads.

QUALIFICATIONS

Master of Education Studies (2014) University of Ballarat
Graduate Diploma of Education (2008) University of Ballarat
Bachelor of Applied Science (1994) University of Ballarat
Certificate IV Training & Assessment (2011) ProSkills Mackay

In Progress
PhD CQUniversity

COMMITTEE MEMBERSHIPS

Central Queensland University (Qld) Research Committee of Academic Board	2013
Local Marine Advisory Committee for the Great Barrier Reef Marine Park Authority	2015 - current
Department of Primary Industries (Vic)	
Wildlife and Small Institutions Animal Ethics Committee	2005 – current
University of Ballarat Animal Experimentation Ethics Committee	2002 – current
Mt Buninyong Reserve Advisory Committee	2002 – 2011
Department of Human Services (Vic) Victorian Biotechnology Advisory Committee	2006 – 2008
Ballarat Region Conservation Strategy Implementation Committee	2001 – 2004

OTHER ASSOCIATIONS

Australasian Wildlife Management Society	1998 – current
Koori Heritage Trust	2002 – current
Australian Association for Environmental Education	2002 – current
Science Teachers Association of Australia	2008 – current
Central Qld Frog Society	2012 – current
Capricornia Landcare Group	2012 – current

Skills

Flora & fauna surveying; wildlife handling
Heavy articulated Driver Licence / 4WD, chainsaw & 1st aid training

PUBLICATIONS

Published research (and in progress)

Santamaria, F.; Keateley, M. and Schlagloth, R. (2005). Does size matter? (Tree use by translocated koalas). The Victorian Naturalist Vol. 122 (1).

Schlagloth, R.; Cahir, F. and; Clark, I. (in progress). The Historic Importance of the Koala in Aboriginal Society in Victoria (Australia): A Reconsideration of the Archival Record Koala in literature. Anthrozoös.

Schlagloth, R. and Golding, B. (in progress). Using the Koala as a community education flagship species: An exploration of the purposes and outcomes of a community programme in Ballarat, Australia. Australian Journal of Adult Learning.

Schlagloth, R., Santamaria, F. and Golding, B. (in progress). The Koala as a flagship species in education. Australian Journal of Environmental Education.

Published reports

Schlagloth, R., Mitchell, D. and Rhodes, J. (2008). Use of Blue Gum Plantations by Koalas. A report to stakeholders in the plantation industry.

Schlagloth, R., Thomson, H. and Mitchell, (2006). Comprehensive Koala Plan of Management for Ballarat City Council (Part 1- The Plan, part 2 – resource document)

Schlagloth, R., Callaghan, J., Thomson, H. and Mitchell, (2006). Draft Comprehensive Koala Plan of Management for Ballarat City Council (Part 1- The Plan, part 2 – resource document)

Schlagloth, R. and Santamaria, F. (2001). Koala Survey for Ballarat. Report on an extensive survey of ratepayers' attitude to, and experiences with, koala conservation. City of Ballarat / Australian Koala Foundation.

Conference presentation & proceedings

Schlagloth, R. (2013). 'Koalas and roads: a case study in Ballarat, Victoria' in Flint, N. and Melzer, A. (eds), *Conserving Central Queensland's koalas*. Pp. 101-105, Koala Research Centre of Central Queensland, CQUniversity Australia, Rockhampton, Queensland.

Schlagloth, R. (2004). Managing koalas on and off Kangaroo Island: towards a proactive, adaptive and multidisciplinary approach. Australasian Wildlife Management Society Symposium Kangaroo Island.

Santamaria, F. and Schlagloth, R. (2001). Survival of island translocated koalas and the impact of Chlamydia. Pp. 181-6 in: Veterinary Conservation Biology: Wildlife Health and Management in Australasia. ed. by A. Martin and L. Vogelnest "Proceedings of International Joint Conference". Taronga Zoo, Sydney.

Schlagloth, R. (2001). How does GIS mapping help the Koala and the City of Ballarat? Newtech Conference for Regional People. Land Victoria. Deakin University Geelong.

Schlagloth, R. (2001). The Koala Conservation Project in Ballarat. Proceedings of a Conference on the Status of the Koala in 2001. Canberra, ACT. Australian Koala Foundation, Brisbane.

Appendix D: Ecological Assessment – Potential Offset Site (Kleinfelder, 2015)

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Ecological Assessment – Potential Offset Site

Department of Transport and Main Roads

Eton Range Realignment Project
Blue Mountain Road, Eton Range

November 2015

Ecological Assessment – Potential Offset Site

Eton Range Realignment Project
Blue Mountain Road, Eton Range

Kleinfelder Report Number: NCA15R30439

Prepared for:

DEPARTMENT OF TRANSPORT AND MAIN ROADS
44 NELSON STREET MACKAY QLD 4740

Only the **Department of Transport and Main Roads**, its designated representatives or relevant statutory authorities may use this document and only for the specific project for which this report was prepared. It should not be otherwise referenced without permission.

Document Control:

Version	Description	Date	Author	Technical Reviewer	Peer Reviewer
1.0	Draft for client review	20 Nov 2015	M Aisthorpe	D Milburn	F Moyle
2.0	Final	27 Nov 2015	M Aisthorpe	D Milburn	F Moyle

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EXECUTIVE SUMMARY

The Department of Transport and Main Roads is assessing a potential offset site to support regional populations of Phascolarctos cinereus *(Koala) to compensate for the impacts of the Eton Range Realignment Project. This project has been referred to the Commonwealth Department of Environment and declared a controlled action (2015/7552). The Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory only) is protected under the* Environment Protection and Biodiversity Conservation Act 1999*. An ecological assessment was required to identify the quality of the proposed site and to gauge its suitability as an offset for the impacts of the proposed project.*

An assessment was undertaken in November 2015 to evaluate the proposed offset site and to quantify using a metric. The assessment found:

- *Moderate to poor habitat as identified by a Modified BioCondition metric;*
- *Good site context in relation to the landscape in which the site is situated;*
- *Medium to High levels of Koala activity; and*
- *Mild to moderate levels of external threats.*

This report presents the findings of the ecological assessment by Kleinfelder. The findings have been discussed to give further understanding and context to the site to assist the proposal by the Department of Transport and Main Roads.

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Figures

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1. INTRODUCTION

As the Eton Range Realignment Project (ERRP) has the potential to impact the local Koala (*Phascolarctos cinereus*) population, Kleinfelder was commissioned by the Department of Transport and Main Roads (TMR) to conduct an ecological assessment of a proposed offset site to compensate for those potential impacts.

The proposed offset site (75ha) is situated in a road reserve along Blue Mountain Road on the Eton Range, 55km south west of Mackay **(Figure 1)**. A study area of increased size was identified to get a broader understanding of assessable attributes. The study area is approximately 200ha and encompasses the proposed offset site. The study area consists of sclerophyll woodland situated over rises composed of igneous rock set amongst alluvial plain deposits.

1.1 SCOPE

The ecological assessment aims to evaluate the study area and to quantify using a metric. Field work was undertaken on 12 and 13 November 2015 to assess:

- Site condition;
- Site context; and
- Species stocking rates.

The raw data will be used to establish the suitability of the site to support the recovery of the Koala population in the region and to compensate for the impacts of the proposed project. This report presents the findings of the ecological impact assessment.

0 1 2 4 6 8 10 km

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PROJECT REFERENCE: 20163096

DATE DRAWN: 19/11/2015 12:00 Version 1

DRAWN BY: gjoyce

DATA SOURCE:

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Locality

Queensland Department of Transport & Main Roads
Eton Range Realignment – Potential Offset Site
Ecological Assessment

FIGURE:

1

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1.2 LEGISLATION

This project was undertaken in accordance with, and/or consideration of, the following Acts and Regulations:

- Commonwealth:
    - *Environment Protection and Biodiversity Conservation Act 1999*.
- State:
    - *Nature Conservation Act 1992*;
    - *Nature Conservation (Wildlife) Regulation 2006*;
    - *Land Protection (Pest and Stock Route Management) Act 2002*; and
    - *Vegetation Management Act 1999.*

Further information regarding these Acts and Policies, along with their application to this project, can be found in **Appendix 1**.

2. METHODOLOGY

As per the EPBC '*How to use the Offsets Assessment Guide*', assessment of the proposed offset site and its suitability to compensate for the impacts of the ERRP to the Koala is comprised of three components. They are used to determine the condition of the habitat, the importance of the site within the landscape, and the current Koala activity levels. Each component is quantifiable and can be combined to produce an overall assessment score of the quality of the proposed offset for the Koala.

2.1 SITE CONDITION

Site condition reflects habitat quality in relation to the ecological requirements of the Koala and considers vegetation condition and structure, the diversity of habitat species, and other parameters (e.g. logging, grazing and bushfire). Site condition assessment considers Koala Habitat Rank and the Modified BioCondition scores.

2.1.1 Koala Habitat Rank

Koala Habitat Rank is to be assessed by Central Queensland University based on information provided in this report. It ranks the relationship of food species to their position in the landform and their overall suitability to support Koalas.

2.1.2 Modified BioCondition Assessment

Habitat condition was assessed using a Modified BioCondition methodology described by Ecological Survey and Management (2013). The modified assessment and scoring metric has been followed to remain consistent with the assessment at the disturbance footprint (ERRP). BioCondition assessment aims to assess the quality of the habitat at the proposed offset site and to quantify it using a metric. The Modified BioCondition assessment scores the following attributes:

- Canopy cover and health;
- Canopy recruitment;
- Canopy height;
- Shrub layer;

- Ground cover;
- Large trees;
- Fallen logs;
- Weed cover;
- Organic litter;
- Size of patch;
- Connectivity; and
- Context.

The Modified BioCondition assessment used quadrats as described in the BioCondition Assessment Methodology (Eyre *et al*. 2015). Benchmarks developed by the Queensland Herbarium were used when calculating the habitat score. Where an established benchmark was not available, a benchmark was used from the most closely related Regional Ecosystem (RE) for dominant species, structure, and landform.

REs were verified (ground truthed) through tertiary and quaternary assessment consistent with methodology provided by the Queensland Herbarium (Nelder *et al.* 2012). Further information relating to site condition survey methodology can be found in **Appendix 2**.

Final BioCondition class was calculated in accordance with the modified category attributes described by Ecological Survey and Management (2013).

2.2 SITE CONTEXT

Site context refers to the relative importance of a site in terms of its position in the landscape. Landscape context is assessed using different parameters depending on whether the assessment site is within a fragmented landscape (patch size, connectivity, context and corridors), or an intact landscape (Eyre *et al*. 2015). The Brigalow Belt Bioregion is listed as a fragmented landscape, defined as areas where the amount of remnant vegetation is less than 65% (McIntyre and Hobbs 2000). Site context is measured using a suite of parameters to describe the location of the habitat within the surrounding landscape and include:

- Patch size;

- Connectivity; and
- Context.

As per the EPBC Offsets Guide, threats to the Koala have also been considered when determining the overall site context scores. Observations were recorded during the field assessment to ascertain the level of threats (or lack of) that may affect the recovery of the Koala. Observations included:

- Evidence of mortality by vehicle strike;
- Evidence of mortality by, or the presence of, feral or domestic dogs and dingos;
- Evidence of bushfire;
- Evidence of listed weed species including Weeds of National Significance (WoNS);
- Evidence of other unnatural disturbance, including habitat fragmentation; and
- Evidence of disease.

2.3 SPECIES STOCKING RATE

The Koala Spot Assessment Technique (KSAT) was used to determine Koala activity levels of the study area at six locations. For each KSAT test, thirty habitat trees around a focal tree were assessed by searching for and counting Koala faecal pellets within 1m of the base of the tree trunk for two person minutes and recording the species of each tree. Fifty percent of pellet production is expected to be located within 1m of the tree base (Phillips and Callaghan 2011). Information recorded during KSAT tests included:

- Species of tree;
- Pellet count; and
- Focal tree location (GPS).

Activity levels are categorised as either low (<22.52%), medium (≥22.52% but ≤32.84%) and high (>32.84%) based on the east coast medium-high benchmarks (Phillips and Callahan 2011).

Habitat trees were defined as trees from the genera *Eucalyptus*, *Angophora*, *Lophostemon*, *Corymbia* and *Melaleuca*, and that are >4 m in height or >10 cm diameter at breast height (DBH).

3. RESULTS

3.1 SITE CONDITION

Habitat condition scores were calculated using the modified BioCondition methodology for six sites within the study area (**Figure 2**). Four REs were identified during ground truthing; each of these REs have been represented in the BioCondition assessment. As a benchmark for RE11.12.3 is currently not available, the benchmark for RE11.12.1 was used as this was determined to be the most closely related ecosystem on the same landform. Scores for attributes at each site are shown in **Table 1**.

The BioCondition scores of the study area produce an average score of 66.25. Patches of REs 11.3.4, 11.12.3 and 11.3.9 in the northern section of the study area exhibited low condition with score categories of 4. Patches in the southern section of the study area exhibited good condition, with patches of RE11.3.9, 11.3.25 and 11.12.3 scoring in category 2.

RE11.3.4 is listed as Of Concern under the *Vegetation Management Act* (1999), all other regional ecosystems are listed as Least Concern.

Table 1: Modified BioCondition Scores for each of the 6 habitat assessment sites

Site Number	1	2	3	4	5	6
Regional Ecosystem	11.3.4	11.12.3*	11.12.3*	11.3.9	11.3.25	11.12.3*
Canopy Cover and Health	5	3	4	3	5	5
Canopy Recruitment	3	3	3	5	5	3
Canopy Height	3	5	5	5	5	4
Shrub Layer	0	0	0	0	5	0
Ground Cover	6	0	0	10	10	10
Large Trees	3	8	3	8	3	8
Fallen logs	2	2	4	4	4	4
Weed Cover	0	3	3	10	10	10
Organic Litter	5	3	3	5	3	5
Size of Patch	10	10	10	10	10	10
Connectivity	4	4	4	4	4	4
Context	4	4	4	4	4	4
Total	**47**	**45**	**43**	**68**	**68**	**67**
Total /100	**55.3**	**52.9**	**50.6**	**80**	**80**	**78.8**
BioCondition Score (EcoSM 2013)	**4**	**4**	**4**	**2**	**2**	**2**

***** Scores calculated from RE11.12.1 benchmark

3.2 SITE CONTEXT

Four parameters were measured to obtain a site context value of the study area; patch size, connectedness, context and existing threats. Descriptions for three of the attributes for the study area are shown in **Table 2**. **Figure 3** identifies these attributes in relation to the study area.

Table 2: Site Context for the study area

Attribute	Description
Patch Size	Size of patch and directly connecting remnant vegetation is **>1000ha**
Connectedness	**65%** of site boundary is connected to remnant vegetation
Context	**43%** remnant vegetation within 1km buffer

3.2.1 Lack of Threats

Two feral and domestic dog or dingo scats were observed (**Figure 4**). Both scats were in grazed areas and could be from domestic or working dogs.

Evidence of bushfire was recorded at three separate locations. Scorching marks on trees indicated the fire(s) likely occurred in recent years and appeared to be of low intensity (**Plate 2**).

Plate 1: Bushfire scorching on trees.

Lantana camara (Lantana) thickets were observed in gullies in the central western section of the site. Isolated Lantana plants can be found throughout the site however they are very sporadic. Lantana is a Class 3 declared weed in Queensland and a WoNS. A species of the genus *Sporobolus* (Giant Rats Tail grass) was observed in three locations in the south of the site. Identification was inconclusive due to the grass having expelled its seed. Giant Rats Tail grasses are Class 2 declared weeds in Queensland. *Hyparrhenia rufa* (Thatch Grass) is a common pastoral weed in the northern areas that are disturbed by grazing. In such areas the Thatch Grass has formed a monoculture in the understorey.

In southern areas of the study area, some localised vegetation clearing has previously been undertaken for unknown reasons. Vegetation has been windrowed in a number of locations within the immediate area.

No evidence from mortality by vehicle strike was recorded during the assessment. The Koala observed within the proposed offset site exhibited no sign of disease.

3.3 SPECIES STOCKING RATES

KSAT tests at the study area indicated high Koala activity levels at four of six sites based on east coast medium-high benchmarks (**Table 3** and see Section 4 for further discussion). Only 7% of habitat trees at site four contained one or more scats, indicating low activity levels. Scat counts (30%) at site five indicate medium Koala activity levels. The species of tree found to have the most activity was *Eucalyptus crebra* (Narrow-leaved Ironbark); nine species of habitat tree recorded activity (**Appendix 3**).

Table 3: Koala Activity Level for the study area

Site	1	2	3	4	5	6
# of trees with faecal pellets	15	11	11	2	9	13
Activity Level	50%	37%	37%	7%	30%	43%

One male Koala was observed during random meander observations within the study area (**Figure 3**). The Koala was situated in a *Eucalyptus tereticornis* (Blue Gum) and appears to be in good health (**Plate 1**).

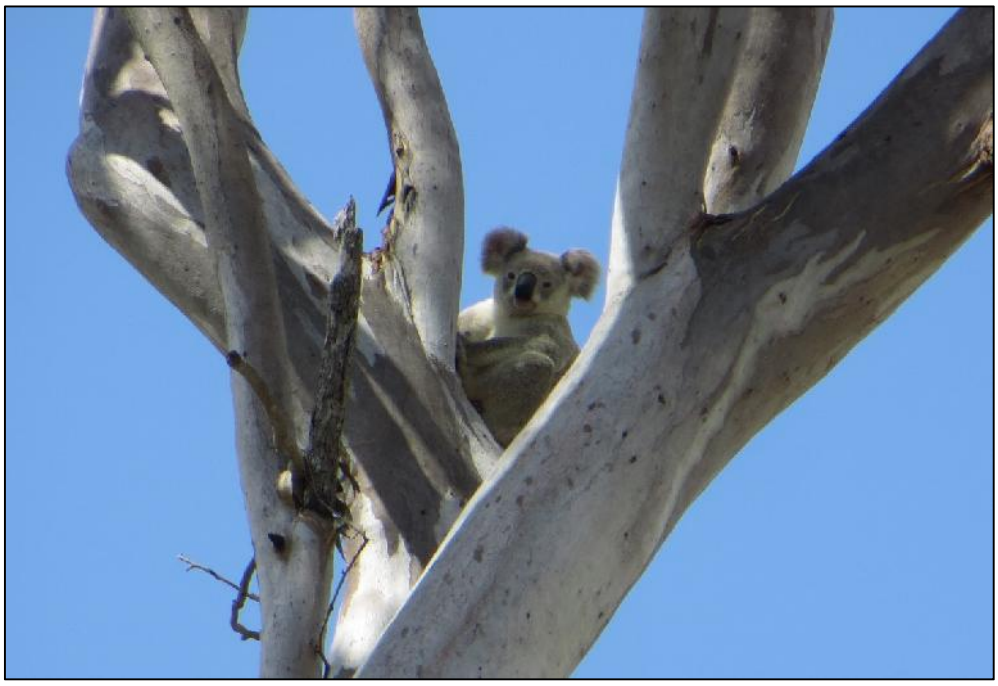
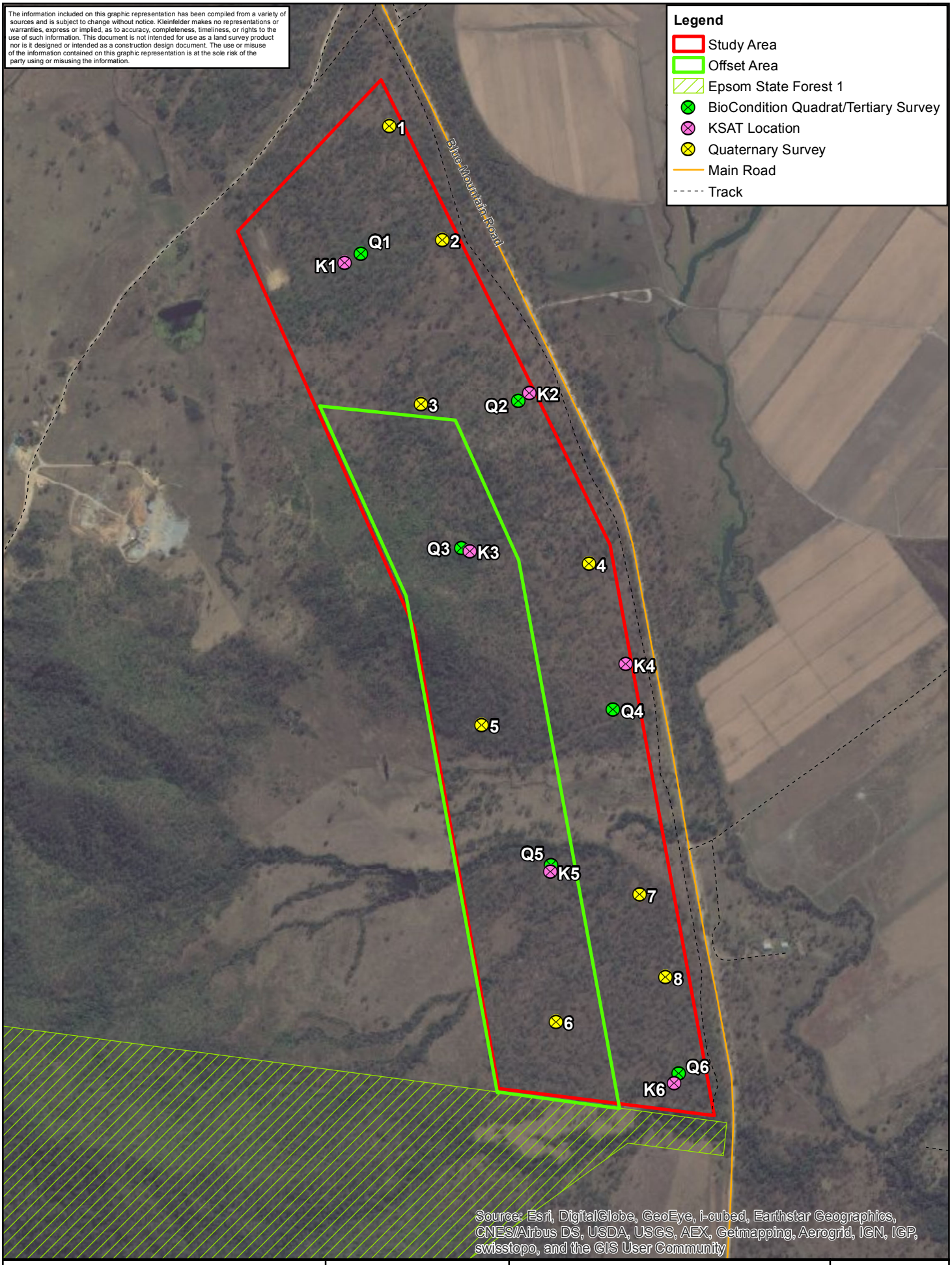


Plate 2: Koala observed within the proposed offset site.



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PROJECT REFERENCE: 20163096
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DATA SOURCE:
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Survey Effort

Queensland Department of Transport & Main Roads
Eton Range Realignment – Potential Offset Site
Ecological Assessment

FIGURE:
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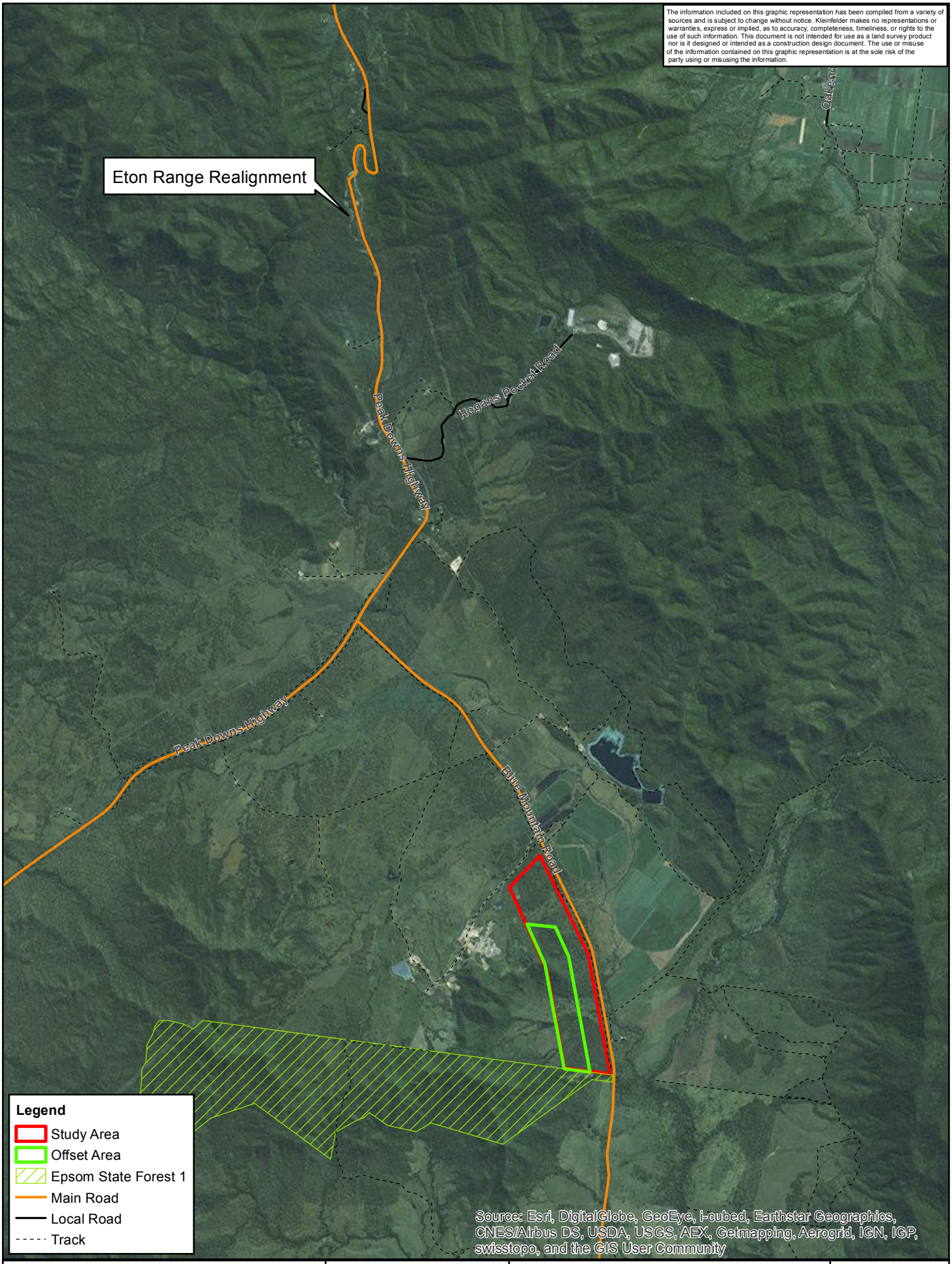

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DATA SOURCE:

Study Area and Offset Site Context

Queensland Department of Transport & Main Roads
Eton Range Realignment – Potential Offset Site Ecological Assessment

FIGURE:

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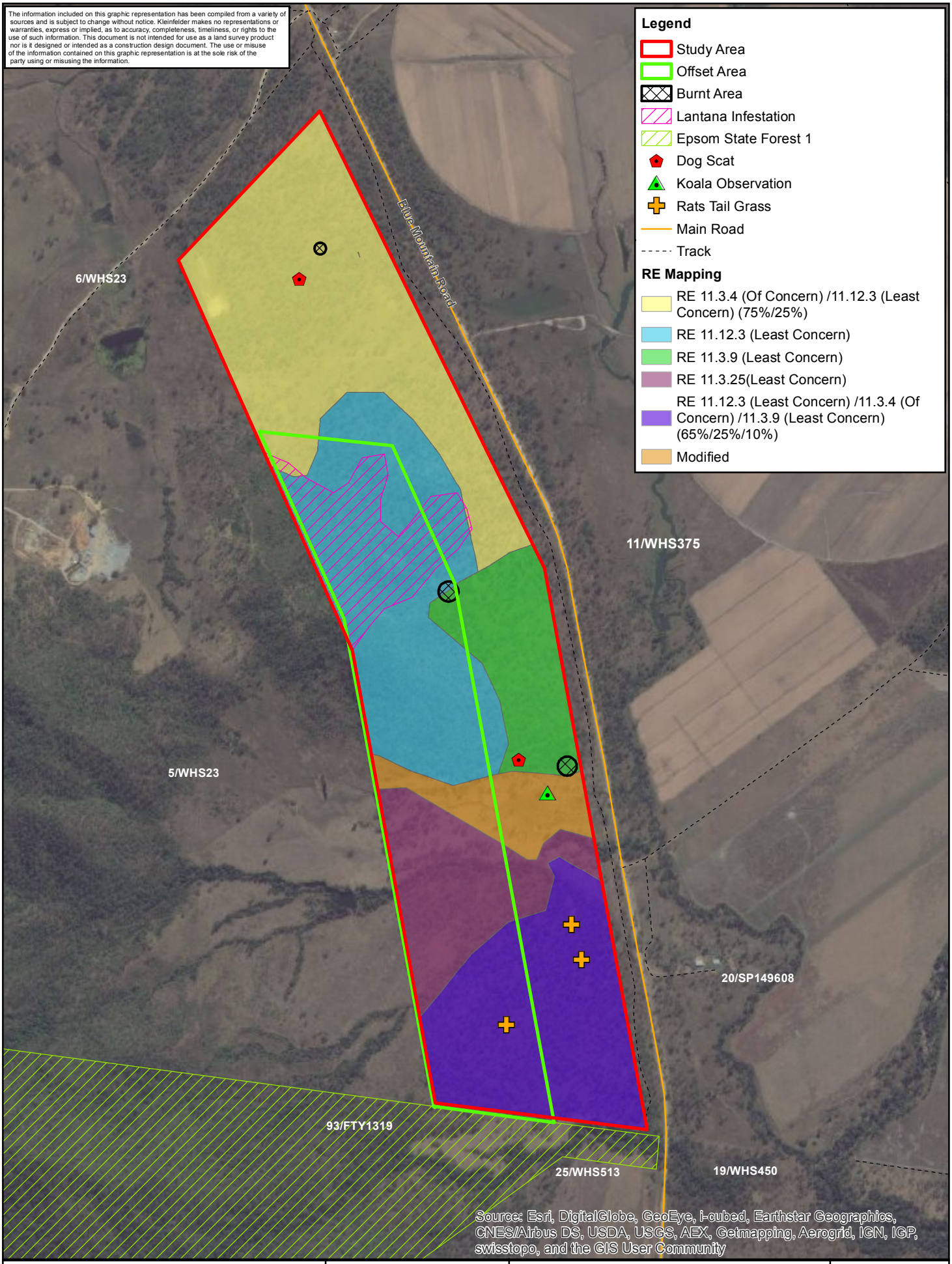

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DATA SOURCE:

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Observations

Queensland Department of Transport & Main Roads
Eton Range Realignment – Potential Offset Site
Ecological Assessment

FIGURE:

4

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4. DISCUSSION

The study area overall was identified as of moderate to poor condition (score averaging), however no characterisation is available on the condition class categories developed by Ecological Survey and Management (2013) which limits interpretation. It should be noted that the condition class metric used by Ecological Survey and Management varies from the metric proposed by Eyre *et al*. (2015). Ecosystems in the northern sections of the study area are more degraded from grazing and the presence of Thatch Grass. Thatch Grass has been identified during separate studies in the area to inhibit Koala movement across the ground (Kleinfelder 2015). Ecosystems in the southern areas score higher and appear undisturbed by agriculture; the understorey exhibits high levels of healthy native grass coverage and good recruitment of Koala feed trees. These areas should be the focus of any potential offset depending on the eventual size required to effectively offset the impacts of the proposed ERRP.

The landscape score of the study area is positive considering that the locality is primarily used for agriculture and is close to a rural road. It exhibits good connectivity and is part of a large regional patch of the required Broad Vegetation Group which forms part of the wider Clarke – Connors Ranges. The study area is also connected at its southern borders to Epsom State Forest.

Species stocking rates indicate medium to high Koala activity in the study area. Broad-leaved Ironbarks and Blue Gums were preferred species with high pellet counts. These species are dominant features of three out of the four REs present on the site.

Threats from external sources appear minimal to moderate. Dog scats were only observed in grazed areas indicating the potential source to be domestic dogs. Uncontrolled domestic dogs can still have a negative impact of Koala recovery objectives. Attacks from domestic dogs are the third most significant known cause of Koala mortality (Environmental Protection Agency 2006). Lantana thickets in the central western areas of the site will hinder movement of Koalas on the ground and inhibit natural recruitment of feed trees. The weed is likely to spread further in the area particularly in places of unstable ground (hill faces) and in the event of bushfire. The Giant Rats Tail Grass is unlikely to spread rapidly from its current position because of the significant coverage of healthy native grass. However in the event of major disturbance such as intense and repeated bushfires or grazing it may spread.

5. REFERENCES

Brooker, M., and Kleinig, D. (2004). *Field Guide to Eucalypts Vol 3*. Bloomings Books.

Cropper, S.C. (1993). *Management of Endangered Plants*. CSIRO Publications, East, Melbourne. DERM (2011a) Regional Ecosystem Version 6.1 Dataset. Department of Environment and Resource Management, Brisbane.

Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016. Environmental Protection Agency, Qld, 2006.

Department of the Environment (2014). *EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)*, Commonwealth of Australia, Canberra.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

Kleinfelder (2015). *Significant Impact Assessment – Black Ironbox and Koala.* Timber Bridge Rectification Works, Peak Downs Highway Unpublished report for TMR.

Melzer, R., and Plumb, J. (2011). *Plants of Capricornia*. Belgamba Publishing.

Nelder, V.J., Wilson, B.A., Thompson, E.J., and Dillewaard, H.A. (2012). *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland.* Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

Phillips, S., and Callaghan, J. (2011). *The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas* Phascolarctos cinereus. Australian Koala Foundation, Brisbane.

APPENDIX 1: LEGISLATION

Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)

Under the EPBC Act assessment and approval is required for actions that are likely to have a significant impact on matters of national environmental significance. An action includes a project, development, undertaking, activity, or series of activities. When a person proposes to take an action they believe may need approval under the EPBC Act, they must refer the proposal to the Australian Government Minister for the Environment. The Act identifies nine matters of national environmental significance:

1. World Heritage properties;
2. National heritage places;
3. Wetlands of international importance (Ramsar Convention);
4. Listed threatened species and communities;
5. Migratory species listed under international agreements;
6. Great Barrier Reef Marine Park;
7. Commonwealth marine areas;
8. Nuclear actions; and
9. A water resource, in relation to coal seam gas development and large coal mining development.

Point 4 is relevant to this proposal.

Nature Conservation Act 1992 (NCA)

The NCA is Queensland's principal legislation which establishes a framework for the identification, gazettal and management of protected areas, the protection of native flora and fauna (protected wildlife) listed under the adjoining *Nature Conservation (Wildlife Management) Regulation 2006* (NC(WM)R). The NCA is administered by the Queensland Department of Environment and Heritage Protection (DEHP).

The NC(WM)R classifies native flora and fauna species according to their conservation status which includes Extinct in the Wild, Endangered, Vulnerable, Near Threatened, and of Least Concern; which reflects their rareness and what actions need to be taken to protect them.

Areas that contain known EVNT species are considered high risk. High risk areas that contain flora species are identified through trigger mapping. Disturbance footprints within areas identified in trigger maps require further assessment of the area by qualified personnel.

Land Protection (Pest and Stock Route Management) Act 2002 (LPA)

The LPA is designed to establish principles and planning of pest management and stock route network management in Queensland. It is achieved through a range of administrative, restrictive, and preventative measures and fosters responsibility onto industries and personnel involved in land management and development. Within this project the LPA was used to identify declared species of weed (State) and Weeds of National Significance (WoNS – Federal) along with appropriate action requirements.

Vegetation Management Act 1999 (VMA)

The VMA principally regulates the clearing of native vegetation in Queensland. It identifies collective vegetation communities (known as Regional Ecosystems) and classifies them according to the amount of remnant vegetation remaining state wide.

- Endangered ecosystems are identified as remnant vegetation that is less than 10 per cent of its pre-clearing extent across the bioregion; or 10–30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares;
- Of Concern ecosystems are identified as remnant vegetation that is 10–30 per cent of its pre-clearing extent across the bioregion; or more than 30 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares;
- Least Concern ecosystems are identified as remnant vegetation that is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares.

The VMA uses this quantification to regulate what clearing can be done and how such clearing must be undertaken to meet the requirements of state legislation.

Essential habitat is also identified under the VMA and considers remnant or high value regrowth ecosystems that hold at least three different essential habitat factors for any species of listed wildlife to occur during any stage of its life cycle.

APPENDIX 2: SITE CONDITION SURVEY METHODOLOGY

BioCondition Surveys

Modified BioCondition surveys were undertaken in six areas of the proposed offset site as outlined in BioCondition methodology by Eyre *et al*. (2015). Five different measurement units were used. **Table 4** identifies the units of measurement and the attributes.

Table 4: Modified BioCondition measurement units and attributes

Measurement	100 x 50m quadrat	100m transect	50 x 20m quadrat	50 x 10m quadrat	1 x 1m quadrat
Attribute	• Large trees • Tree canopy height • Recruitment of habitat species	• Tree canopy cover • Native shrub cover	• Coarse woody debris	• Weed coverage	• Native ground cover richness • Organic matter

Regional Ecosystem Verification

Six standard 0.05 ha (50 m x 10 m) tertiary floristic quadrats were sampled for flora species. One quadrat was undertaken in the study area and one in the reference site. Quadrats were placed in areas deemed to be representative of individual vegetation communities and where vegetation was sufficient. Each quadrat was carefully examined to identify all plant species present and their relative abundance. This assessment is consistent with methodologies used by Nelder *et al.* (2012) for mapping vegetation in Queensland:

Quaternary Survey or Rapid Data Points (RDP) are summaries of dominant floristic composition and stratification taken at random points over a large spatial scale. They are used as a fast and reliable way of identifying ecosystem distribution and support Regional Ecosystem mapping. RDPs are not a standard size; they simply document the vegetation within view (approximate 50m radius), aiming to describe the vegetation type present at any given point. Eight RDPs were used during the survey of the site.

Floristic Identification and Nomenclature

Floristic identification and nomenclature was devised from a variety of published literature and online resources. If a plant was unable to be identified using these references or a specimen was potentially rare or threatened, samples were sent to the Queensland Herbarium.

Vegetation Community Mapping

The identification of vegetation communities was based on dominant species in the overstorey, midstorey, shrub and ground layers as recorded in 0.05 ha floristic quadrats, and supported through RDPs. The species associations recorded in the study area were compared to descriptions of vegetation communities provided by the Queensland Herbarium and supported through DEHP. Vegetation communities that best matched those observed in the proposed offset site were adopted by this study. Observations of Regional Ecosystems (REs) remaining in the area were also used as visual reference points prior to and throughout the study.

APPENDIX 3: KSAT RESULTS – PELLET COUNTS

Table 5: KSAT results per habitat tree.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Total
Eucalyptus tereticornis	9	30	16	-	42	7	**104**
Eucalyptus crebra	91	16	29	2	0	25	**163**
Corymbia clarksoniana	11	0	0	1	4	5	**21**
Corymbia tessellaris	5	0	0	0	0	20	**25**
Corymbia dallachiana	-	12	-	-	-	-	**12**
Corymbia intermedia	-	3	1	0	11	-	**15**
Corymbia erythrophloia	-	-	0	-	0	-	**0**
Eucalyptus platyphylla	-	-	-	0	0	0	**0**
Lophostemon suaveolens	-	-	-	0	0	-	**0**
Total	**116**	**61**	**46**	**3**	**57**	**57**	

APPENDIX 4: SITE PHOTOS

The following images were taken from the centre of each BioCondition quadrat and represent a north east south west aspect, top left to bottom right.

Plate 3: BioCondition quadrat 1 (RE11.3.4/11.12.3)

Plate 4: BioCondition quadrat 2 (RE11.3.4/11.12.3)

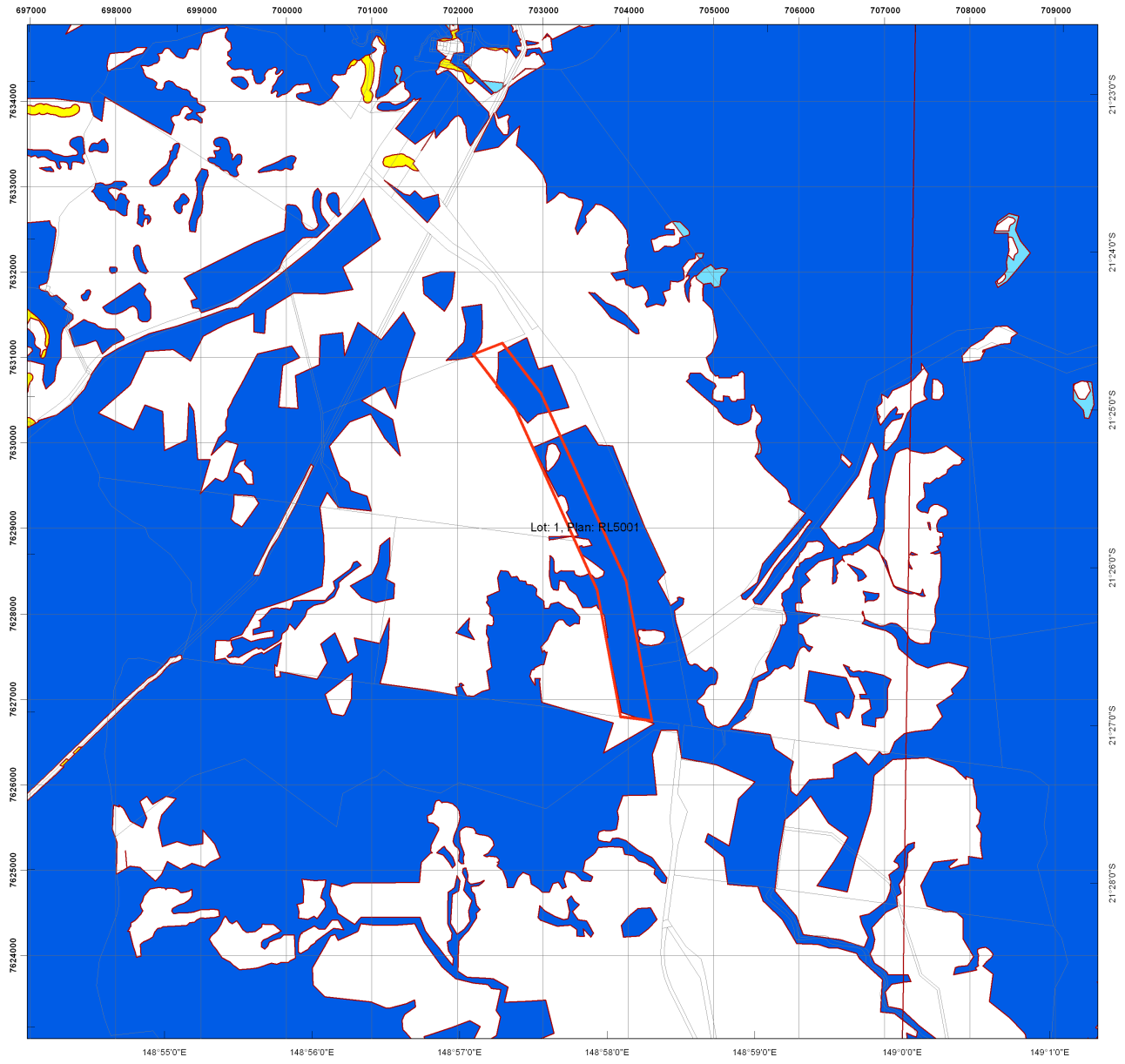
Plate 5: BioCondition quadrat 3 (RE11.12.3)

Plate 6: BioCondition quadrat 4 (RE11.3.9)

Plate 7: BioCondition quadrat 5 (RE11.3.25)

Plate 8: BioCondition quadrat 6 (RE11.12.3/11.3.4/11.3.9)

Appendix E: Desktop Assessment for Potential Offset Site



Regulated Vegetation Management Map

Legend

- Lot and Plan
- Category A area (Vegetation offsets/compliance notices/VDecs)
- Category B area (Remnant vegetation)
- Category C area (High-value regrowth vegetation)
- Category R area (Reef regrowth watercourse vegetation)
- Category X area (Vegetation not regulated under the VMA)
- Water
- Area not categorised
- Cadastral line
  Property boundaries shown are provided as a locational aid only

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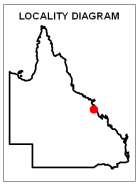
LOCALITY DIAGRAM



N

0 680 1,360 2,040 2,720 3,400 m

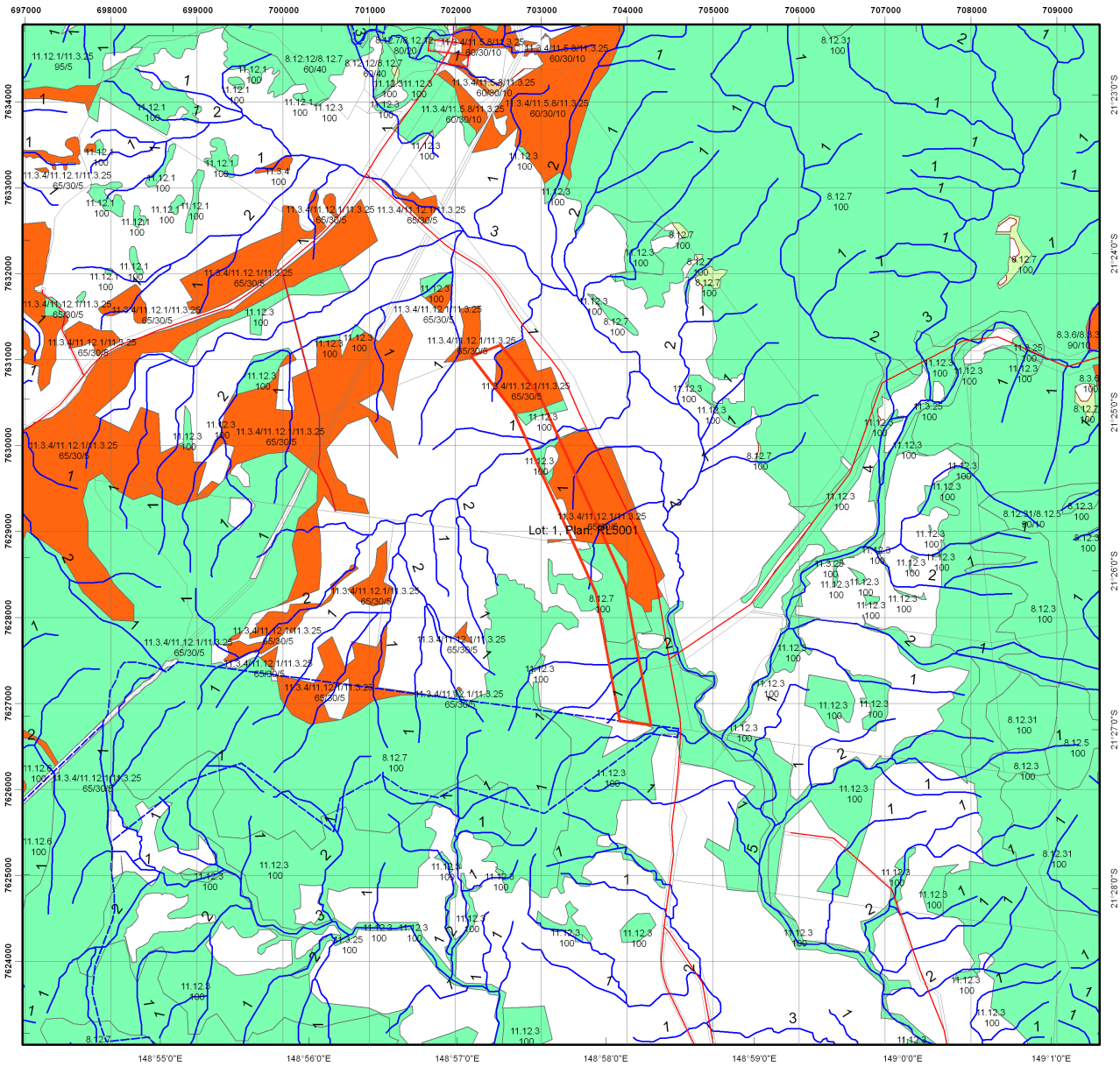
This product is projected into:
GDA 1994 MGA Zone 55

Disclaimer:
While every care is taken to ensure the accuracy of this product, the Department of Natural Resources and Mines makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you might incurr as a result of the product being inaccurate or incomplete in any way and for any reason.

Additional information required for the assessment of vegetation values is provided in the accompanying "Vegetation Management Supporting map". For further information go to the web site: www.dnrm.qld.gov.au or contact the Department of Natural Resources and Mines.

Digital data for the regulated vegetation management map is available from the Queensland Spatial Portal at http://www.information.qld.gov.au/

This map is updated on a monthly basis to ensure new PMAVs are included as they are approved.



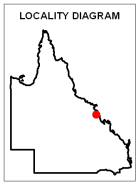
Vegetation Management Supporting Map

Legend

- Lot and Plan
- Category A or B area containing endangered regional ecosystems
- Category A or B area containing of concern regional ecosystems
- Category A or B area that is a least concern regional ecosystem
- Category A or B area containing remnant vegetation
- Category A or B area under Section 20AH
  These areas are edged in yellow and filled with the remnant RE Status
- Category C area containing endangered regional ecosystems
- Category C area containing of concern regional ecosystems
- Category C area that is a least concern regional ecosystem
- Category C area containing high value regrowth vegetation
- Category C area under Section 20AI
  These areas are edged in purple and filled with the remnant RE Status
- Non Remnant
- Water
- Wetland on the vegetation management wetlands map
- Essential habitat on the essential habitat map
- Essential habitat species record
- Watercourse on the vegetation management watercourse and drainage feature map
  (Stream order shown as black number against stream where available)
- Roads
- National Parks, State Forest and other reserves
- Cadastral line
  Property boundaries shown are provided as a locational aid only

Queensland Government

LOCALITY DIAGRAM



N

0 490 980 1,470 1,960 2,450 m

This product is projected into:
GDA 1994 MGA Zone 55

Labels for Essential Habitat are centred on the area of enquiry.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/- 100 metres.

Disclaimer:
While every care is taken to ensure the accuracy of this product, the Department of Natural Resources and Mines makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you might incurr as a result of the product being inaccurate or incomplete in any way and for any reason.

Additional information may be required for the purposes of land clearing or assessment of a regional ecosystem map or PMAV applications. For further information go to the web site: www.dnrm.qld.gov.au or contact the Department of Natural Resources and Mines.

Digital data for the vegetation management watercourse and drainage feature map, vegetation management wetlands map, essential habitat map and the vegetation management remnant and regional ecosystem map are available from the Queensland Spatial Portal at http://www.information.qld.gov.au/

Vegetation Management Act 1999 - Extract from the essential habitat database

Essential habitat is required for assessment under the:

- State Development Assessment Provisions - Module 8: Native vegetation clearing which sets out the matters of interest to the state for development assessment under the *Sustainable Planning Act 2009*; and
- Self-assessable vegetation clearing codes made under the *Vegetation Management Act 1999*

Essential habitat for one or more of the following species is found on and within 1.1 km of the identified subject lot/s or on and within 2.2 km of an identified coordinate on the accompanying essential habitat map.

This report identifies essential habitat in Category A, B and Category C areas.

The numeric labels on the essential habitat map can be cross referenced with the database below to determine which essential habitat factors might exist for a particular species.

Essential habitat is compiled from a combination of species habitat models and buffered species records.

The Department of Natural Resources and Mines website (http://www.dnrm.qld.gov.au) has more information on how the layer is applied under the State Development Assessment Provisions - Module 8: Native vegetation clearing and the *Vegetation Management Act 1999*.

Regional ecosystem is a mandatory essential habitat factor, unless otherwise stated.

Essential habitat, for protected wildlife, means a category A area, a category B area or category C area shown on the regulated vegetation management map-

1) (a) that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or
2) (b) in which the protected wildlife, at any stage of its life cycle, is located.

Essential habitat identifies endangered or vulnerable native wildlife prescribed under the *Nature Conservation Act 1994*.

Essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Species Information

(no results)

Essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Regional Ecosystems Information

(no results)

Essential habitat in Category A and B (Remnant vegetation) areas:1100m Species Information

(no results)

Essential habitat in Category A and B (Remnant vegetation) areas:1100m Regional Ecosystems Information

(no results)

Essential habitat in Category C (High value regrowth vegetation) areas:1100m Species Information

(no results)

Essential habitat in Category C (High value regrowth vegetation) areas:1100m Regional Ecosystems Information

(no results)

Atlas of Living Australia Search Results (Nov 2015)

Species Name	Scientific Name Authorship	Taxon Rank	Kingdom	Phylum	Class	Order	Family	Genus	Vernacular Name
Malurus (Musciparus) melanocephalus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MALURIDAE	Malurus	Red-backed Fairy-wren
Eucalyptus melanophloia	F.Muell.	species	Plantae	Charophyta	Equisetopsida	Myrtales	Myrtaceae	Eucalyptus	Silver-leaf Ironbark
Rhipidura (Sauloprocta) leucophrys	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	RHIPIDURIDAE	Rhipidura	Willie Wagtail
Cracticus nigrogularis	(Gould, 1837)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE	Cracticus	Pied Butcherbird
Corvus orru	Bonaparte, 1850	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CORVIDAE	Corvus	Torresian Crow
Microcerotermes turneri	(Froggatt, 1898)	species	ANIMALIA	ARTHROPODA	INSECTA	BLATTODEA	TERMITIDAE	Microcerotermes	
Parsonsia straminea	(R.Br.) F.Muell.	species	Plantae	Charophyta	Equisetopsida	Gentianales	Apocynaceae	Parsonsia	Common Silkpod
Eucalyptus tereticornis	Sm.	species	Plantae	Charophyta	Equisetopsida	Myrtales	Myrtaceae	Eucalyptus	Forest Red Gum
Clerodendrum floribundum	R.Br.	species	Plantae	Charophyta	Equisetopsida	Lamiales	Lamiaceae	Clerodendrum	Lolly Bush
Anas (Anas) superciliosa	Gmelin, 1789	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Anas	Pacific Black Duck
Aphaenogaster pythia	Forel, 1915	species	ANIMALIA	ARTHROPODA	INSECTA	HYMENOPTERA	FORMICIDAE	Aphaenogaster	
Porphyrio (Porphyrio) porphyrio	(Linnaeus, 1758)	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Porphyrio	Purple Swamphen
Aphaenogaster barbara	Shattuck, 2008	species	ANIMALIA	ARTHROPODA	INSECTA	HYMENOPTERA	FORMICIDAE	Aphaenogaster	
Philemon (Microphilemon) citreogularis	(Gould, 1837)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE	Philemon	Little Friarbird
Coracina (Coracina) novaehollandiae	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CAMPEPHAGIDAE	Coracina	Black-faced Cuckoo-shrike
Geopelia striata	(Linnaeus, 1766)	species	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE	Geopelia	Peaceful Dove
Philemon (Tropidorhynchus) corniculatus	(Latham, 1790)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE	Philemon	Noisy Friarbird
Anthus (Anthus) novaeseelandiae	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MOTACILLIDAE	Anthus	Australasian Pipit
Nettapus (Cheniscus) coromandelianus	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Nettapus	Cotton Pygmy-goose
Anas (Nettion) gracilis	Buller, 1869	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Anas	Grey Teal
Microeca (Microeca) flavigaster	Gould, 1843	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PETROICIDAE		Lemon-bellied Flycatcher
Hypseleotris compressa	(Krefft, 1864)	species	ANIMALIA	CHORDATA	ACTINOPTERYGII	PERCIFORMES	ELEOTRIDAE	Hypseleotris	Empire Gudgeon
Trichoglossus chlorolepidotus	(Kuhl, 1820)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	PSITTACIDAE	Trichoglossus	Scaly-breasted Lorikeet
Pardalotus (Pardalotinus) striatus	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PARDALOTIDAE	Pardalotus	Striated Pardalote
Ardea (Bubulcus) ibis	Linnaeus, 1758	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Ardea	Cattle Egret
Tachybaptus novaehollandiae	(Stephens, 1826)	species	ANIMALIA	CHORDATA	AVES	PODICIPEDIFORMES	PODICIPEDIDAE	Tachybaptus	Australasian Grebe
Dendrocygna (Dendrocygna) arcuata	(Horsfield, 1824)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Dendrocygna	Wandering Whistling-duck
Microcarbo melanoleucos	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PELECANIFORMES	PHALACROCORACIDAE	Microcarbo	Little Pied Cormorant
Myzomela (Cosmeteira) obscura	Gould, 1843	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE	Myzomela	Dusky Honeyeater
Grallina cyanoleuca	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MONARCHIDAE	Grallina	Magpie-lark
Anseranas semipalmata	(Latham, 1798)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANSERANATIDAE	Anseranas	Magpie Goose
Smicrornis brevirostris	(Gould, 1838)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ACANTHIZIDAE	Smicrornis	Weebill
Trichoglossus haematodus	(Linnaeus, 1771)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	PSITTACIDAE	Trichoglossus	Rainbow Lorikeet
Merops (Merops) ornatus	Latham, 1801	species	ANIMALIA	CHORDATA	AVES	CORACIIFORMES	MEROPIDAE	Merops	Rainbow Bee-eater
Lichmera (Lichmera) indistincta	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE	Lichmera	Brown Honeyeater
Petrochelidon (Hylochelidon) nigricans	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	HIRUNDINIDAE	Petrochelidon	Tree Martin
Anhinga novaehollandiae	(Gould, 1847)	species	ANIMALIA	CHORDATA	AVES	PELECANIFORMES	ANHINGIDAE	Anhinga	Australasian Darter
Petrochelidon (Petrochelidon) ariel	(Gould, 1842)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	HIRUNDINIDAE	Petrochelidon	Fairy Martin
Centropus (Polophilus) phasianinus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	CUCULIFORMES	CENTROPODIDAE	Centropus	Pheasant Coucal
Pachycephala (Alisterornis) rufiventris	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PACHYCEPHALIDAE	Pachycephala	Rufous Whistler
Dendrocygna (Leptotarsis) eytoni	(Eyton, 1838)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Dendrocygna	Plumed Whistling-duck
Cracticus tibicen	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE	Cracticus	Australian Magpie
Irediparra gallinacea	(Temminck, 1828)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	JACANIDAE	Irediparra	Comb-crested Jacana
Ardea (Casmerodius) modesta	J.E. Gray, 1831	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Ardea	Eastern Great Egret
Vanellus (Lobipluvia) miles	(Boddaert, 1783)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	CHARADRIIDAE	Vanellus	Masked Lapwing
Neochmia (Aegintha) temporalis	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ESTRILDIDAE	Neochmia	Red-browed Finch
Gallinula (Gallinula) tenebrosa	Gould, 1846	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Gallinula	Dusky Moorhen
Dacelo (Dacelo) leachii	Vigors & Horsfield, 1827	species	ANIMALIA	CHORDATA	AVES	CORACIIFORMES	ALCEDINIDAE	Dacelo	Blue-winged Kookaburra
Myiagra (Myiagra) rubecula	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MONARCHIDAE	Myiagra	Leaden Flycatcher
Phascolarctos cinereus	(Goldfuss, 1817)	species	ANIMALIA	CHORDATA	MAMMALIA	DIPROTODONTIA	PHASCOLARCTIDAE	Phascolarctos	Koala
Colluricincla (Colluricincla) harmonica	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PACHYCEPHALIDAE	Colluricincla	Grey Shrike-thrush
Myzomela (Myzomela) sanguinolenta	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE	Myzomela	Scarlet Honeyeater
Sorghum nitidum	(Vahl) Pers.	species	Plantae	Charophyta	Equisetopsida	Poales	Poaceae	Sorghum	
Sporobolus jacquemontii	Kunth	species	Plantae	Charophyta	Equisetopsida	Poales	Poaceae	Sporobolus	American Ratstail Grass
Eragrostis spartinoides	Steud.	species	Plantae	Charophyta	Equisetopsida	Poales	Poaceae	Eragrostis	
Paspalidium distans	(Trin.) Hughes	species	Plantae	Charophyta	Equisetopsida	Poales	Poaceae	Paspalidium	Spreading Panic-grass
Urochloa mutica	(Forssk.) T.Q.Nguyen	species	Plantae	Charophyta	Equisetopsida	Poales	Poaceae	Urochloa	Para Grass
Ageratum conyzoides	L.	species	Plantae	Charophyta	Equisetopsida	Asterales	Asteraceae	Ageratum	Billygoat Weed
Fimbristylis tristachya	R.Br.	species	Plantae	Charophyta	Equisetopsida	Poales	Cyperaceae	Fimbristylis	

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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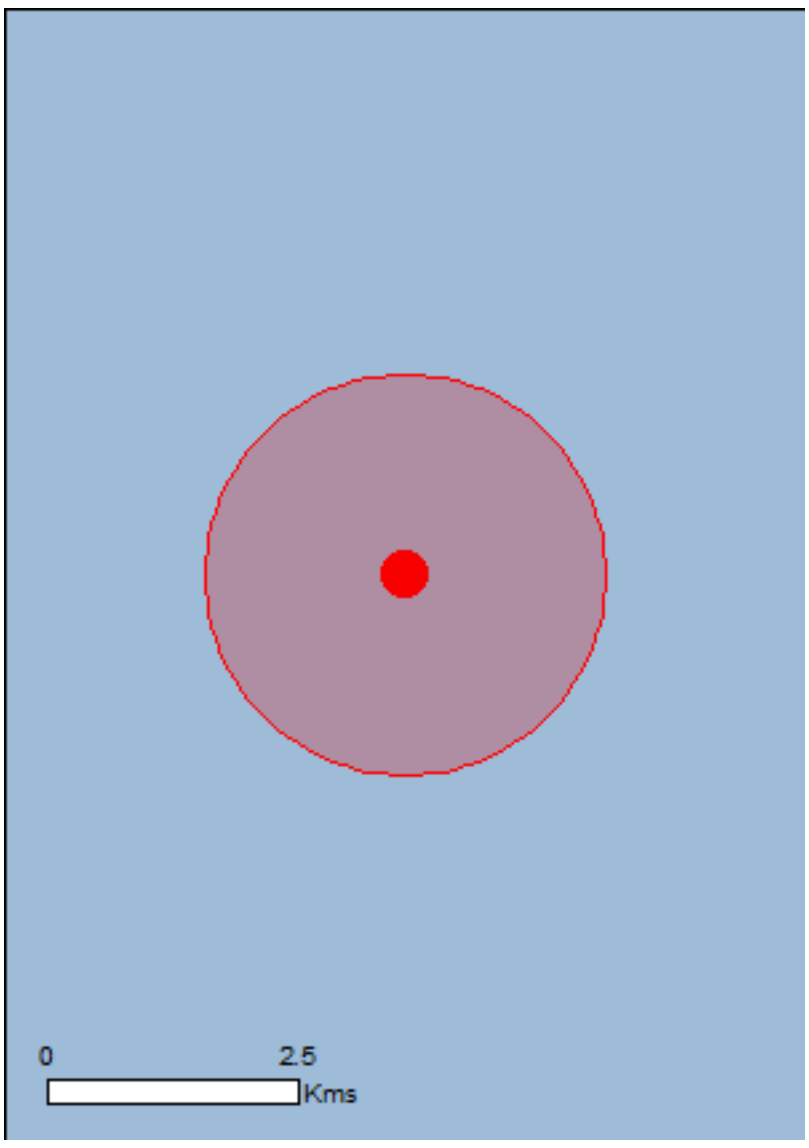
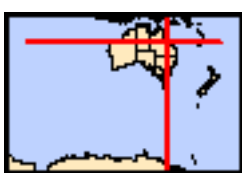


Coordinates

Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	17
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	22
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rhinolophus robertsi Large-eared Horseshoe Bat, Greater Large-eared Horseshoe Bat [87639]	Endangered	Species or species habitat may occur within area
Other		

Name	Status	Type of Presence
Cycas ophiolitica [55797]	Endangered	Species or species habitat likely to occur within area
Plants		
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Omphalea celata [64586]	Vulnerable	Species or species habitat likely to occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
Reptiles		
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat may occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]		
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.4407 148.9676

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: -21.4407
Longitude: 148.9676
Distance: 2
Email: timothy.b.dalton@tmr.qld.gov.au
Date submitted: Tuesday 24 Nov 2015 14:03:38
Date extracted: Tuesday 24 Nov 2015 14:10:12

The number of records retrieved = 24

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		1
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		1
animals	birds	Artamidae	*Cracticus tibicen*	Australian magpie		C		1
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		1
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		1
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		1
animals	birds	Estrildidae	*Neochmia temporalis*	red-browed finch		C		1
animals	birds	Hirundinidae	*Petrochelidon ariel*	fairy martin		C		1
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		1
animals	birds	Meliphagidae	*Myzomela sanguinolenta*	scarlet honeyeater		C		1
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		1
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		1
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		1
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		1
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		1
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		1
animals	birds	Petroicidae	*Microeca flavigaster*	lemon-bellied flycatcher		C		1
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		1
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		1
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		1
plants	higher dicots	Apocynaceae	*Parsonsia straminea*	monkey rope		C		1/1
plants	higher dicots	Lamiaceae	*Clerodendrum floribundum*			C		1/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix F: ERRP Fauna Assessment Report (EcoSM, 2013)

ETON RANGE REALIGNMENT PROJECT
FAUNA ASSESSMENT REPORT

Department of Transport and Main Roads

December 2013

ecological survey & management

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1. Introduction

Ecological Survey & Management was engaged by the Department of Transport and Main Roads to undertake a fauna and habitat assessment of an area proposed for realignment of the Peak Downs Highway crossing of the Eton Range, approximately 40 km south-west of Mackay (Figure 1). This area of the Peak Downs Highway is known as Spencer Gap.

The objective of the fauna and habitat assessment was to identify key fauna constraints within the area of interest (the Study Area) to inform design and approvals required for the Project.

1.1. Background

A number of studies have been undertaken as part of the route selection and design of the Project, including:

- 2010 Ecological Assessment Report Peak Downs Highway Realignment Eton Range Crossing undertaken by Ecological Survey & Management
- 2013 Eton Range Upgrade Project – Options Q1a-W21 and X1A-X2A undertaken by Ecological Survey & Management.

These surveys largely focused on vegetation and flora assessment and mapping. This current assessment expands on the results of these previous surveys by assessing the fauna values of the Study Area.

Additionally, the Study Area has been altered since the 2010 and 2013 surveys were undertaken and this assessment addresses the vegetation mapping and threatened flora values of the expanded Study Area.

1.1.1. Scope of works

This assessment involved:

- Review of existing information such as existing field-validated regional ecosystem (RE) mapping and previous assessments, aerial photography and relevant database searches such as Queensland Museum, Wildlife Online and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool
- Undertake a four (4) day fauna assessment to assess quality of habitats and apply targeted survey techniques aimed at identifying significant fauna species
- Identify potential breeding places, such as bird nests, hollow-bearing trees and caves within the Study Area
- Prepare significance assessments for EPBC Act listed fauna species known or considered likely to occur in the Study Area
- Undertake a one (1) day vegetation mapping exercise to capture REs in the expanded Study Area and map additional locations of Significant species known to occur in the area.

2. Methods

2.1. Desktop Review

A number of database and mapping sources were reviewed as part of this assessment and were used to target field survey methods for the Study Area. Sources included:

- EPBC Act Protected Matters Search Tool (SEWPaC 2013b)
- Wildlife Online database (EHP 2013)
- Queensland Museum Database (Queensland Museum 2013)
- Vegetation Management Regional Ecosystem and Remnant Map (Version 8.0) (NRM 2013b) and Essential Habitat Map (Version 4.0) (NRM 2013a)
- Nearmap 2011 Aerial photography
- Atlas of Groundwater Dependent Ecosystems (National Water Commission 2013).

2.2. Field Survey

A total of 11 survey sites were established throughout the Study Area that combined a number of survey techniques in order to target the range of significant fauna species that potentially occur in the Study Area. A description of these techniques and survey effort is described in Sections 2.2.1 – 2.2.8. The distribution of survey techniques employed throughout the Study Area is shown on Figure 1.

2.2.1. Spotlighting

Spotlighting was undertaken on foot over three nights for a total of 18 person hours. The distinctive calls of some fauna were also used to identify their presence. All habitat types were spotlighted during the survey period.

2.2.2. Call playback

Call playback involved broadcasting a recorded call of an owl or arboreal mammals through a megaphone in an effort to elicit a territorial response from any animals that hear the call. Animals either call in response to the recording and/or move in to the location that the call was played from. The call is played and then approximately 2 to 3 minutes are spent listening for a response and looking for animals that have moved into the area without calling. Call playback was undertaken at six sites. Following the call playback session, spotlighting was conducted of the immediate area to locate any owls that had flown into the area without calling and had not been seen during the call playback. The calls of the following species were played:

- Barking Owl (*Ninox connivens*)
- Masked Owl (*Tyto novaehollandiae*)
- Southern Boobook (*Ninox novaeseelandiae*)

- Barn Owl (*Tyto alba*)
- Koala (*Phascolarctos cinereus*)

2.2.3. Active Searching

Active searching was conducted to detect reptiles, frogs and small ground dwelling mammals. It involved the searching of suitable microhabitat such as logs, bark, deep leaf litter, surface rocks and shedding bark. Active searching was undertaken at five sites for a total of 10 person hours across the Study Area.

2.2.4. Anabat

The Anabat surveys involved the use of an SD1 Anabat detector to record the echolocation calls of micro-bats as they forage. A sonogram was then produced suing software that allows for comparison against reference calls for identified. Unfortunately, some species of bat have very similar and/or quiet calls and cannot be positively distinguished via Anabat (e.g. *Nyctophilus* species). Therefore, a probability rating is provided for calls identified. All Anabat calls were analysed by Greg Ford, a specialist in analysing Anabat recordings.

Anabat units were deployed for one night from dusk until dawn at 6 locations across the Study Area. Anabat survey sites were selected on the basis of having suitable flyways, flowering trees that attract insects or water that attracts insects and bats.

2.2.5. Koala Line Transects

The Wildlife Online search indicated that the Koala had been previously recorded from the search area. Therefore, targeted line transects were conducted in the Study Area to provide information in relation to the use of the Study Area by this species. In line with the Interim Koala Referral Advice for Proponents (SEWPaC 2012b), line transects were stratified across the Study Area to establish an estimate of population density, distribution and habitat preferences.

The methodology employed for the line transects involved two ecologists walking a distance of 25 m apart for a length of 500 m on one side of a centreline and then returning along the other side of the 500 m centreline also remaining a distance of 25 m apart, while inspecting each tree along this transect. This results in a search area of 5 ha (500 m x 100 m search area) for each transect. In total, five line transects were conducted, with 25 ha of potential habitat actively searched for this species in the Study Area.

For trees where a Koala or evidence of a Koala was identified, the type of observation, species of the tree and location were noted.

2.2.6. Infrared Cameras

Cameras were set on a bait station of a chicken frame, apple and sweet potato. Cameras were set at 5 sites across the Study Area for a duration of four nights each.

2.2.7. Bird Surveys

Bird surveys were conducted at each of the 11 survey sites, with all birds seen and heard recorded. Eleven person hours were spent conducting bird surveys throughout the Study Area. Opportunistic records of birds were also made while undertaking other activities throughout the Study Area. Approximately 60 person hours were spent undertaking opportunistic bird surveys during the field survey.

2.2.8. Opportunistic Observations

Records of fauna in the Study Area were also made opportunistically while undertaking other activities, such as moving between trap sites, throughout the survey periods.

2.3. Habitat Assessment

The BioCondition Assessment Methodology (Eyre et al. 2011) was developed by the former Queensland Environmental Protection Agency to provide a methodology for the rapid assessment of terrestrial ecosystem condition. The methodology is similar to the Habitat Hectare and BioMetric methodologies developed in Victoria and New South Wales respectively.

The BioCondition methodology provides a measure of the condition of a 'patch' of vegetation in comparison to the same vegetation in its 'undisturbed' or pre-European state. This involves the assessment of a patch of vegetation against a 'benchmark'. For example, the number of large trees in a patch is measured and compared against the number of benchmark large trees for that vegetation type, and scored accordingly. A BioCondition assessment provides a condition score for a patch of vegetation as a score out of 100.

To date a comprehensive set of benchmarks for REs has yet to be developed. In this case the user is required to identify and assess the best available patch of vegetation of the same type, in a similar landscape context within the region, to use as a benchmark.

Due to the practical limitations of identifying a suitable and accessible reference site to determine a benchmark for the relevant vegetation type, Ecological Survey & Management developed a simplified BioCondition methodology to enable a rapid assessment of vegetation condition that generally follows the BioCondition methodology without the requirement for a benchmark reference site. The modified methodology is based on judgement of the difference of the vegetation from undisturbed conditions. While this greatly increases the subjectivity of the assessment it still provides an objective assessment framework and is considered an improvement on purely subjective assessments of habitat and vegetation condition.

However, without a benchmark it is not possible to conduct some parts of the BioCondition assessment. Specifically, these are the assessment of native species richness within each life form and the detailed assessment of native grass cover, native herb and forb cover, and native annual species cover. This simplified methodology includes an assessment of the level of cover of native species in the understorey against what would be

expected in an undisturbed example of the vegetation type. Therefore, the modified assessment provides a score out of 85 that is then multiplied by 1.176 to obtain a score out of 100.

Once a score out of 100 is developed, this is then compared to Table 1, to rate the patch of vegetation on a scale of 1 to 4, whereby 1 represents vegetation of good biodiversity condition and 4 represents poor biodiversity condition.

Table 1: Categorisation of BioCondition Scores

Condition Class	BioCondition Score
1	>85 %
2	>or= 70 – 84 %
3	>or= 60 – 69 %
4	<6 %

This methodology was applied at 17 habitat assessment sites throughout the Study Area (Figure 1). Sites were chosen to represent each polygon or patch, as well as provide duplicates where possible for each RE occurring within the Study Area. A series of vegetation attributes were assessed at each site to establish using scores outlined in the BioCondition Assessment Methodology (Eyre et al. 2011), including:

- Canopy cover and health
- Canopy recruitment
- Canopy height
- Shrub layer
- Ground cover
- Large trees
- Fallen logs
- Weed cover
- Organic litter
- Size of patch
- Connectivity
- Context.

2.4. Significant Species Assessment

Database searches identified significant species that potentially occur within the Study Area. The likelihood of such species occurring was then assessed based on the results of the field assessment.

The likelihood of species occurring within the Study Area was classified using the criteria presented in Table 2. The assessment was based on the

species' known ranges and habitat preferences, which were evaluated based on characteristics of the Study Area observed during field surveys.

Table 2: Criteria to assess potential for species to occur in the Study Area

Likelihood to Occur	Definition
Present	The species was recorded within the Study Area during the field surveys.
High	The species was not recorded within the Study Area during field surveys, but is known to occur within the surrounding area, and habitat of suitable quality exists within the Study Area.
Moderate	The species was not recorded within the Study Area during field surveys, although it is known to occur in the wider region. Habitat was identified for the species in the Study Area during the field surveys, however, it is marginal, fragmented and/or small in size, or degraded.
Low	The species was not recorded within the Study Area during the field surveys. The species is either: a) Unlikely to occur in the wider region and due to the lack of, or extremely poor quality habitat in the Study Area, the species is not expected to occur within the Study Area b) May forage periodically in the wider region and may overfly the Study Area, but the habitat in the Study Area is generally not suitable.

2.4.1. Impact Assessments

For species listed under the EPBC Act that were recorded or considered to have a high likelihood of occurring in the Study Area, the significance of impacts was assessed in accordance with the Significant Impact Guidelines (DoE 2013c).

Species of a moderate or lower likelihood of occurring in the Study Area were not assessed against the Significant Impact Guidelines as the Study Area is not considered to provide good quality or important habitat for these species due to:

- the relatively small area of impact
- the highly disturbed nature of the Study Area as a result of the existence of the Peak Downs Highway
- extensive and more intact habitat to the east and west of the Study Area in the Eton and Connors Ranges.

Therefore, there is a high confidence that impacts to these species would not be significant.

There is no prescribed methodology for the assessment of potential impacts under the NC Act or the subordinate NC Regulation. Assessments of the potential impacts to species listed under the NC Act were undertaken on the basis of the species' known ecology, project design and potential mitigation measures.

2.5. Fauna Field Survey Standards

The Queensland Government has developed Terrestrial Vertebrate Fauna Survey Guidelines (DSITIA 2012) that outline recommended survey effort and techniques for survey of terrestrial vertebrate fauna in Queensland.

Similarly, the Commonwealth Government has developed a series of specific guidelines tailored to the threatened species being targeted e.g. threatened reptiles, bats, birds, fish and mammal species.

These guidelines have been considered in development of survey methods for this Project, particularly with regard to survey timing and techniques employed to target significant species most likely to occur in the Study Area.

2.6. Limitations

Ecological survey often fails to record all species of flora and fauna present on a site for a variety of reasons, such as seasonal absence or reduced activity during certain seasons. Furthermore, the ecology and nature of Significant and/or cryptic species means that such species are potentially not recorded during short survey periods.

Therefore, it is possible that some fauna species that have a larger home range may not have been detected in the Study Area during the fauna survey periods.

This assessment overcomes these limitations by assessing impacts not only on species recorded during the field survey, but on species that are potentially present (based on known distribution and habitat availability).

3. Results

3.1. Fauna

3.1.1. Habitat and Landscape Connectivity

The maintenance of landscape connectivity between patches of habitat is a fundamental aspect of conservation ecology (Endler 1977; Forman 1995). Habitat corridors are often recommended to maintain and/or enhance landscape connectivity (Bennett et al. 1999).

The Study Area lies within a large connected landscape of remnant vegetation associated with the Eton and Connors Ranges. This landscape corridor links important refuges of Spencer Gap State Forest and Ben Mohr State Forest in close proximity to the Study Area and Crediton State Forest, Homevale National Park and Eungella National Park further west and north-west of the Study Area.

A first order stream is located in the north of the Study Area and flows in a northerly direction towards Sandy Creek.

3.1.2. Habitat Assessment

Using the modified BioCondition methodology, habitat condition scores were established for 17 sites within the Study Area, representing each of the four REs occurring in the Study Area. These scores are presented in Table 3. The Study Area presented an average condition score of 68.9, which falls within the condition class of 3. However, patches within REs 8.12.3, 8.12.5 and 8.12.7 represented relatively good condition, with score categories of 1 and 2 (Table 3).

The relatively low average condition score for the Study Area is most likely a reflection of the existing disturbance within the Study Area, resulting from the existing Peak Downs Highway. The cleared corridor and associated edge effects degrade the overall quality of vegetation and habitat.

Table 3: Modified BioCondition Scores for each of the 17 habitat assessment sites within the Study Area

Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Regional Ecosystem	8.12.3	8.12.12	8.12.5	8.12.3	8.12.12	8.12.3	8.12.5	8.12.7	8.12.7	8.12.12	8.12.7	8.12.7	8.12.12	8.12.7	8.12.7	8.12.7	8.12.7
Canopy cover and Health	5	5	5	5	5	5	5	5	5	5	5	3	5	4	5	3	5
Canopy Recruitment	3	3	3	5	0	5	3	3	3	3	3	5	3	0	3	5	3
Canopy Height	5	3	3	3	5	5	5	3	3	3	5	3	3	3	5	3	3
Shrub Layer	5	3	5	5	3	5	5	5	5	5	5	3	5	3	5	3	5
Ground Cover	10	2	10	6	0	10	6	10	10	6	10	6	6	6	2	2	10
Large Trees	8	3	3	8	3	8	8	3	8	3	6	8	3	0	3	3	1
Fallen Logs	3	2	2	3	2	3	2	4	2	2	2	4	2	2	2	0	4
Weed cover	5	0	10	5	0	10	5	10	10	5	5	3	3	3	3	0	10
Organic Litter	5	3	5	5	3	5	5	5	5	5	5	5	3	3	3	3	5
Size of Patch	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Connectivity	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2	4	5
Context	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5

Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total	69	44	66	65	41	76	64	68	71	57	66	60	53	44	47	40	66
Total /100	81	52	78	76	48	89	75	80	83	67	78	71	62	52	55	47	78
BioCondition Score Category (Eyre et al. 2011)	2	4	2	2	4	1	2	2	2	3	2	2	3	4	4	4	2

3.1.3. Fauna Diversity

The fauna survey resulted in records of 73 species in the Study Area, including 3 amphibians, 53 birds, 9 mammals and 8 reptiles.

Amphibians

Three amphibians were recorded during the survey, one of these being the introduced Cane Toad (**Rhinella marina*), which was recorded at most sites in most habitats (Appendix A). The two native species were recorded at one site only, Site 4 (Figures 1 and 2).

Birds

A total of 53 bird species were recorded during the survey with most species commonly recorded at Sites 7, 8, 9 10 and 11. The most commonly occurring species were Cicadabird (*Coracina tenuirostris*), Australian Brush-turkey (*Alectura lathami*), Leaden Flycatcher (*Myiagra rubecula*), Rufous Whistler (*Pachycephala rufiventris*), Torresian Crow (*Corvus orru*). The dry rainforest along the creek lines was the most diverse habitat type (8.12.3).

One species, the Spectacled Monarch (*Monarcha trivirgatus*), recorded in the Study Area is listed as Migratory under the Migratory provisions of the Commonwealth EPBC Act. This species and the potential for other significant species to occur in the Study Area is discussed in Section 3.1.4.

Habitat for a range of bird species occurs throughout the Study Area and a number of potential habitat trees, suitable for nesting bird species have been recorded in the Study Area. These habitat trees are shown on Figure 3 and described in Appendix A.

Mammals

Field surveys recorded 28 mammal species in the Study Area, including at least 15 species of microchiropteran bat. Another 3 recorded bat calls could not be reliably identified due to poor call quality and/or known call similarities between sympatric species (Ford 2013). One exotic mammal, the Wild Dog/Dingo (**Canis lupus*) was recorded.

One species, the Koala (*Phascolarctos cinereus*), listed as Vulnerable under the Commonwealth EPBC Act was recorded at three locations and heard calling during spotlighting activities (Figure 3).

Further discussion about this species and the likelihood for other significant species to occurring the Study Area is provided in Section 3.1.4.

As discussed previously, a number of potential habitat trees, supporting hollows, were recorded in the Study Area. A total of 88 habitat trees were recorded, mainly comprises Pink Bloodwood (*Corymbia intermedia*). This is considered a high number of habitat trees given the relatively small area of the Study Area. These habitat trees are shown on Figure 3 and described in Appendix A.

Reptiles

Habitat quality for reptiles is strongly influenced by attributes such as leaf litter, fallen logs and debris. The loss of these habitat elements very often occurs in disturbed environments and often leads to reductions in both diversity and abundance of reptiles.

Most sites assessed had a good density and coverage of leaf litter, whilst fallen timber forming hollow logs and debris was not abundant across most areas of the Study Area (Table 3). Nonetheless a moderate number of reptiles species were recorded given the relatively small Study Area and extent of disturbance created by clearing for the Peak Downs Highway.

The Open-litter Rainbow-skink (*Carlia pectoralis*) and Lace Monitor (*Varanus varius*) were most commonly recorded and most species were identified in Sites 1 and 2 (Appendix A).

3.1.4. Significant Species

Database search results for a 20 km radial area surrounding the Study Area, indicates the potential for 27 fauna species listed under the Queensland NC Act and/or Commonwealth EPBC Act to occur in the search area (Table 4). This includes 1 amphibian, 15 birds, 7 mammals and 4 reptiles which are discussed further below.

EPBC Act-listed Species

Sixteen species listed under the EPBC Act were returned from database searches for the search area. Of these, one (the Koala) was recorded in the Study Area during field surveys and four are considered to have a moderate likelihood of occurring in the Study Area due to the availability of suitable habitat (Table 4).

The four species with a moderate likelihood of occurring in the Study Area include:

- Red Goshawk (*Erythrotriorchis radiatus*) - Vulnerable
- Squatter Pigeon (*Geophaps scripta scripta*) - Vulnerable
- Northern Quoll (*Dasyurus hallucatus*) - Endangered
- Masked Owl (*Tyto novaehollandiae kimberli*) - Vulnerable.

While habitat within the Study Area is considered potentially suitable for these species, and there are known records of the Squatter Pigeon and Northern Quoll in the search area, these species would occur throughout the Eton and Connors Ranges and extensive areas of more intact habitat are available for these species. The Study Area is unlikely to support breeding habitat for any of these species due to lack of specific habitat features, such as caves and watercourses. Therefore, the Study Area would not form unique or important habitat for these species.

Koala

The Koala was identified at three locations in the Study Area. Two females and one male animal were observed in two Lemon Scented Gums (*Corymbia citriodora* var. *citriodora*)and one in a Broad-leaved Stringybark

(*Eucalyptus portuensis*). All three animals observed were within 8.12.7 (Figures 2 and 3). Calls of this species were also heard in adjacent areas during spotlighting activities during the field survey.

Based on the number of records, in a relatively small area over a short timeframe, the Koala is considered to occur in high abundance within and surrounding the Study Area. Therefore, there is potential for the Koalas that were identified in the Study Area to form part of an important population in the region. All vegetation in the Study Area is expected to provide suitable habitat for this species, except for the vine thicket community represented by RE 8.12.3. This habitat area equates to 80.7 ha in the Study Area. The Study Area is not considered particularly unique or of good quality, and therefore, it is expected that the more intact and remote areas of the Eton and Connors Ranges provide more important habitat for this species.

The existing Peak Downs Highway, is likely to cause a barrier effect to movement of the Koala either side of the highway, and there would be a risk of injury or fatality for individuals crossing the highway. However, this highway probably doesn't form a complete barrier given the persistence of this species in the Study Area.

Migratory Species

Table 5 lists the migratory species returned from the EPBC Act Protected Matters Search Tool for the search area. Of the 16 species returned from this search, one, the Spectacled Monarch (*Monarch trivirgatus*), was identified in 8.12.3 in the Study Area and another two, Black-faced Monarch (*Monarcha melanopsis*) and Rufus Fantail (*Rhipidura rififrons*), are considered to have a moderate or higher likelihood of occurring in the Study Area.

All vegetated areas within the Study Area provide potential suitable habitat for these species.

NC Act-listed Species

In addition to the 16 EPBC Act listed species identified in database search results, 11 NC Act species are considered to potentially occur in the search area, based on previous records.

Of these, five have a moderate likelihood of occurring in the Study Area (Table 4):

- Grey Goshawk (*Accipiter novaehollandiae*) – Near Threatened
- Australian Swiftlet (*Aerodramus terraereginae*) – Near Threatened
- Square-tailed Kite (*Lophoictinia isura*) – Near Threatened
- Black-chinned Honeyeater (*Melithreptus gularis*) – Near Threatened
- Ghost Bat (*Macroderma gigas*) - Vulnerable.

All of these species have been recorded in the search area and all potential forage in suitable habitat throughout the Study Area. Most of these species are more likely to overfly the Study Area, although the Ghost Bat and Black-chinned Honeyeater may forage within vegetated

habitat. However, none of these species are likely to nest or roost in the Study Area due to lack of suitable habitat features, such as caves and cliffs and watercourses.

No species listed under the NC Act were identified in the Study Area during field surveys.

3.1.5. Pests

Two exotic species were identified in the Study Area. One of these, the Wild Dog/Dingo is listed as a Class 2 declared species under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (Appendix A).

Other declared species are likely to occur in the Study Area and broader landscape.

Table 4: Significant fauna returned from database searches for the search area

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
Amphibians						
Taudactylus eungellensis	Eungella Day Frog	E	E	DoE	Occurring in upland rainforest streams primarily within Eungella National Park, Cathu State Forest and Eungella State Forest (DEH 2005).	Low: This species is associated with wet tropical rainforest, which does not occur within the study area.
Birds						
Accipiter novaehollandiae	Grey Goshawk	NT	-	Wildlife Online	Occurs in a wide range of habitats including rainforest, gallery forest, dense or open forest, swamp forest, woodlands, plantations and mangroves but is most abundant where vegetation provides cover for hunting from perches (Marchant & Higgins 1994).	**Moderate:** Habitat in the Study Area is suitable for this species.
Aerodramus terraereginae	Australian Swiftlet	NT	-	Wildlife Online	This species flies over rainforest, cleared lands, beaches and gorges and breeds in isolated caves. It occurs in north eastern Queensland south to about Mackay (Pizzey et al. 2012).	**Moderate:** Habitat in the Study Area suitable for this species.
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	Wildlife Online	This species occurs in eucalypt woodlands with an understorey or sub-canopy of Casuarina or Allocasuarina on the seeds of which its diet is based. It nests in tree hollows (Garnett & Crowley	Low: There are few Allocasuarina trees within the Study Area.

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					2000).	
Ephippiorhynchus asiatucus	Black-necked Stork	NT	-	Wildlife Online	The species forages mainly in open fresh waters such as flooded grassland or sedgelands, shallow swamps with abundant aquatic and short emergent vegetation and permanent pools on floodplains. It also uses freshwater meadows, wet heathland, semi-permanent swamps with tall emergent vegetation, paperbark swamps, watercourses and reservoirs (Marchant & Higgins 1994).	Low: Open wetland habitat does not occur in the Study Area.
Erythrotriorchis radiatus	Red Goshawk	E	V	DoE	The Red Goshawk is generally found in open woodland, the edges of rainforest, and in dense riverine vegetation of coastal and subcoastal forests (Marchant & Higgins 1993). This species is known to have a large home range but nest in tall trees usually within 1km of a waterway or wetland (Garnett and Crowley 2000).	**Moderate:** It is possible that the Red Goshawk could forage within the Study Area, although the lack of substantial waterways or wetlands make it unlikely to nest within the Study Area.
Geophaps scripta scripta	Squatter Pigeon	V	V	Wildlife Online, DoE	This species in known from tropical dry, open sclerophyll woodlands and sometimes savanna (Higgins and Peter 1996). It appears to favour sandy soil dissected with low gravely ridges and is less common on heavier soils with	**Moderate:** Although this species is more common west of the range it is possible that it may occur within the woodland vegetation types

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					dense grass cover. It is nearly always found in close association with permanent water. The southern sub-species of the Squatter Pigeon is described as occurring south of the Burdekin River (Higgins and Davies 1996).	within the Study Area.
Lewinia pectoralis	Lewin's Rail	NT	-	Wildlife Online	Densely vegetated, fresh, brackish or saline wetlands, usually with areas of standing water. Favours permanent wetlands but will use ephemeral wetlands. Wetland habitat may include swamps, marshes, lakes, inundated depressions, small pools, swampy or tidal creeks and streams, saltmarshes, coastal lagoons, estuaries and farm dams with dense fringing or emergent vegetation, such as reeds, grasses and sedges. Occurs between Julatten inland to Atherton Tablelands, south to Proserpine. Also likely in south-east Queensland from Fraser Island south and inland to Toowoomba (Marchant & Higgins 1993).	Low: Wetland habitat does not occur in the Study Area.
Lophoictinia isura	Square-tailed Kite	NT	-	Wildlife Online	This species hunts primarily over open forest, woodlands and mallee vegetation types that are rich in passerines, as well as adjacent low scrubby areas and wooded towns.	**Moderate:** This species could potentially occur within the Study Area.

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					It appears to prefer a structurally diverse landscape (Garnett & Crowley 2000).	
Melithreptus gularis	Black-chinned Honeyeater	NT	-	Wildlife Online	This species occurs in the dry eucalypt woodlands with an annual rainfall of 400 - 700mm usually on the inland slopes of the Great Divide but extending to the coast between Brisbane and Rockhampton. It appears to favour vegetation associations with box and ironbark (Garnett and Crowley 2000).	**Moderate:** This species could potentially occur within the woodland vegetation types within the Study Area.
Neochmia ruficauda ruficauda	Star Finch	E	E	DoE	The Star finch usually inhabits low dense damp grasslands bordering wetlands and waterways and also open savannah woodlands near water or subject to inundation (Higgins et. al. 2006). Absent from expanses of open county and uplands, usually occurring in valleys (Higgins et. al. 2006). In Queensland this species' range has largely contracted to the southern Cape York. There have not been any confirmed records from the Cairns to Townsville region for some time and none were recorded during the Birds Australia Atlas project (Higgins et. al. 2006). Recent records around Rockhampton are thought likely to	Low: This species is usually found in valleys and the Study Area lacks suitable habitat.

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					be aviary escapees (Higgins et. al. 2006).	
Nettapus coromandelianus	Cotton Pygmy-goose	NT	-	Wildlife Online	This species is found on freshwater lakes, swamps and large water impoundments (Garnett and Crowley 2000).	Low: Suitable habitat not present within study area
Poephila cincta cincta	Black-throated Finch	E	E	DoE	This species is known from dry, open grassy woodlands and forests and grasslands of the sub-tropics and tropics with seeding grasses and ready access to water (Higgins et al 2006). Also thought to probably require a mosaic of different habitat in the wet season to find seed (Mitchell 1996 in Garnett and Crowley 2000). Mainly inhabit dry open to very open eucalypt woodlands with dense grassy ground cover and often along watercourses (Higgins et. al. 2006). This species has undergone a significant range contraction from the southern parts of its former distribution. It has not been recorded in south-east Queensland since the early 80s and is now thought to be extinct in NSW(Higgins et al. 2006). It is noted as being mostly absent from the coastal plain but occasionally recorded from the area around Townsville and Ingham (Higgins et	Low: The Study Area is represented by wet sclerophyll mid-dense to dense forests, which are unsuitable for this species.

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					al. 2006).	
Rostratula australis	Australian Painted Snipe	V	E	Wildlife Online, DoE	This species occurs in shallow, vegetated temporary or infrequently filled wetlands, sometimes with trees or shrubs where it feeds at the water's edge on seeds and invertebrates (Garnett and Crowley 2000). Since 1990 there have been fewer than 100 records of this species throughout Australia (Garnett and Crowley 2000).	Low: Suitable wetland habitat is not present within the Study Area.
Tadorna radjah	Radjah Shelduck	NT	-	Wildlife Online	Tropical coast wetlands and rivers, mud-flats, salt-marsh, mangroves, paperbark swamps (Simpson & Day 1998).	Low: Suitable waterway and wetland habitat is not present within the Study Area.
Tyto novaehollandiae kimberli	Masked Owl	V	V	DoE	Forests, woodlands, caves along the entire east coast of Australia (Simpson et al. 2010).	**Moderate:** There are no known records of this species in the vicinity of the Study Area, and it is more likely to occur in more intact areas of the Eton and Connors Ranges, however, vegetation and terrain is potentially suitable.
Mammals						

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
Dasyurus hallucatus	Northern Quoll	LC	E	Wildlife Online, DoE	The Northern Quoll was once widespread in Queensland but has undergone a severe range contraction and is now absent from much of its former range. It is usually associated with dissected rocky escarpments but also known from eucalypt forest and woodlands, around human settlement and occasionally rainforest. In the Northern Territory Northern Quoll populations are becoming extinct within one year of the arrival of the Cane Toad (*Rhinella marina*) although in Queensland some remnant quoll populations persist in areas where Cane Toads have long been present (Van Dyck & Strahan 2008). The areas where the quoll persist in Queensland tend to be steep, rocky areas close to water that have not been recently burnt and appear to have become extinct in many lowland habitats formerly occupied (Woinarski et. al. 2008).	**Moderate:** It is possible that this species occurs within the broader area but is considered more likely to be associated with the steeper and less accessible areas of the Eton/Connors Range.
Macroderma gigas	Ghost Bat	V	-	Wildlife Online	The Ghost Bats roosts in shallow caves along cliff lines, boulder pile and deep limestone caves. They occur in a broad range of habitats including arid spinifex hill sides,	**Moderate:** Suitable roosting habitat potentially exists for this species close to the Study Area but

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					grasslands, monsoon forest, savannah woodlands, tall open forest, deciduous vine forest and tropical rainforest (Churchill 2008).	not within the Study Area. Therefore, it could potentially forage but is unlikely to roost within the Study Area.
Nyctophilus timoriensis / corbeni	South-eastern Long-eared Bat	V	V	DoE	Strahan (1995) notes that the eastern long-eared bat is distributed south of the Tropic of Capricorn but uncommon and localised. This species has undergone recent taxonomic review and is now considered to be Nyctophilus species 2 (Churchill 2008).	Low: This species is generally not considered to occur as far north as Mackay and is generally found further inland.
Phascolarctos cinereus	Koala	LC	V	Wildlife Online, DoE	This species is widespread in Sclerophyll forest and woodlands on foothills and plains on both sides of the Great Dividing Range from about Chillagoe, Queensland to Mt Lofty ranges in South Australia (Menkhorst & Knight 2011).	**Present:** This species was recorded at three locations in the Study Area in RE 8.12.7. All areas of the Study Area, except RE 8.12.3 are considered to provide habitat for this species.
Pteropus poliocephalus	Grey-headed Flying-fox	LC	V	DoE	It occurs in a coastal belt from Rockhampton to Melbourne roosting in camps commonly formed in gullies, typically not far from water and usually in vegetation with dense canopy. Various habitats that include	Low: This Study Area is beyond the northern range of this species.

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
					Eucalyptus, Angophoras, tea-trees and Banksias (van Dyck & Strahan 2008).	
Rhinolophus philippinensis (large form)	Greater Large-eared Horseshoe Bat	E	E	DoE	Restricted to a broad strip of coastal and near-coastal habitat in north-eastern Queensland from Iron Range on Cape York Peninsula south to Townsville. May occur inland where suitable cave habitat exists, in Broken River, Undara, Chillagoe. May also occur south of Townsville at Mt Elliot and Cape Cleveland. Habitat includes rainforest, riparian forest, open forest and woodland. Roosts in caves and possibly tree hollows, dense foliage and large bridge culverts (van Dyck & Strahan 2008).	Low: The Study Area is outside the known distribution of this species. There have been no records of this species in the vicinity of the Study Area.
Xeromys myoides	Water Mouse	V	V	DoE	The Water Mouse inhabits saline grassland, mangroves, margins of freshwater swamps and lakes close to fore dunes in coastal Northern Territory and Queensland coast from Cooloola to Proserpine as well as Bribie and Stradbroke Islands (Menkhorst & Knight 2011).	Low: There is not suitable habitat in the Study Area and the terrain is unsuitable.
Reptiles						
Denisonia maculata	Ornamental	V	V	DoE	The Ornamental Snake is found in close association with frogs which	Low: Preferred Brigalow and gilgai

Scientific Name	Common Name	NC Reg'n [1]	EPBC Act [2]	Source [3]	Preferred habitat	Potential to occur in the study area? [4]
	Snake				form the majority of its prey. It is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways (SEWPaC 2013a).	habitat is not present in the Study Area.
Egernia rugosa	Yakka Skink	V	V	DoE	A ground dwelling reptile found in dry open forests, woodlands and rocky areas of the Brigalow Belt. It is often found under dead timber and in deep rock crevices (Wilson, 2005).	Low: This species is usually found further inland and from drier habitats.
Eulamprus amplus	Lemon-barred Forest Skink	NT	-	Qld Museum	Confined to rainforest in the Eungella National Park, Finch Hatton, Mt Blackwood and Conway State Forest areas where it is often seen basking on rocks along waterways (Wilson 2005).	Low: Appears to be restricted to wet rainforests, which do not occur in the Study Area.
Rheodytes leukops	Fitzroy River Turtle	V	V	DoE	Known from the Fitzroy River and its tributaries (Cogger 2000).	Low: There is not suitable habitat for this species within the Study Area.

Table 5: Migratory species returned from database searches for the search area

Species	Common Name	EPBC Act Status	Preferred Habitat	Potential to occur in the Study Area
Apus pacificus	Fork-tailed Swift	Migratory & Marine: Species or species habitat likely to occur within area	Aerial over open habitat sometimes over forests and cities (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Hiaeetus leucogaster	White-bellied Sea-eagle	Migratory & Marine: Species or species habitat likely to occur within area	Coasts, islands, estuaries, large rivers, lakes and reservoirs (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Hirundapus caudacutus	White-throated Needletail	Migratory & Marine: Species or species habitat likely to occur within area	Aerial over forests, woodlands, farmlands, plains, lakes and towns (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Merops ornatus	Rainbow Bee-eater	Migratory & Marine: Species or species habitat may occur within area	Woodlands, beaches, rainforest and mangroves (Pizzey et al. 2012).	Low: More likely to occur in lowland areas.
Monarcha melanopsis	Black-faced Monarch	Migratory & Marine: Species or species habitat likely to occur within area	Rainforest, eucalypt woodlands and forest, coastal scrubs, rainforest gullies (Pizzey et al. 2012).	**High:** Prefers similar habitat to Spectacled Monarch, which occurs throughout the Study Area.
Monarcha trivirgatus	Spectacled Monarch	Migratory & Marine: Species or species habitat may occur within area	Rainforest, thickly wooded gullies, waterside vegetation (Pizzey et al. 2012).	**Present:** This species was identified during a bird survey in 8.12.3 in the Study Area.
Myiagra cyanoleuca	Satin Flycatcher	Migratory & Marine: Species or species habitat may occur within area	Heavily vegetated gullies in forests and taller woodlands and during migration coastal forests, woodlands,	Low: Prefers more coastal areas of habitat.

Species	Common Name	EPBC Act Status	Preferred Habitat	Potential to occur in the Study Area
			mangroves, gardens and open country (Pizzey et al. 2012).	
Rhipidura rififrons	Rufous Fantial	Migratory & Marine: Species or species habitat may occur within area	Rainforest, wet eucalypt forests, monsoon forests, paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks (Pizzey et al. 2012).	**Moderate:** All vegetated areas within the Study Area provide potential habitat for this species.
Ardea alba	Great Egret	Migratory & Marine: Species or species habitat known to occur within area	Shallows of rivers, estuaries, tidal mudflats, freshwater wetlands, sewage ponds, larger dams (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Ardea ibis	Cattle Egret	Migratory & Marine: Species or species habitat likely to occur within area	Stock paddocks, pastures, croplands, garbage dumps, wetlands, tidal mudflats and drains (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Gallinago hardwickii	Latham's Snipe	Migratory & Marine: Species or species habitat may occur within area	Soft wet ground or shallow water with tussocks, wet paddocks, seepage below dams, irrigated areas, scrub or open woodland (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Hirundo rustica	Barn Swallow	Migratory: Species or species habitat may occur within area	Open forests, woodlands, grasslands, caves, ledges, offshore rocky islands, farmlands, grain stubbles, rail	Low: Is more likely to occur in open communities.

Species	Common Name	EPBC Act Status	Preferred Habitat	Potential to occur in the Study Area
			yards, towns. Occasionally roosts in old buildings. Is widespread in Australia and coastal islands (Pizzey et al. 2012).	
Rostratula benghalensis	Australian Painted Snipe	Vulnerable, Migratory & Marine: Species or species habitat may occur within area	Refer Table 4	Low: Refer Table 4.
Anseranas semipalmata	Magpie Goose	Marine: Species or species habitat may	Large seasonal wetlands and well vegetated dams with rushes and sedges, wet grasslands and floodplains (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Pandion haliaetus	Osprey	Marine: Species or species habitat likely to occur within area	Coasts, estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs and lagoons (Pizzey et al. 2012).	Low: Suitable habitat does not occur in the Study Area.
Crocodylus porosus	Salt-water Crocodile	Marine: Species or species habitat likely to occur within area	Occurs in coastal waters, estuaries, freshwater sections of lakes, inland swamps and marshes in all coastal areas north of Rockhampton, west to King Sound (near Broome) in Western Australia (DoE 2013a).	Low: Suitable estuarine habitat does not occur in the Study Area.

3.2. Vegetation

On-ground vegetation mapping was undertaken for the new expanded Study Area and is shown in Figure 2. Twenty-one vegetation assessment sites were performed as part of this mapping.

No new REs were identified to that mapped as part of the previous 2011 vegetation assessment undertaken by Ecological Survey & Management (reference 11027 Ltr01a). All vegetation is listed as Least Concern under the Queensland *Vegetation Management Act 1999*.

None of the vegetation assemblages identified in the Study Area are listed as Threatened Ecological Communities under the Commonwealth EPBC Act.

3.2.1. Significant Species

New locations of the NC Act listed Near Threatened Rough Malletwood (*Rhodamnia pauciovulata*) were identified, in addition to those recorded as part of the 2011 vegetation assessment undertaken for the Project. Approximately 18 individuals have now been identified in the Study Area. One additional NC Act-listed plant was recorded in the Study Area, Veiny Whitewood (*Atalaya rigida*) is listed as Near Threatened, and was recorded in RE 8.12.3 in the same location as the Rough Malletwood population. A full list of species recorded in the Study Area according to RE type is provided in Appendix B.

4. Impacts and Recommendations

4.1. Habitat Disturbance and Fragmentation

Up to 86 ha of potential habitat, in the form of remnant Least Concern vegetation may be removed within the Study Area. This will result in a reduction of the overall carrying capacity of the local area.

This disturbance has the potential to exacerbate barrier effects currently created by the Peak Downs Highway as a wider road corridor will be established. However, increased or new fragmentation is unlikely as impacts will largely involve expanding the existing cleared area, which have already fragmented habitat either side of the highway. No habitat areas will be isolated from other habitat areas as a result of vegetation clearing.

General habitat features, such as native feed trees, ground and hollow habitat are likely to be lost to some extent, however, no outstanding or unique habitat features will be lost as a result of the Project.

4.2. Edge Effects

Edge effects in the form of species and structure modification through increased light, wind sheer, weed invasion or changed species composition, is unlikely to be significant as a result of this Project given these effects are already acting on habitat either side of the Peak Downs Highway.

The most likely outcome will be that edge effects will be increase the depth of edge effects to some extent, although new edges are unlikely to be created for this Project. The denser vine thicket community, represented by RE 8.12.3, will be most susceptible to edge effects although the dense nature of this community will limit the depth of edge effects into intact areas.

4.3. Indirect Impacts

Noise and vibration emissions will result from vegetation clearing, some blasting may also be required in the creation of expanded carriageways and steep batters. Temporary or intermittent noise and vibration emissions will be associated with machinery and activity associated with construction of the Project.

Most fauna species exhibit a high degree of adaptability to these noise impacts. Construction noise may cause some behavioural modification by birds, potentially altering feeding activity, and sudden loud noises may also startle bird and mammal species. Consequently, depending on the magnitude of construction noise, there may be some species that will be repulsed by noise and therefore, will forego utilisation of habitat within the noise disturbance zones. This zone will likely be different for individual species and depend on the intensity and nature of the noise sources. It is not possible to quantify the proportion of the local fauna community that will be adversely affected by this issue but it is expected to be a minority of species, and repulsion of fauna is unlikely to occur over a significant

distance from the noise source. In the case of temporary noise associated with construction or clearing activities, native fauna are likely to return to affected habitat areas within a short period of the noise emissions ceasing.

Impacts on fauna from ground vibration (e.g. from blasting and the operation of some equipment) will be similar to noise disturbance. It is possible that some species would forego the utilisation of areas close to the vibration source, where the intensity of the vibration exceeds the tolerance of the species. However, again this is likely to be temporary during the construction period.

Dust deposition will be greatest during vegetation clearing activities and blasting activities and the severity will depend on local weather conditions.

Potential impacts of light spill from lighting associated with construction will also be temporary and most types of common and adaptable species identified in the Study Area during the field survey, are generally able to adapt to environmental conditions over small areas.

The indirect and temporary impacts described above can be easily managed in most cases through standard mitigation measures and attenuation devices as well as sensitive site planning, i.e. minimising blasting activities or vegetation clearing in adverse weather conditions. Overall, indirect impacts will not have significant impacts on fauna.

With regard to indirect impacts as a result of operation of the realigned Peak Downs Highway, these types of impacts in the form or noise and light area already occurring in the Study Area and the magnitude of these is unlikely to change.

4.4. Pest Plants and Animals

The Project has the capacity to result in the introduction and spread of weed species and to facilitate the establishment and expansion of existing populations of pest animals and plants. The invasion of pest plants could degrade the quality of fauna habitats further, increase pest animals such as European Rabbits and Red Foxes and result in direct predation of native fauna species. However, the Peak Downs Highway already presents this risk and many of these types of pests already occur in the Study Area.

Evidence of pest animals, particularly Wild Dog/Dingo were common along the edges of the Peak Downs Highway. This pest species has the ability to move freely and in some cases long distances throughout the landscape and/or readily colonise new areas. Other species, which weren't detected are also likely to be present, particularly given the conduit effect of the Peak Downs Highway, which is a major transport route in Queensland. Therefore, it is unlikely this Project will introduce new species, but rather attract some feral animal species for periods, for example Wild Dogs/Dingos during vegetation clearing activities.

A Pest Animal and Weed Management Plan will be developed and implemented to manage pest animals as part of the Project.

4.5. EPBC Act-listed Species

An assessment of the significance of impacts using the DoE Significant Impact Guidelines (2013) has been undertaken for the EPBC Act listed species identified in the Study Area, i.e. the Koala. This significance assessment is provided in Appendix C.

The outcome of the Koala significance assessment indicates that although the individuals identified in the Study Area potentially form part of an important population, it is unlikely a significant impact will occur to this species as a result of the Project, due to there being no important habitat in the Study Area for any EPBC Act listed species and better quality intact habitat occurs extensively throughout the Eton and Connors Ranges.

Significance assessment for other EPBC Act-listed species potentially occurring in the Study Area were considered redundant given the relatively small and disturbed nature of the large sections of the Study Area, extensive more intact habitat elsewhere in the Eton and Connors Ranges and the lack of evidence from field survey suggesting an important population of any other EPBC Act-listed species occurs in the Study Area. Also, the Study Area is unlikely to support breeding habitat for any other potentially occurring EPBC Act-listed species. Therefore, the Project would not cause a Significant impact to any other EPBC Act-listed species.

4.5.1. Migratory species

A number of migratory birds are considered to potentially occur in the Study Area as listed in Table 5. Approximately 86 ha of habitat will be cleared as part of this Project.

In accordance with the Significant impact guidelines 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, destroy or isolate an area of important habitat for a migratory species
- 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
- Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

It is considered unlikely the Study Area provides important habitat for any migratory species as the habitat is homogenous in the surrounding landscape and would be unlikely to form important breeding habitat for any migratory species. Additionally, the Study Area already suffers from edge effects from the existing Peak Downs Highway, including weed incursion and modified habitat. For these reasons, the Study Area is unlikely to support an ecologically significant proportion of the population of a migratory species.

Therefore, the Project is considered unlikely to result in a significant impact to a migratory species.

4.6. NC Act-listed Species

Up to 86 ha of potential habitat for a number of NC Act-listed species may be impacted in the Study Area.

These impacts will mainly occur in the form of habitat clearing, temporary increased risk of predation, temporary disturbance from construction activities and increased barrier effects and increased edge effects adjacent newly cleared areas.

The type of impact in the Study Area is not new as the Peak Downs Highway has already created many of these impacts, resulting in habitat that is modified and not optimal. More intact habitat areas occur in close proximity to the Study Area and extent more than 25 km in a south-east and north-west direction throughout the Eton and broader Connors Ranges.

Overall, the Project is unlikely to disturb large areas or important habitat for NC Act-listed species.

4.7. Impact Mitigation

Very steep terrain constrains the design of the realignment, which allows little opportunity to avoid important habitat features. Nonetheless, where an opportunity is identified to avoid specific habitat trees (outlined in Appendix A and shown on Figure 3) and significant plants in the Study Area, this should be undertaken.

All of the significant plants occur in the vine thicket community in the northern portion of the Study Area, therefore, this habitat should be avoided as far as possible. Options for relocation of the Rough Malletwood and Veiny Whitewood should be investigated to maintain their presence in this area.

A number of controls on clearing methods and construction of the realigned highway is proposed in order to minimise impacts to vegetation and habitat and should be included in the construction Environmental Management Plan (EMP) as well as other specific management plans. Proposed controls are:

- Work areas in the vicinity of remnant vegetation will be clearly delineated during construction to prevent unnecessary encroachment of disturbance into adjacent remnant vegetation
- A Species Management Program will be developed that includes spotter/catcher pre-clearing inspections and monitoring
- Clearing will be undertaken sequentially and in accordance with all necessary internal, Queensland and Commonwealth Government permits and approvals. This will restrict the area of remnant vegetation to be cleared to that required for the safe construction and operation of the Project
- Clearing is limited to only that necessary for the Project
- Vegetation clearing and construction activities should be avoided during wet seasons particularly in the vicinity of drainage channels

- A weed and pest animal management plan will be developed that includes measures such as weed audits and mapping, design of an appropriate treatment control program, wash-down procedures and passive monitoring and control of pest plants
- If blasting is required, it should be undertaken in favourable climatic conditions, i.e. not during wet or windy conditions
- Dust suppression techniques are employed where necessary
- Speed limits are enforced throughout the Project area during construction
- Runoff and siltation of the drainage channel in the northern portion of the Study Area is managed to avoid downstream impacts to water quality.

4.8. Permits and Approvals

A Species Management Program (SMP) will be required for significant species identified or considered likely to occur within the Study Area as outlined in this report in accordance with the NC Act. The SMP will outline actions to be undertaken to minimise impacts on animal breeding places and will be submitted to the EHP for approval prior to the commencement of construction activities. The SMP will include prescriptions on the nature and duration of clearing, translocation surveys where relevant, as well as measures to be employed during clearing activities, such as direction of clearing, leaving habitat trees and clearing surrounding vegetation, monitoring and managing water quality of downstream watercourses. The role of the spotter/catcher will be important as part of the SMP. Pre-clearance surveys will be undertaken by the spotter/catcher as part of the SMP. Where a significant species is identified, e.g. a Koala, an exclusion zone will be established around the animal and the individual allowed to move on of its own accord.

A Clearing Permit will be required to disturb plants listed under the NC Act. This will be relevant for the Veiny Whitewood and Rough Malletwood in the Study Area. Translocation or offsets may be required as part of this permit.

4.9. Residual impacts

4.9.1. EPBC Act Environmental Offsets Policy

Up to 80.7 ha of Koala habitat will be impacted as a result of the Project. The EPBC Act Environmental Offsets Policy (Offsets Policy) (SEWPaC 2012a) relates to all protected matters under the EPBC Act, including species and communities listed under Sections 18 and 18A, which includes the Koala.

Sections 4 and 5.2 of the Offsets Policy states that offsets under the EPBC Act are only required if residual impacts are ‘significant’. ‘Significant’ impacts are defined under the Significant Impact Guidelines (DoE 2013c).

This assessment has found that significant impacts to species or communities listed under the EPBC Act as a result of the Project are unlikely as a result of the proportionally small area of habitat proposed to

be cleared compared with that surrounding the Study Area and the low potential for the Study Area to provide important habitat for an EPBC Act listed species.

4.9.2. Queensland Biodiversity Offsets Policy

The Queensland Government has previously committed, through the Six Month Action Plan – July to December 2013 to review the overarching framework for environmental offsets in Queensland in order to 'implement a single environmental offsets policy for Queensland'.

To date a new environmental offset framework or policy has not been implemented and EHP has advised that until a new policy is in place the existing framework and policies remain in effect. Therefore, the Queensland Biodiversity Offset Policy (QBOP) (DERM 2011) is the primary mechanism requiring offsets for impacts to state significant biodiversity values, as a result of state controlled road activities, in Queensland.

Based on the descriptions provided in the QBOP, the state significant flora and fauna values that will be impacted by the Project include:

- Potential habitat for the Grey Goshawk, Squatter Pigeon, Square-tailed Kite, Black-chinned Honeyeater and Ghost Bat (86 ha)
- Known habitat for the Veiny Whitewood and Rough Malletwood (5.6 ha).

First order streams shown on the Vegetation management Supporting Map are also considered state significant biodiversity values and which do occur in the northern portion of the Study Area. Offsetting of these values may be required through determination by the Department of Environment and Heritage Protection (EHP) under the QBOP. However, with the recent reforms of the *Vegetation Management Act 1999* and repeal of the Regional Vegetation Management Codes, offsetting requirements regarding watercourses may no longer be required and would require negotiation with the EHP.

5. Conclusions

Approximately 86 ha of Least Concern remnant vegetation occurs in the Study Area and all vegetation provides potential habitat for a number of state and Commonwealth listed species, including:

- Northern Quoll – Endangered (EPBC Act)
- Red Goshawk – Endangered (NC Act); Vulnerable (EPBC Act)
- Squatter Pigeon – Vulnerable (NC Act and EPBC Act)
- Masked Owl – Vulnerable (NC Act and EPBC Act)
- Ghost Bat – Vulnerable (NC Act)
- Grey Goshawk – Near Threatened (NC Act)
- Australian Swiftlet – Near Threatened (NC Act)
- Black-chinned Honeyeater – Near Threatened (NC Act).

One EPBC Act listed Vulnerable species, the Koala, was identified in the Study Area and the population that occurs in this location is likely to form part of an important population as defined under the Significant Impact Guidelines, due to the abundance of individuals recorded in the Study Area. Approximately 80.7 ha of habitat for this species occurs in the Study Area.

One migratory, the Spectacled Monarch, was recorded in the Study Area and another two species are considered to have a moderate or higher likelihood of occurring in the Study Area. All vegetated areas of the Study Area, 86 ha, provides suitable habitat for these species.

Up to 86 ha of clearing may occur for the Project, however, this is unlikely to cause a significant impact to state or Commonwealth listed species, due to the extensive and more intact habitat available throughout the Eton and Connors Ranges and the relatively small area of habitat to be disturbed.

A number of measures have been recommended to minimise impacts to significant species, including retaining the identified habitat trees where possible, translocating significant plants and minimising vegetation clearing as far as possible.

A Species Management Plan for NC Act-listed fauna and a Clearing Permit for NC Act-listed flora is likely to be required for the Project. Offsets for these values may be required under the QBOP.

6. References

Bennett, A.F., Resources, I.U. for C. of N. and N. & Programme, I.F.C., 1999. *Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation*, International Union for the Conservation of Nature, Gland, Switzerland.

DERM, 2011. *Queensland Biodiversity Offset Policy (version 1)*, Department of Environment and Resource Management, Queensland Government, Brisbane.

DoE, 2013a. *Crocodylus porosus - Salt-water Crocodile, Estuarine Crocodile SPRAT Profile*, Department of the Environment, Australian Government, Canberra. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1774.

DoE, 2013b. *Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) SPRAT Profile*, Department of the Environment, Australian Government, Canberra.

DoE, 2013c. *Significant Impact Guidelines 1.1: Matters of National Environmental Significance*, Department of the Environment, Australian Government, Canberra.

DSITIA, 2012. *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Version 1.0)*, Biodiversity and Ecosystem Sciences, Department of Science, Information Technology, Innovation and the Arts, Queensland Government, Brisbane. Available at: http://www.ehp.qld.gov.au/ecosystems/biodiversity/pdf/fauna_survey_guidelines.pdf.

Van Dyck, S. & Strahan, R., 2008. *The Mammals of Australia*, New Holland Publishers, Sydney.

EHP, 2013. *Wildlife Online Database Search*, Department of Environment and Heritage Protection, Queensland Government, Brisbane. Available at: http://www.ehp.qld.gov.au/wildlife/wildlife-online/.

Endler, J.A., 1977. *Geographical Variation, Speciation, and Clines*, Princeton University Press, New Jersey, USA.

Eyre, T.J., Kelly, A.L. & Neldner, V.J., 2011. *Biocondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland, Assessment Manual, Version 2.1* Department.,

Ford, G., 2013. *Microbat Call Identification Report*, Balance Environmental, Brisbane.

Forman, R.T.T., 1995. Some general principles of landscape and regional ecology. *Landscape Ecology*, 10(3), pp.133–142. Available at: http://www.ege.fcen.uba.ar/materias/general/Principles of landscape %26 regional ecology.pdf.

Hanger, J. & Loader, J., 2009. *Infectious disease in koalas: Implications for conservation. In: Koala Conservation Conference.*, Friends of the Koala, Lismore.

Higgins, P.J., Peter, J.M. & Cowling, S.J., 2006. *Handbook of Australian, New Zealand and Antarctic Birds. Volume 7 Boatbill to Starlings*, Oxford University Press, Melbourne.

Marchant, S. & Higgins, P. eds., 1994. *The Handbook of Australian, New Zealand and Antarctic Birds: Volumes 1 & 2*, Oxford University Press, Melbourne.

Marchant, S. & Higgins, P.J., 1993. *Handbook of Australian, New Zealand & Antarctic Birds, Volume 2*, Oxford University Press, Melbourne.

Melzer, A. et al., 2000. Overview, critical assessment, and conservation implications of koala distribution and abundance. *Conservation Biology*, (14), pp.619–628.

Menkhorst, P. & Knight, F., 2011. *Field Guide to Mammals of Australia*, Oxford University Press, Melbourne.

National Water Commission, 2013. *National Atlas of Groundwater Dependent Ecosystems*, Bureau of Meteorology, Commonwealth Government, Canberra. Available at: http://www.bom.gov.au/water/groundwater/gde/index.shtml.

NRM, 2013a. *Vegetation Management - Essential Habitat Map (Version 4.0)*, Department of Natural Resources and Mines, Queensland Government, Brisbane.

NRM, 2013b. *Vegetation Management Regional Ecosystem and Remnant Map (Version 8.0)*, Department of Natural Resources and Mines, Queensland Government, Brisbane.

Pizzey, G., Knight, F. & Pizzey, S., 2012. *The Field Guide to the Birds of Australia*, HarperCollins Publishers, Sydney.

Queensland Herbarium, 2013. *Regional Ecosystem Description Database (REDD). Version 8.0 (November 2013)*, Department of Science, Information Technology, Innovation and the Arts, Queensland Government, Brisbane.

Queensland Museum, 2013. Zoology Data Search. Available at: http://www.qm.qld.gov.au/Research/Biodiversity/Studying+biodiversity/Zoology+Data+Search.

SEWPaC, 2013a. *Denisonia maculata - Ornamental Snake in Species Profile and Threats Database*, Department of Sustainability, Environment, Water, Population and Communities, Commonwealth Government, Canberra. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1193.

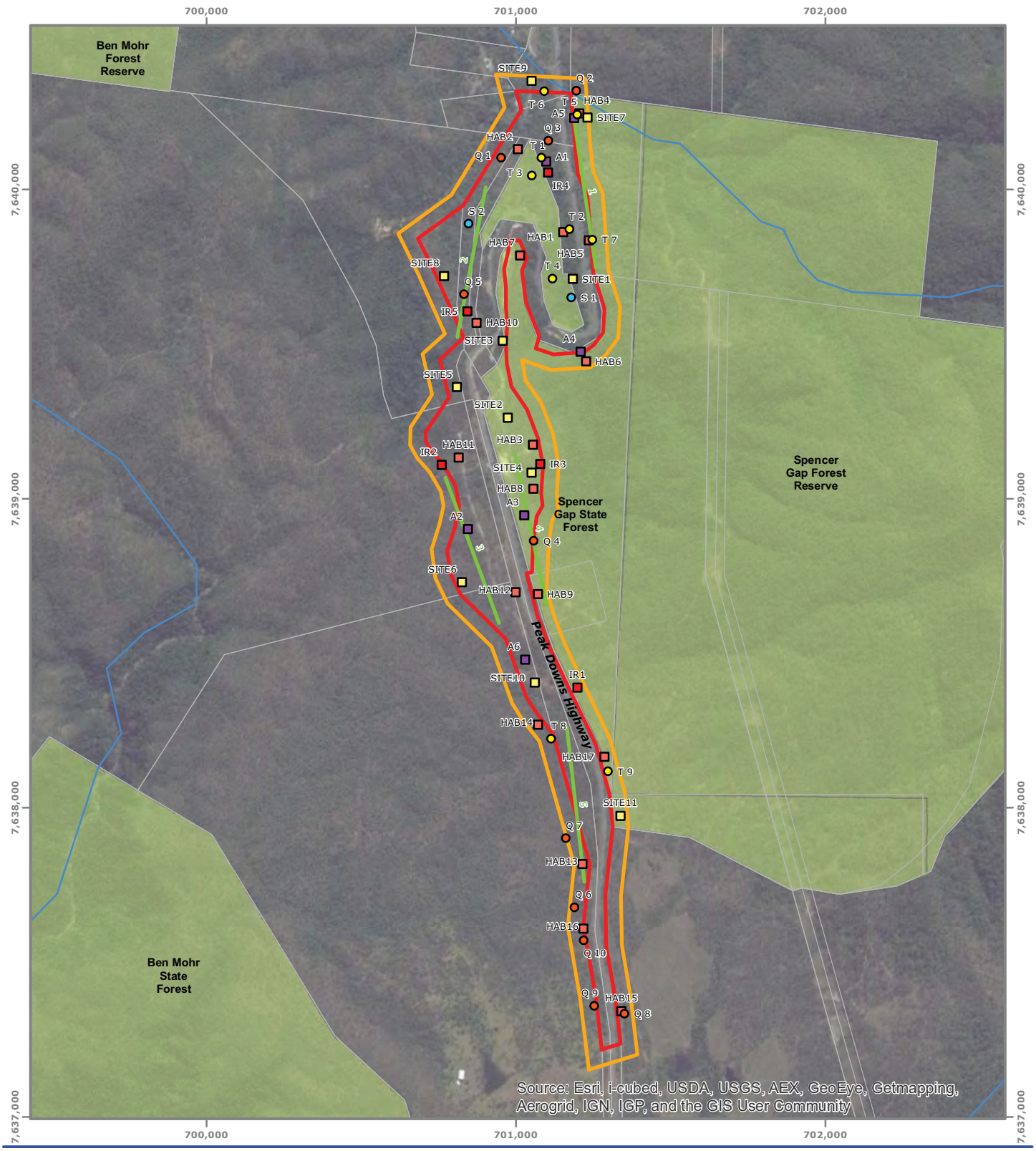
SEWPaC, 2012a. *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (October 2012)*, Department of Sustainability, Environment, Water, Population and Communities, Commonwealth Government, Canberra. Available at: http://www.environment.gov.au/epbc/publications/pubs/offsets-policy.pdf.

SEWPaC, 2013b. *EPBC Act Protected Matters Search Report*, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available at: http://www.environment.gov.au/epbc/pmst/index.html.

SEWPaC, 2012b. *Interim koala referral advice for proponents*, Department of Sustainability, Envirnoment, Water, Population and Communities, Commonwealth Government, Canberra. Available at: http://www.environment.gov.au/epbc/publications/pubs/bio240-0612-interim-koala-referral-advice.pdf.

Simpson, K., Trusler, P. & Day, N., 2010. *Field Guide to the Birds of Australia*, Penguin Group Australia, Melbourne.

FIGURES



Legend

- Study Area
- Buffer
- Watercourse
- Protected Areas
- Cadastral Boundaries

Vegetation Assessment Site

- Quaternary (Q1-Q10)
- Tertiary (T1-T9)
- Secondary (S1-S2)

Fauna Survey Sites

- Anabat Site (A1-A6)
- Habitat Assessment Site (HAB1-HAB17)
- Infrared Camera Site (IR1-IR5)
- Site (SITE1-SITE11)
- KoalaTransects

Figure 1 : Flora and fauna survey sites

Eton Range

Map Number: 13025_01_e
Date: 23 December 2012
Map Projection: MGA94 (Zone 55)

0 0.5 1
Kilometers

N

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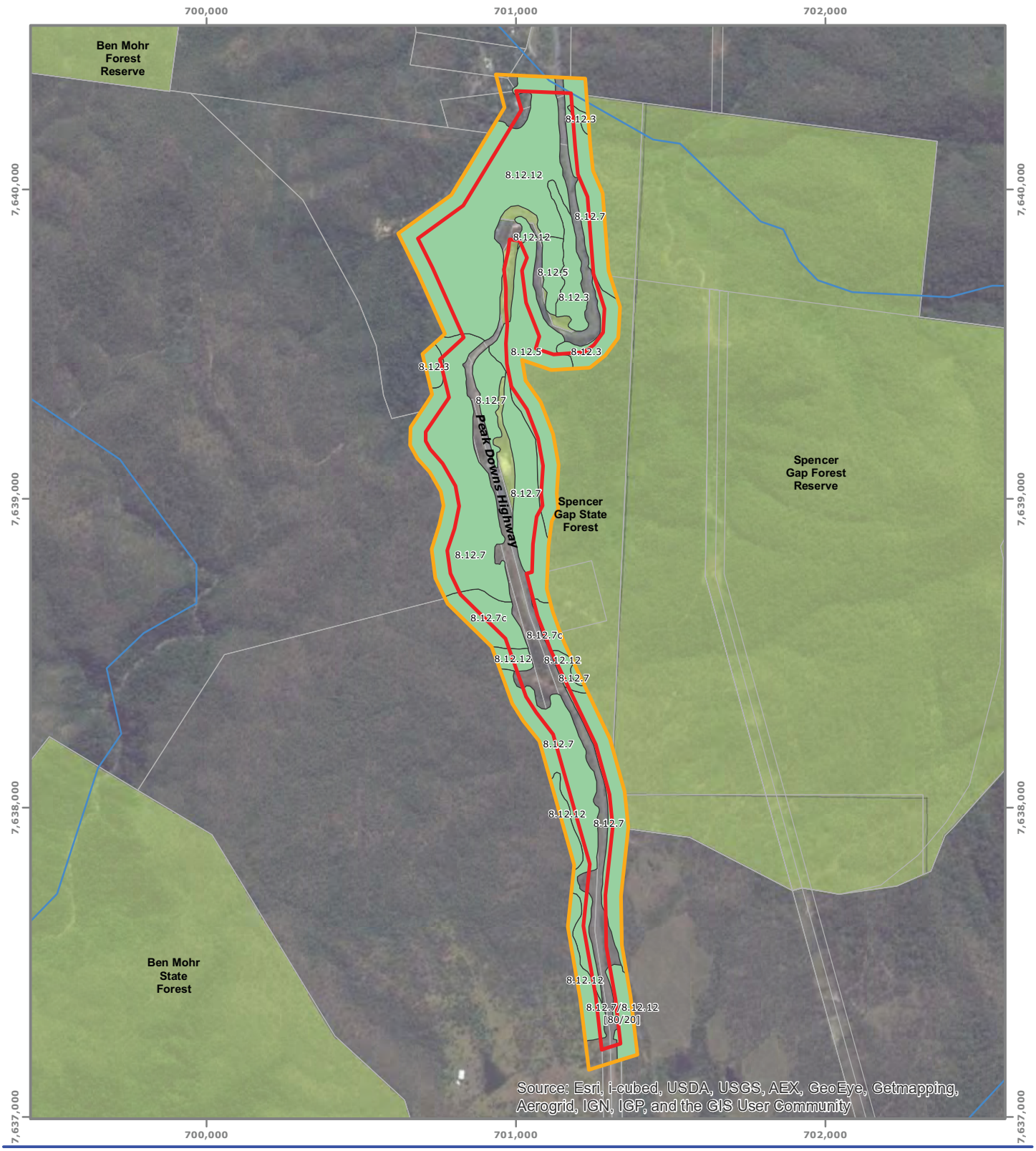

Legend

- Study Area
- Buffer
- Watercourse
- Protected Areas
- Cadastral Boundaries

Remnant Vegetation (RV)

Vegetation Management Status

- Least concern

Figure 2 : Field-validated vegetation mapping in Study Area

Eton Range

Map Number: 13025_02_d
Date: 19 December 2012
Map Projection: MGA94 (Zone 55)

0 0.5 1
Kilometers

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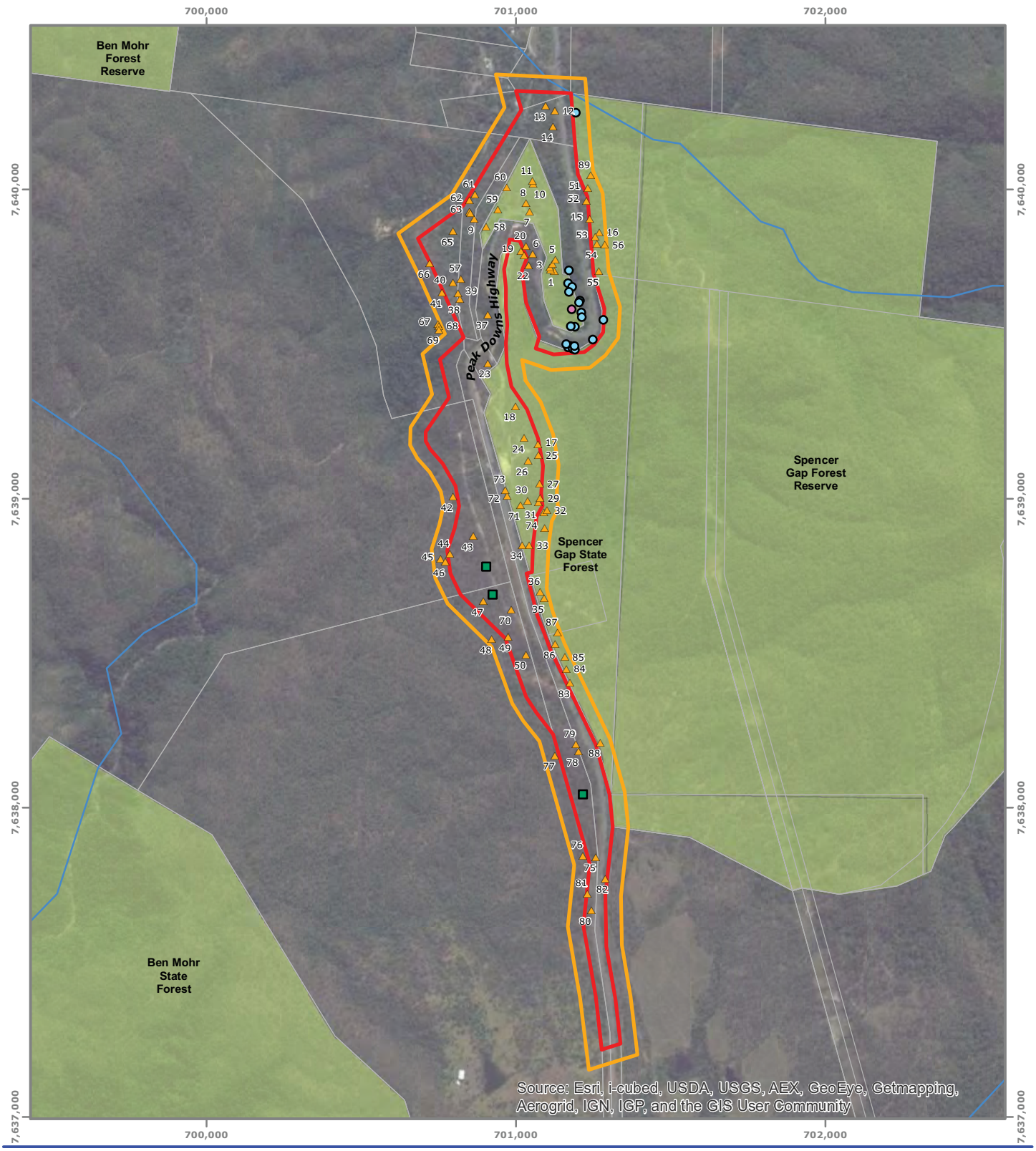

Legend

- Study Area
- Buffer
- Watercourse
- Protected Areas
- Cadastral Boundaries
- Habitat Tree (1-98)

Significant Fauna Species Records

- Koala *(Phascolarctos cinereus)* - Vulnerable (EPBC Act)

Significant Flora Species Records

- Veiny Whitewood *(Atalaya rigida)* - Near Threatened (NC Act)
- Rough Malletwood *(Rhodamnia pauciovulata)* - Near Threatened (NC Act)

Figure 3 : Significant species records

Eton Range

Map Number: 13025_03_d
Date: 19 December 2012
Map Projection: MGA94 (Zone 55)

0 0.5 1
Kilometers

N

ecological survey & management

APPENDIX A

FAUNA AND HABITAT TREE RECORDS FOR THE STUDY AREA

Table A1: Fauna inventory for the Study Area

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
Amphibians																					
Cane toad	*Rhinella marina*	*	*		Sp, AS	Sp	Sp	Sp	Sp	Sp	AS	Sp									
Eastern sedge frog	*Litoria fallax*	LC	NL				H														
Green tree frog	*Litoria caerulea*	LC	NL				Sp														
Birds																					
Australasian Figbird	*Sphecotheres vieilloti*	LC	NL																		X
Australian Brush-turkey	*Alectura lathami*	LC	NL				Ir	Ir		X											X
Australian Magpie	*Cracticus tibicen*	LC	NL																		X
Australian Owlet-nightjar	*Aegotheles cristatus*	LC	NL				H					H									
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	LC	NL											X							
Brown Honeyeater	*Lichmera indistincta*	LC	NL																		X
Brush Cuckoo	*Cacomantis variolosus*	LC	NL										X								X
Channel-billed Cuckoo	*Scythrops novaehollandiae*	LC	NL																		X, X
Cicadabird	*Coracina tenuirostris*	LC	NL							X	X			X							X
Eastern Barn Owl	*Tyto javanica*	LC	NL						H												
Eastern Koel	*Eudynamys orientalis*	LC	NL																		X, X

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
Emerald Dove	*Chalcophaps indica*	LC	NL																		X
Fairy Gerygone	*Gerygone palpebrosa*	LC	NL							X											
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	LC	NL																		X
Forest Kingfisher	*Todiramphus macleayii*	LC	NL																		X
Laughing Kookaburra	*Dacelo novaeguineae*	LC	NL																		X
Leaden Flycatcher	*Myiagra rubecula*	LC	NL							AS	X		X								X
Lewin's Honeyeater	*Meliphaga lewinii*	LC	NL							X	X										X
Little Shrike-thrush	*Colluricincla megarhyncha*	LC	NL																		X
Noisy Friarbird	*Philemon corniculatus*	LC	NL							X											X, X
Noisy Pitta	*Pitta versicolor*	LC	NL																		X
Olive-backed Oriole	*Oriolus sagittatus*	LC	NL										X								X
Pale-headed Rosella	*Platycercus adscitus*	LC	NL																		X
Peaceful Dove	*Geopelia striata*	LC	NL																		X
Pheasant Coucal	*Centropus phasianinus*	LC	NL																		X
Pied Butcherbird	*Cracticus nigrogularis*	LC	NL																		X
Pied Currawong	*Strepera graculina*	LC	NL																		X
Rainbow Lorikeet	*Trichoglossus haematodus*	LC	NL								X		X								X

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
Red-backed Fairy-wren	*Malurus melanocephalus*	LC	NL							X											X
Red-browed Finch	*Neochmia temporalis*	LC	NL										X								X
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	LC	NL								X										X
Red-winged Parrot	*Aprosmictus erythropterus*	LC	NL							X											
Restless Flycatcher	*Myiagra inquieta*	LC	NL																		X
Rufous Whistler	*Pachycephala rufiventris*	LC	NL							X	X		X	X							X
Scarlet Honeyeater	*Myzomela sanguinolenta*	LC	NL																		X
Southern Boobook	*Ninox novaeseelandiae*	LC	NL									H									
Spangled Drongo	*Dicrurus bracteatus*	LC	NL							X											X
Spectacled Monarch	*Symposiarchus trivirgatus*	LC	M																		X
Spotted Nightjar	*Eurostopodus argus*	LC	NL																		X
Striated Pardalote	*Pardalotus striatus*	LC	NL																		X
Sulphur-crested Cockatoo	*Cacatua galerita*	LC	NL																		X
Torresian Crow	*Corvus orru*	LC	NL			Ir				X			X	X							
Varied Triller	*Lalage leucomela*	LC	NL																		X
Weebill	*Smicrornis brevirostris*	LC	NL																		X, X

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
White-bellied Cuckoo-shrike	*Coracina papuensis*	LC	NL								X										X
White-browed Robin	*Poecilodryas superciliosa*	LC	NL																		X
White-browed Scrubwren	*Sericornis frontalis*	LC	NL							X											X, X
White-cheeked Honeyeater	*Phylidonyris niger*	LC	NL																		X, X
White-throated Gerygone	*Gerygone albogularis*	LC	NL		AS								X								
White-throated Honeyeater	*Melithreptus albogularis*	LC	NL							X											X
Willie Wagtail	*Rhipidura leucophrys*	LC	NL																		X
Wompoo Fruit-Dove	*Ptilinopus magnificus*	LC	NL																		X
Yellow Honeyeater	*Lichenostomus flavus*	LC	NL																		X
Mammals																					
Beccari's Free-tailed Bat	*Mormopterus beccarii*	LC	NL												A		A			A	
Chocolate Wattled Bat	*Chalinolobus morio*	LC	NL												Au						
Common Brushtail Possum	*Trichosurus vulpecula*	LC	NL	Ir, Sp								Sp									
Common Dunnart	*Sminthopsis murina*	LC	NL		Sp																
Dingo, Wild Dog	*Canis lupus*	*	*																		Tr, Sc

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
Eastern Cave Bat	*Vespadelus troughtoni*	LC	NL																Au		
Eastern Forest bat	*Vespadelus pumilus*	LC	NL												A						
Eastern Free-tailed Bat	*Mormopterus ridei*	LC	NL												A		A		A		
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*	LC	NL												A		A	A	A	A	
Forest Pipistrelle	*Pipistrellus adamsi*	LC	NL														Au				
Gould's Wattled Bat	*Chalinolobus gouldii*	LC	NL														A			A	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	LC	NL														Au				
Hoary Wattled Bat	*Chalinolobus nigrogriseus*	LC	NL												Au	A	Au				
Inland Forest Bat	*Vespadelus baverstocki*	LC	NL														Au				
Koala	*Phascolarctos cinereus*	LC	V	H					H								A				X, X
Large-footed Myotis	*Myotis macropus*	LC	NL																Au	Au	
Little Bent-wing Bat	*Miniopterus australis*	LC	NL												A		A		A		
Little Broad-nosed Bat/Northern Broad-nosed Bat	*Scotorepens greyii/S. sanborni*	LC	NL													A	A				A
Northern Bent-winged Bat	*Miniopterus orianae oceanensis*	LC	NL												A		A		Au	A	
Northern Free-tailed Bat	*Chaerephon jobensis*	LC	NL														A			A	

Common Name	Species Name	NC Act Status	EPBC Act Status	Survey Sites											Anabat Sites						
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	A1	A2	A3	A4	A5	A6	Incidental
Red-necked Wallaby	*Macropus rufogriseus*	LC	NL													Ir					
Sugar Glider	*Petaurus breviceps*	LC	NL			Sp															
Troughton's Sheath-tail Bat	*Taphozous troughtoni*	LC	NL												Au	A		A			
Tube-nosed Bat	*Murina florium*	LC	NL	Sp																	
Whiptail Wallaby	*Macropus parryi*	LC	NL																		X
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	LC	NL																H	H	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	LC	NL													A	A	A		A	
	Nyctophilus sp.																	A	Au	Au	
Reptiles																					
Blue-throated Rainbow-skink	*Carlia rhomboidalis*	LC	NL	Sp						X											
Bynoe's gecko	*Heteronotia binoei*	LC	NL		AS																
Chain-backed Dtella	*Gehyra catenata*	LC	NL		Sp							Sp									
Lace Monitor	*Varanus varius*	LC	NL	Ir	Ir	Ir															
Ocellated Velvet Gecko	*Oedura monilis*	LC	NL																		Spot
Open-litter Rainbow-skink	*Carlia pectoralis*	LC	NL	AS						Sp, AS			AS								X
Peron's snake-eyed skink	*Cryptoblepharus plagiocephalus*	LC	NL		AS									AS							
Yellow-faced Whipsnake	*Demansia psammophis*	LC	NL	AS																	

Notes

Heard	H
Active search	AS
Anabat recording	A
Anabat recording unconfirmed	AU
General observation	X
Infra-red camera	Ir
Scats	Sc
Spotlighting	Sp
Tracks	Tr

Table A2: Habitat trees in the Study Area

Tree No.	Latitude	Longitude	Species	Hollow Size	Location of Hollow	Number of Hollows	Nest Present?
1	-21.333218	148.939269	*Corymbia intermedia*	Small	Branch	Several	
2	-21.333172	148.939156	*Corymbia intermedia*	Medium	Branch	Several	
3	-21.333107	148.939133	*Corymbia intermedia*	Medium	Trunk	Several	
4	-21.333012	148.939216	*Corymbia intermedia*	Medium	Trunk	Several	
5	-21.332894	148.939292	*Corymbia intermedia*	Small	Branch	Several	
6	-21.332723	148.938601	*Corymbia intermedia*	Medium	Branch	Numerous	
7	-21.331482	148.938483	*Eucalyptus platyphylla*	Small	Branch	Several	
8	-21.331248	148.938367	*Corymbia intermedia*	Small	Branch	Several	
9	-21.33173	148.936755	*Corymbia intermedia*	Medium	Trunk	One	
10	-21.330672	148.938588	*Corymbia intermedia*	Small	Branch	One	
11	-21.330591	148.938553	*Eucalyptus platyphylla*	Small	Branch	Numerous	
12	-21.328542	148.939232	*Eucalyptus platyphylla*	Medium	Branch	Several	
13	-21.328401	148.938944	"Stag"	Small	Branch	Several	
14	-21.329	148.939176	*Corymbia intermedia*	Small	Branch	Several	
15	-21.331689	148.940358	*Corymbia intermedia*	Small	Branch	Several	Termitorium
16	-21.332069	148.940662	*Corymbia intermedia*	Small	Branch	Several	
17	-21.338293	148.938828	*Eucalyptus portuensis*	Small	Branch	Several	
18	-21.337174	148.938114	*Eucalyptus portuensis*	Small	Branch	Several	
19	-21.332652	148.938224	*Eucalyptus portuensis*	Small	Branch	Several	
20	-21.332497	148.938375	*Eucalyptus portuensis*	Medium	Branch	Several	
21	-21.332771	148.938323	*Eucalyptus portuensis*	Small	Branch	Several	
22	-21.333058	148.938477	*Corymbia intermedia*	Small	Branch	Several	
23	-21.335936	148.937238	*Eucalyptus portuensis*	Small	Branch	One	

Tree No.	Latitude	Longitude	Species	Hollow Size	Location of Hollow	Number of Hollows	Nest Present?
24	-21.338106	148.938397	*Eucalyptus portuensis*	Small	Branch	Several	
25	-21.338606	148.938842	*Eucalyptus drepanophylla*	Small	Trunk	Several	
26	-21.338765	148.938528	*Eucalyptus drepanophylla*	Small	Branch	Several	
27	-21.339447	148.938895	"stag"	Small	Trunk	Several	
28	-21.339971	148.938868	"stag"	Medium	Trunk	Several	
29	-21.339849	148.938921	*Eucalyptus portuensis*	Small	Branch	Several	
30	-21.339928	148.938527	*Eucalyptus portuensis*	Small	Trunk	Several	
31	-21.340253	148.939041	*Corymbia citriodora ssp. citriodora*	Medium	Branch	Several	
32	-21.340209	148.939135	*Corymbia citriodora ssp. citriodora*	Medium	Branch	Several	
33	-21.341232	148.938586	*Eucalyptus portuensis*	Small	Branch	Several	Termitorium
34	-21.341232	148.938377	"stag"	Medium	Branch	Several	
35	-21.342769	148.939078	*Eucalyptus exserta*	Medium	Branch	One	
36	-21.342588	148.93896	*Eucalyptus exserta*	Medium	Branch	Several	
37	-21.334512	148.937216	*Eucalyptus portuensis*	Medium	Trunk	Several	
38	-21.334066	148.936341	*Eucalyptus platyphylla*	Small	Branch	One	
39	-21.333907	148.936279	*Eucalyptus platyphylla*	Small	Branch	Several	
40	-21.333589	148.936123	*Eucalyptus platyphylla*	Medium	Trunk	One	
41	-21.333885	148.93579	*Corymbia intermedia*	Medium	Trunk	One	
42	-21.339854	148.936198	*Eucalyptus drepanophylla*	Medium	Branch	Several	
43	-21.340992	148.936844	"stag"	Medium	Trunk	Several	
44	-21.341515	148.936119	"stag"	nil	nil	nil	Termitorium
45	-21.341673	148.935841	*Eucalyptus exserta*	Medium	Trunk	Several	

Tree No.	Latitude	Longitude	Species	Hollow Size	Location of Hollow	Number of Hollows	Nest Present?
46	-21.341747	148.935979	*Eucalyptus exserta*	Small	Branch	Several	
47	-21.342888	148.937183	*Corymbia citriodora ssp. citriodora*	Small	Branch	Several	
48	-21.344	148.937457	*Corymbia citriodora ssp. citriodora*	Medium	Trunk	Several	
49	-21.343923	148.937967	*Lophostemon suaveolens*	Small	Trunk	Several	
50	-21.344426	148.938534	"stag"	Medium	Trunk	Several	
51	-21.330777	148.940277	*Eucalyptus platyphylla*	Medium	Trunk	Several	
52	-21.331156	148.94025	*Corymbia intermedia*	*nil*	*nil*	*nil*	Termitorium
53	-21.332207	148.940525	*Corymbia intermedia*	Small	Branch	Several	
54	-21.332406	148.940593	*Corymbia intermedia*	Medium	Branch	Several	
55	-21.333196	148.94066	*Corymbia intermedia*	Small	Branch	Several	
56	-21.33244	148.940839	*Corymbia intermedia*	Small	Branch	Several	
57	-21.333475	148.936367	*Corymbia intermedia*	Medium	Branch	Several	
58	-21.331942	148.937134	*Eucalyptus platyphylla*	Small	Branch	Several	
59	-21.33144	148.937499	*Eucalyptus platyphylla*	Medium	Branch	One	
60	-21.330795	148.93775	*Corymbia intermedia*	Small	Trunk	One	
61	-21.331012	148.936766	*Corymbia intermedia*	Small	Trunk	One	
62	-21.331168	148.936599	*Corymbia intermedia*	Medium	Branch	One	
63	-21.331514	148.936609	*Eucalyptus platyphylla*	Medium	Trunk	Several	
64	-21.33156	148.936641	*Corymbia intermedia*	Small	Trunk	One	
65	-21.332085	148.936103	*Corymbia tessellaris*	Small	Branch	Several	
66	-21.333028	148.935388	*Eucalyptus drepanophylla*	Small	Trunk	One	
67	-21.33481	148.935667	*Corymbia intermedia*	Medium	Trunk	Several	

Tree No.	Latitude	Longitude	Species	Hollow Size	Location of Hollow	Number of Hollows	Nest Present?
68	-21.334857	148.935697	*Corymbia intermedia*	Medium	Branch	Several	
69	-21.33497	148.935697	*Corymbia intermedia*	Small	Branch	Several	
70	-21.343121	148.938057	*Eucalyptus exserta*	*nil*	*nil*	*nil*	Termitorium
71	-21.34006	148.938301	*Corymbia citriodora ssp. citriodora*	Small	Branch	Several	
72	-21.339796	148.937882	*Corymbia citriodora ssp. citriodora*	Medium	Branch	Several	
73	-21.339624	148.937833	*Eucalyptus exserta*	Medium	Branch	Several	
74	-21.340729	148.939068	*Eucalyptus portuensis*	Small	Branch	Several	
75	-21.350314	148.940786	*Eucalyptus portuenis*	Medium	Branch	Several	
76	-21.350277	148.940381	*Corymbia trachyphloia*	*nil*	*nil*	*nil*	Termitorium
77	-21.347365	148.939476	*Eucalyptus portuensis*	*nil*	*nil*	*nil*	Termitorium
78	-21.347248	148.940211	*Corymbia citriodora ssp. citriodora*	Medium	Trunk	Several	
79	-21.347022	148.94012	*Eucalyptus portuensis*	Medium	Branch	Several	
80	-21.351873	148.940671	*Eucalyptus drepanophylla*	*nil*	*nil*	*nil*	Termitorium
81	-21.351388	148.940546	*Corymbia citriodora ssp. citriodora*	Small	Branch	Several	
82	-21.350938	148.941089	*Eucalyptus portuenis*	Medium	Trunk	One	
83	-21.345244	148.939917	*Melaleuca fluviatilis*	Medium	Trunk	One	
84	-21.344837	148.939802	"stag"	Medium	Branch	Several	
85	-21.344494	148.939756	*Eucalyptus platyphylla*	Medium	Branch	Several	
86	-21.344106	148.939444	*Eucalyptus portuensis*	Small	Branch	Several	
87	-21.343766	148.93951	*Eucalyptus portuensis*	Large	Trunk	One	
88	-21.34697	148.940882	*Eucalyptus exserta*	Medium	Trunk	Several	

Tree No.	Latitude	Longitude	Species	Hollow Size	Location of Hollow	Number of Hollows	Nest Present?
89	-21.33041	148.940358	"stag"	Medium	Trunk	One	

APPENDIX B

FLORA RECORDS FOR THE STUDY AREA

Table B1: Flora inventory for the Study Area

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
CYPERACEAE	*Abildgaardia ovata*	*ncn*	LC	NL			+		
MIMOSACEAE	*Acacia bidwillii*	Corkwood Wattle	LC	NL			+-2		
MIMOSACEAE	*Acacia disparrima ssp. disparrima*	Hickory Wattle	LC	NL	+-2	2		1-2	
MIMOSACEAE	*Acacia leiocalyx ssp. leiocalyx*	Black Wattle	LC	NL		+-2	+-3		
MIMOSACEAE	*Acacia leptocarpa*	*ncn*	LC	NL		+-2	+-2	+	
MYRTACEAE	*Acmena smithii*	Lilly Pilly	LC	NL	1				
RUTACEAE	*Acronychia laevis*	Glossy Acronychia	LC	NL	2-3				
EUPHORBIACEAE	*Actephila latifolia*	*ncn*	LC	NL	1				
EUPHORBIACEAE	*Actephila lindleyi*	Actephila	LC	NL	1				
ADIANTACEAE	*Adiantum aethiopicum*	Maidenhair Fern	LC	NL	2-3	1			
ADIANTACEAE	*Adiantum hispidulum var. hispidulum*	Rough Maidenhair Fern	LC	NL	2-3				
FABACEAE	*Aeschynomene indica*	Buddha Pea	*	*					1
ASTERACEAE	*Ageratum conyzoides ssp. conyzoides*	Blue Top	LC	NL		+-3 (e)	1		+-3
RUBIACEAE	*Aidia racemosa*	Archer Cherry	LC	NL	1				
SIMAROUBACEAE	*Ailanthus triphysa*	White Bean	LC	NL	2	+			
MIMOSACEAE	*Albizia lebbeck*	Indian Siris	*	*				+	
MIMOSACEAE	*Albizia procera*	Native Siris	LC	NL	1-2 (e)	+	+	+	
EUPHORBIACEAE	*Alchornea ilicifolia*	Native Holly	LC	NL	1				
EUPHORBIACEAE	*Alchornea thozetiana var. thozetiana*	Thozet's Holly	LC	NL	+				
SAPINDACEAE	*Alectryon subdentatus*	Hard Alectryon	LC	NL	+				
SAPINDACEAE	*Alectryon tomentosa*	Hairy Alectryon	LC	NL	+				
POACEAE	*Alloteropsis semialata*	Cockatoo Grass	LC	NL		1	1		
RHAMNACEAE	*Alphitonia excelsa*	Red Ash	LC	NL		2	+-3	3	
APOCYNACEAE	*Alstonia constricta*	Milky Pine	LC	NL	2-5				
APOCYNACEAE	*Alstonia scholaris*	Milky Pine	LC	NL	2				

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
AMARANTHACEAE	*Alternanthera dentata*	Purple Hedge	*	*		+			
FABACEAE	*Alysicarpus vaginalis*	Alyce Clover	*	*					+
APOCYNACEAE	*Alyxia ruscifolia*	Chain Fruit	LC	NL	2				
LORANTHACEAE	*Amyema biniflorum*	Bronze Mistletoe	LC	NL				1	
LORANTHACEAE	*Amyema congener ssp. rotundifolium*	Variable Mistletoe	LC	NL			+		
POACEAE	*Ancistrachne uncinulata*	Hooky Grass	LC	NL	+-2				
ULMACEAE	*Aphananthe phillipinensis*	Rough-Leaved Elm	LC	NL	2				
ARAUCARIACEAE	*Araucaria cunninghamii*	Hoop Pine	LC	NL	+				
MIMOSACEAE	*Archidendropsis thozetiana*	Southern Siris	LC	NL	+				
STERCULIACEAE	*Argyrodendron polyandrum*	Brown Tulip Oak	LC	NL	2-5				
POACEAE	*Aristida calycina*	Dark Wiregrass	LC	NL			+-3		
POACEAE	*Aristida gracilipes*	(a) Wiregrass	LC	NL	+				
POACEAE	*Aristida latifolia*	*ncn*	LC	NL					+
POACEAE	*Aristida ramosa*	Purple Wiregrass	LC	NL					1
SAPINDACEAE	*Arytera distylis*	Twin-leaved Coogera	LC	NL	+				
SAPINDACEAE	*Arytera divaricata*	Coogera	LC	NL	2				
POLYPODIACEAE	*Asplenium paleaceum*	Scaly Asplenium	LC	NL	+				
SAPINDACEAE	*Atalaya australiana*	*ncn*	LC	NL	+				
RUBIACEAE	*Atractocarpus fitzalanii*	Native Gardenia	LC	NL	+				
FABACEAE	*Austrosteenisia blackii*	Blood Vine	LC	NL	3				
SCROPHULARIACEAE	*Bacopa procumbens*	*ncn*	*	*					+
EUPHORBIACEAE	*Baloghia inophylla*	Scrub Bloodwood	LC	NL	2 (d/l)				
ASTERACEAE	*Bidens alba var. radicata*	Sheppard's Needles	*	*				1-3	1-3
POACEAE	*Bothriochloa bladhii*	Forest Bluegrass	LC	NL		1			

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
POACEAE	*Bothriochloa ewartiana*	Desert Bluegrass	LC	NL					+
POACEAE	*Brachiaria decumbens*	Signal Grass	*	*		+	+		+-3
PHYLLANTHACEAE	*Breynia oblongifolia*	Coffee Bush	LC	NL	+	1		+	
EUPHORBIACEAE	*Bridelia leichhardtii*	Small-Leaved Scrub Ironbark	LC	NL	1				
BURSERACEAE	*Canarium australianum*	Mango Bark	LC	NL	1				
POACEAE	*Capillipedium spicigerum*	Scented Top	LC	NL		1-3	+-1		
CAPPARACEAE	*Capparis arborea*	Native Pomegranate	LC	NL	2-3				
CAPPARACEAE	*Capparis ornans*	Showy Caper	LC	NL	+				
APOCYNACEAE	*Carissa ovata*	Klunkerberry	LC	NL	2				
LAURACEAE	*Cassytha filiformis*	Dodder Laurel	LC	NL	1			1	
VITACEAE	*Cayratia acris*	Soft Water Vine	LC	NL	+				
FABACEAE	*Centrosema molle*	Centro	*	*			+-2		+-2
CAESALPINIACEAE	*Chamaecrista bifida*	*ncn*	LC	NL			+		
CAESALPINIACEAE	*Chamaecrista nomame*	*ncn*	LC	NL			+		
CAESALPINIACEAE	*Chamaecrista rotundifolia*	Wynn's Cassia	*	*					+
ADIANTACEAE	*Cheilanthes sieberi ssp. sieberi*	Mulga Fern	LC	NL			1		
ADIANTACEAE	*Cheilanthes tenuifolia*	Rock Fern	LC	NL			1		
OLEACEAE	*Chionanthus ramiflora*	Native Olive	LC	NL	3-4			+	
POACEAE	*Chloris gayana cv.*	Rhodes Grass	*	*					+-2
POACEAE	*Chloris inflata*	Purpletop Chloris	*	*					+-2
POACEAE	*Chloris virgata*	Feathertop Rhodes Grass	*	*					+-2
POACEAE	*Chrysopogon fallax*	Golden Beard Grass	LC	NL			+		
VITACEAE	*Cissus cardiophylla*	Heart-Leaved Water Vine	LC	NL	+-2				
VITACEAE	*Cissus oblonga*	Smooth Water Vine	LC	NL	+-3		+		

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
RUTACEAE	*Clausena brevistyla var. brevistyla*	Native Wampi	LC	NL	+				
EUPHORBIACEAE	*Cleistanthus dallachyanus*	*ncn*	LC	NL	+-2				
POACEAE	*Cleistochloa subjuncea*	*ncn*	LC	NL			1		
RANUNCULACEAE	*Clematis glycinoides*	Clematis	LC	NL	1				
VITACEAE	*Clematocissus opaca*	Forest Grape	LC	NL	+	+			
VERBENACEAE	*Clerodendrum floribundum*	Smooth Lolly Bush	LC	NL	2 (e)				
RUTACEAE	*Coatesia paniculata*	Axebreaker	LC	NL	+				
BORAGINACEAE	*Cordia dichotoma*	Snotty Gobbles	LC	NL	2				
LAXMANNIACEAE	*Cordyline murchisoniae*	Small Palm Lily	LC	NL	-2				
MYRTACEAE	*Corymbia citrodora ssp. citriodora*	Lemon-Scented Gum	LC	NL		1	3-6	+-2	
MYRTACEAE	*Corymbia dallachiana*	Dallachy's Gum	LC	NL			+		
MYRTACEAE	*Corymbia erythrophloia*	Variable-Barked Bloodwood	LC	NL				+	
MYRTACEAE	*Corymbia intermedia*	Pink Bloodwood	LC	NL	2 (e)	2-4		2	
MYRTACEAE	*Corymbia tessellaris*	Carbeen	LC	NL	+(e)	+-2	+	2-3	
MYRTACEAE	*Corymbia torelliana*	Cadaghi	LC	NL				+	
MYRTACEAE	*Corymbia trachyphloia ssp. trachyphloia*	Brown Blood	LC	NL		+	+-2		
ASTERACEAE	*Crassocephalum crepidioides*	Thickhead	*	*			+		+
FABACEAE	*Crotalaria goreensis*	Gambia Pea	*	*			+		+-2
FABACEAE	*Crotalaria lanceolata ssp. lanceolata*	*ncn*	*	*					+-1
LAURACEAE	*Cryptocarya bidwillii*	Yellow Laurel	LC	NL	1				
LAURACEAE	*Cryptocarya hypospodia*	Northern Laurel	LC	NL	1				
LAURACEAE	*Cryptocarya onoprienkoana*	Rose Maple	LC	NL	1				
LAURACEAE	*Cryptocarya triplinervis var. pubens*	Three-Veined Laurel	LC	NL	3	+			
SAPINDACEAE	*Cupaniopsis simulata*	Northern Tuckeroo	LC	NL	3-4		+		

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
ASTERACEAE	*Cyanthillium cinereum*	*ncn*	LC	NL		+	2		
ZAMIACEAE	*Cycas media*	*ncn*	LC	NL		3	1	+-2	
RUBIACEAE	*Cyclophyllum coprosmoides*	Coast Canthium	LC	NL	+-2				
ORCHIDACEAE	*Cymbidium canaliculatum*	Black Orchid	LC	NL			+		
CYPERACEAE	*Cyperus gracilis*	Whisker Grass	LC	NL	+	+	1	+	
CYPERACEAE	*Cyperus gunnii var. novae-hollandiae*	*ncn*	LC	NL	2				
CYPERACEAE	*Cyperus victoriensis*	*ncn*	LC	NL			+		
FABACEAE	*Dalbergia sissoo*	Himalayan Raintree	*	*		1		+-1	1
AMARANTHACEAE	*Deeringia arborescens*	*ncn*	LC	NL	+				
FABACEAE	*Desmodium rhytidophyllum*	Hairy Tre-Foil	LC	NL			2		
FABACEAE	*Desmodium tortuosum*	*ncn*	*	*		+	+-2	1	
FABACEAE	*Desmodium triflorum*	*ncn*	LC	NL		1	+-2		
HEMEROCALLIDACEAE	*Dianella caerulea*	Blue Flax Lily	LC	NL	+		+		
POACEAE	*Dichanthium aristatum*	Angleton Grass	*	*					+
POACEAE	*Digitaria breviglumis*	*ncn*	LC	NL	+-3 (e)		1-2		
POACEAE	*Digitaria eriantha*	Pangola Grass	*	*					
SAPINDACEAE	*Dioscorea transversa*	Native Yam	LC	NL	1				
EBENACEAE	*Diospyros australis*	Black Plum	LC	NL	1				
EBENACEAE	*Diospyros geminata*	Scaly Ebony	LC	NL	2				
EBENACEAE	*Diospyros hebecarpa*	(an) Ebony	LC	NL	1				
SAPINDACEAE	*Diploglottis obovata*	Native Tamarind	LC	NL	+-3				
ORCHIDACEAE	*Dockrillia bowmanii*	*ncn*	LC	NL	+				
SINOPTERIDACEAE	*Doryopteris concolor*	*ncn*	LC	NL	3-4				
POLYPODIACEAE	*Drynaria sparsisora*	*ncn*	LC	NL	1	+(e)			
EUPHORBIACEAE	*Drypetes deplanchei*	Yellow Tulip	LC	NL	3				
MELIACEAE	*Dysoxylum mollissimum ssp. molle*	Red Bean	LC	NL	1				
ELAEOCARPACEAE	*Elaeocarpus obovatus*	Hard Quandong	LC	NL	+-4				

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
SAPINDACEAE	*Elattostachys xylocarpa*	White Tamarind	LC	NL	+				
POACEAE	*Eleusine indica*	Crows Foot Grass	LC	NL					2
ASTERACEAE	*Emilia sonchifolia*	Emilia	LC	NL			+		
LAURACEAE	*Endiandra compressa*	White Bark	LC	NL	1				
ASTERACEAE	*Epaltes australe*	*ncn*	LC	NL			+		2
POACEAE	*Eragrostis spartinoides*	*ncn*	LC	NL		2	+-3		
POACEAE	*Eragrostis tenuiflora*	Elastic Grass	*	*					
MYRTACEAE	*Eucalyptus drepanophylla*	Northern Grey Ironbark	LC	NL		+-3	+-4	2-3	
MYRTACEAE	*Eucalyptus exserta*	Queensland Peppermint	LC	NL		2-4	+-2		
MYRTACEAE	*Eucalyptus platyphylla*	Poplar Gum	LC	NL			+-1		
MYRTACEAE	*Eucalyptus portuensis*	White Mahogany	LC	NL	1(e)	4-6	+-4	1	
MYRTACEAE	*Eucalyptus tereticornis*	Queensland Blue Gum	LC	NL				3-4	
MYRTACEAE	*Eugenia reinwardtiana*	Beach Cherry	LC	NL	1				
ANACARDIACEAE	*Euroschinus falcata*	Ribbonwood	LC	NL	+-3		+	2	
LAXMANNIACEAE	*Eustrephus latifolius*	Wombat Berry	LC	NL	+-1	1		1	
CONVOLVULACEAE	*Evolvulus alsinoides*	Creeping Speedwell	LC	NL		+			
CYPERACEAE	*Exocarya scleroides*	*ncn*	LC	NL	+-2				
MORACEAE	*Ficus hillii*	Sandpaper Fig	LC	NL	2				
MORACEAE	*Ficus opposita*	Sandpaper Fig	LC	NL	+		+	1	
MORACEAE	*Ficus racemosa*	Cluster Fig	LC	NL	2-3 (d/l)			+	
MORACEAE	*Ficus rubiginosa forma rubiginosa*	Rock Fig	LC	NL			+		
MORACEAE	*Ficus virens ssp. sublanceolata*	White Fig	LC	NL	+				
MORACEAE	*Ficus watkinsiana*	Strangler Fig	LC	NL	+				
CYPERACEAE	*Fimbristylis cinnamometorum*	*ncn*	LC	NL			+-2		+-3
FABACEAE	*Flemingia lineata*	*ncn*	LC	NL		1	+-2	2	+-2

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
RUTACEAE	*Flindersia australis*	Crows Ash	LC	NL		+			
RUTACEAE	*Flindersia schottiana*	Cudgeree	LC	NL	+-3				
PHYLLANTHACEAE	*Flueggea leucopyrus*	Currant Bush	LC	NL		+			
CYPERACEAE	*Gahnia aspera*	Saw Sedge	LC	NL	+-2				
SAPINDACEAE	*Ganophyllum falcatum*	*ncn*	LC	NL	2				
RUTACEAE	*Geijera salicifolia var. latifolia*	Broad-Leaved Wilga	LC	NL	2				
ORCHIDACEAE	*Geodorum densiflorum*	Pink Nodding Orchid	LC	NL		+	+		
PHYLLANTHACEAE	*Glochidion apodogynum*	Cheese Tree	LC	NL	2 (e)	+-1	+-2	+-2	
ASTERACEAE	*Glossocardia bidens*	Native Cobblers Pegs	LC	NL			+		
VERBENACEAE	*Glossocarya hemiderma*	Glossocarya	LC	NL	+				
FABACEAE	*Glycine cyrtoloba*	*ncn*	LC	NL			+		
FABACEAE	*Glycine tabacina*	Glycine Pea	LC	NL			2		
APOCYNACEAE	*Gomphocarpus physocarpus*	Balloon Cotton	*	*					+
MYRTACEAE	*Gossia bidwillii*	Python Tree	LC	NL	3				
MYRTACEAE	*Gossia hillii*	Scaly Myrtle	LC	NL	+				
SAPINDACEAE	*Guioa acutifolia*	Northern Guioa	LC	NL	1				
HALORAGACEAE	*Haloragis aspera*	*ncn*	LC	NL				+	
ASTERACEAE	*Helichrysum boormanii*	*ncn*	LC	NL			+		
POACEAE	*Heteropogon contortus*	Bunched Speargrass	LC	NL		1-3	2-5		
POACEAE	*Heteropogon triticeus*	Giant Speargrass	LC	NL			2-4		
APOCYNACEAE	*Heterostemma acuminatum*	Blue Tiger Butterfly Vine	LC	NL					
MALVACEAE	*Hibiscus divaricatus*	*ncn*	LC	NL		2		1	
CELASTRACEAE	*Hippocratea obtusifolia var. barbata*	Knot Vine	LC	NL	2				
VIOLACEAE	*Hybanthus stellarioides*	Spade Flower	LC	NL			+		
POACEAE	*Hyparrhenia rufa ssp. altissima*	Thatch Grass	*	*		+-2	+		2-5

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
LAMIACEAE	*Hyptis suaveolens*	Hyptis	*	*					+
MENISPERMACEAE	*Hypserpa decumbens*	Hypserpa	LC	NL	2				
POACEAE	*Imperata cylindrica*	Blady Grass	LC	NL		+		+-4	+-2
FABACEAE	*Indigofera brevidens var. brevidens*	(an) Indigo	LC	NL	+ (e)				
FABACEAE	*Indigofera hirsuta*	Hairy Indigo	LC	NL					+-2
CONVOLVULACEAE	*Ipomoea hederifolia*	Scarlet Creeper	*	*					2
CONVOLVULACEAE	*Ipomoea quamoclit*	Star Of Bethlehem	*	*					1
SAPINDACEAE	*Jagera pseudorhus var. pseudorhus*	Foam Bark	LC	NL	2-5	+-2	+	1	
OLEACEAE	*Jasminum didymum ssp. racemosum*	Slender Jasmine	LC	NL	2-5				
OLEACEAE	*Jasminum singuliflorum*	Soft Jasmine	LC	NL	2				
RUBIACEAE	*Kailarsenia ochreata*	Native Gardenia	LC	NL	1		1-2	+-3	
VERBENACEAE	*Lantana camara var. camara*	Common Lantana	*	*	+-3 (e)		+-1	1-5	
DRYOPTERIDACEAE	*Lastreopsis microsora*	Creeping Shield Fern	LC	NL	-3				
CAESALPINIACEAE	*Leucaena leucocephala*	White Popinac	*	*					+-2
LAMIACEAE	*Leucas linifolia*	*ncn*	*	*					+
LAURACEAE	*Litsea leefeana*	Brown Bolly Gum	LC	NL	1				
LAURACEAE	*Litsea reticulata*	Bolly Gum	LC	NL	+				
CAMPANULACEAE	*Lobelia purpurascens*	White Root	LC	NL			+		
LAXMANNIACEAE	*Lomandra longifolia*	Spiny-Headed Mat-Rush	LC	NL			+		
LAXMANNIACEAE	*Lomandra multiflora ssp. multiflora*	Many-Headed Mat Rush	LC	NL		+	+		
MYRTACEAE	*Lophostemon confertus*	Brush Box	LC	NL	3		+-5		
MYRTACEAE	*Lophostemon grandiflorus*	Northern Swamp Box	LC	NL				2	
MYRTACEAE	*Lophostemon suaveolens*	Swamp Box	LC	NL			+-2	2-5	

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
EUPHORBIACEAE	*Macaranga tanarius*	Macaranga	LC	NL	+ (e)			+-3	
MORACEAE	*Maclura cochinchinensis*	Cockspur Vine	LC	NL	1				
FABACEAE	*Macroptilium atropurpureum*	Sirartro	*	*				+-2	1-5
EUPHORBIACEAE	*Mallotus philippensis*	Red Kamala	LC	NL	4		1	1	
CELASTRACEAE	*Maytenus disperma*	Orange Bush	LC	NL	+ (e)				
POACEAE	*Megathyrsus maximus var. maximus cv. Hamil*	Guinea Grass	*	*					1
POACEAE	*Megathyrsus maximus var. pubiglume*	Green Panic	*	*		+-2	+	+-4	1-5
MYRTACEAE	*Melaleuca fluviatilis*	Paper-Barked Tea Tree	LC	NL				1	
MYRTACEAE	*Melaleuca viridiflora*	Broad-Leaved Tea Tree	LC	NL			+-4		
POACEAE	*Melinis minutiflora*	Molasses Grass	*	*			1	+-4(e)	1-5
ANNONACEAE	*Melodorum leichhardtii*	Zig-Zag Vine	LC	NL	2				
MELASTOMATACEAE	*Memecylon pauciflorum var. pauciflorum*	*ncn*	LC	NL	1				
RUTACEAE	*Micromelum minutum*	Micromelum	LC	NL	2-5				
POLYPODIACEAE	*Microsorum sp. (n-r)*	*ncn*	LC	NL	+-3				
ANNONACEAE	*Miliusa brahei*	*ncn*	LC	NL	2-4				
FABACEAE	*Millettia pinnata*	Indian Beech	LC	NL	+-4(g)				
MIMOSACEAE	*Mimosa pudica var. unijuga*	Common Sensitive Plant	*	*			1	+-2	+-3
SAPINDACEAE	*Mischocarpus anodontus*	Veiny Pear-Fruit	LC	NL	1				
POACEAE	*Mnesithea rottboellioides*	*ncn*	LC	NL		+	1	+-4	+
COMMELINACEAE	*Murdannia graminea*	Slug Herb	LC	NL			+		
MYOPORACEAE	*Myoporum acuminatum*	Boobialla	LC	NL		1			
MYRSINACEAE	*Myrsine porosa*	(a) Muttonwood	LC	NL	+				
LAURACEAE	*Neolitsea brassii*	Northern Bolly Gum	LC	NL	+-2				
OLEACEAE	*Notelaea microcarpa var. microcarpa*	Narrow-Leaved Mock Olive	LC	NL	+				

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
OLEACEAE	*Olea paniculata*	Native Olive	LC	NL	1				
POACEAE	*Oplismenus aemulus*	Paddymelon Grass	LC	NL	+				
POACEAE	*Oplismenus mollis*	Beard Grass	LC	NL	1-3	1			
POACEAE	*Ottochloa gracillima*	Graceful Grass	LC	NL	+				
BIGNONIACEAE	*Pandorea pandorana*	Wonga Vine	LC	NL	1-2				
POACEAE	*Panicum effusum*	Hairy Panic	LC	NL			+		
POACEAE	*Panicum simile*	Two-Coloured Panic	LC	NL		+	+-2		+
MIMOSACEAE	*Paraserianthes toona*	Mackay Cedar	LC	NL	2				
APOCYNACEAE	*Parsonsia longipetiolata*	Green-Leaved Silkpod	LC	NL	+				
APOCYNACEAE	*Parsonsia paulforsteri*	Narrow-Leaved Silkpod	LC	NL	2				
POACEAE	*Paspalidium distans*	Shot Grass	LC	NL		+	1		
PASSIFLORACEAE	*Passiflora foetida*	Stinking Passionvine	*	*					+
PASSIFLORACEAE	*Passiflora suberosa*	Corky Passionvine	*	*	2-3	1-2		+-2	
RUBIACEAE	*Pavetta australiensis*	Butterfly Bush	LC	NL	2-3				
ADIANTACEAE	*Pellaea nana*	Small-Leaved Sickle Fern	LC	NL	+-3				
RUTACEAE	*Pentaceras australe*	Penta's Ash	LC	NL	1				
PIPERACEAE	*Peperomia blanda var. floribunda*	*ncn*	LC	NL	+-3				
ASTERACEAE	*Peripleura hispidula*	*ncn*	LC	NL			1		
PROTEACEAE	*Persoonia falcata*	(a) Geebung	LC	NL			+-1		
PHYLLANTHACEAE	*Phyllanthus gunnii*	Gunn's Phyllanthus	LC	NL	+	1			
PHYLLANTHACEAE	*Phyllanthus virgatus*	*ncn*	LC	NL			2		
URTICACEAE	*Pipturus argenteus*	Native Mulberry	LC	NL	+ (e)				
NYCTAGINACEAE	*Pisonia aculeata*	Pisonia	LC	NL	+				
PITTOSPORACEAE	*Pittosporum ferrugineum ssp. linifolium*	Rusty Pittosporum	LC	NL	+				

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
LECYTHIDACEAE	*Planchonia careya*	Cocky Apple	LC	NL		+	+-2	+-2	
PLANTAGINACEAE	*Plantago debilis*	*ncn*	LC	NL			+		+
ANACARDIACEAE	*Pleiogynium timorense*	Burdekin Plum	LC	NL	+-2		+		
MENISPERMACEAE	*Pleogyne australe*	Wiry Grape	LC	NL	1				
RUBIACEAE	*Pogonolobus reticulatus*	*ncn*	LC	NL			+		
ANNONACEAE	*Polyalthia nitidissima*	Canary Beech	LC	NL	+-3				
ARALIACEAE	*Polyscias elegans*	Celery Wood	LC	NL	2			+	
SAPOTACEAE	*Pouteria myrsinifolia*	Blunt-Leaved Coondoo	LC	NL	1				
SAPOTACEAE	*Pouteria pohlmaniana*	Yellow Boxwood	LC	NL	1				
RUBIACEAE	*Psychotria sp. (Shute Harbour L.J. Webb 7916)*	*ncn*	LC	NL	2		+-2 (e)		
RUBIACEAE	*Psydrax odorata ssp. australiana*	Shiny Canthium	LC	NL		+			
ASTERACEAE	*Pterocaulon redolens*	*ncn*	LC	NL			1		
ASTERACEAE	*Pterocaulon sphacelatum*	Applebush	LC	NL					+
POLYPODIACEAE	*Pyrrosia confluens*	Robber Fern	LC	NL	+				
MYRTACEAE	***Rhodamnia pauciovulata***	**Small-Leaved Malletwood**	**NT**	NL	**2**				
POACEAE	*Rhynchelytrum repens*	Red Natal Grass	*	*			+		+-3
PHYTOLACCACEAE	*Rivina humilis*	Baby Pepper	*	*	+-4				
LAMIACEAE	*Salvia reflexa*	Mintweed	*	*		+		1	
RUTACEAE	*Sarcomelicope simplicifolia*	Bauer	LC	NL	1				
POACEAE	*Sarga nitida forma aristata*	*ncn*	LC	NL		+-3	+-3	+-3	1
CYPERACEAE	*Scleria mackaviensis*	*ncn*	LC	NL	2-3	3	2		
FLACOURTIACEAE	*Scolopia braunii*	Flintwood	LC	NL	+				
APOCYNACEAE	*Secamone elliptica*	Corky Milk Vine	LC	NL	+				
CAESALPINIACEAE	*Senna obtusifolia*	Sicklepod	*	*					1
POACEAE	*Setaria oplismenioides*	*ncn*	LC	NL	1				
POACEAE	*Setaria surgens*	*ncn*	LC	NL					+-2
MALVACEAE	*Sida cordifolia*	Flannel Weed	LC	NL			+		

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
ASTERACEAE	*Sigesbeckia orientalis*	Indian Weed	*	*	+ (e)				
SMILACACEAE	*Smilax australis*	Austral Sarsparilla	LC	NL	2-3				
SOLANACEAE	*Solanum nigrum*	Blackberry Nightshade	*	*					+
SOLANACEAE	*Solanum seaforthianum*	Brazilian Nightshade	*	*	+-2				
SOLANACEAE	*Solanum torvum*	Devil's Fig	*	*			+		+
ASTERACEAE	*Sonchus oleraceus*	Milk Thistle	*	*					+
POACEAE	*Sorghum halepense*	Johnson Grass	*	*					+-2
RUBIACEAE	*Spermacoce brachystema*	*ncn*	LC	NL			+-2		
VERBENACEAE	*Stachytarpheta jamaicensis*	Blue Snakeweed	*	*			+		
MENISPERMACEAE	*Stephania japonica var. discolor*	Tape Vine	LC	NL		+			
STERCULIACEAE	*Sterculia quadrifida*	Peanut Tree	LC	NL	1				
MORACEAE	*Streblus pendulinus*	Whalebone Tree	LC	NL	+				
FABACEAE	*Stylostanthes harmata*	Stylo	*	*		+	1		1
FABACEAE	*Stylostanthes scabra*	Shrubby Stylo	*	*					1-3
MYRTACEAE	*Syzygium australe*	Brush Cherry	LC	NL	+-3 (d/l)				
FABACEAE	*Tephrosia filipes*	*ncn*	LC	NL		+	1		+
COMBRETACEAE	*Terminalia porphyrocarpa*	(a) Damson Tree	LC	NL	2-3				
COMBRETACEAE	*Terminalia sericocarpa*	Brown Damson	LC	NL	1-4				
VITACEAE	*Tetrastigma nitens*	Native Grape	LC	NL	2				
POACEAE	*Themeda quadrivalvis*	Grader Grass	*	*					1-4
POACEAE	*Themeda triandra*	Kangaroo Grass	LC	NL			1-5	2	
RUBIACEAE	*Timonius timon*	Timon Tree	LC	NL	2				
MENISPERMACEAE	*Tinospora smilacina*	Arrow-Head Vine	LC	NL	+				
ULMACEAE	*Trema tomentosa var. tomentosa*	Poison Peach	LC	NL			1		
BORAGINACEAE	*Trichodesma zeylanica*	Rough Bluebell	LC	NL		2			

FAMILY	Botanical Name	Common Name	NC Act Status[1]	EPBC Act Status[2]	8.12.3	8.12.5	8.12.7	8.12.12	Road Reserve
JOHNSONIACEAE	*Tricoryne elatior*	*ncn*	LC	NL				1	
ASTERACEAE	*Tridax procumbens*	Tridax Daisy	*	*					+-2
RUBIACEAE	*Triflorensia ixoroides*	*ncn*	LC	NL	+				
ULMACEAE	*Triumfetta rhomboidea*	Chinese Burr	*	*				+-3	+-2
MORACEAE	*Trophis scandens var. scandens*	Burney Vine	LC	NL	+-2				
FABACEAE	*Uraria lagopodioides*	*ncn*	LC	NL			+	1	
POACEAE	*Urochloa mosambicensis*	Sabi Grass	*	*					+
GOODENIACEAE	*Velleia pubescens*	*ncn*	LC	NL			+-2		+-2
ASTERACEAE	*Wedelia spilanthoides*	*ncn*	LC	NL				1	
LAXMANNIACEAE	*Xanthorrhoea latifolia ssp. latifolia*	Forest Grass Tree	LC	NL			+-3		
FABACEAE	*Zornia muriculata*	*ncn*	LC	NL			2		

1. Queensland NC Ac Status: Least Common (LC), Near Threatened (NT), Naturalised Exotic (*) flora species.
2. Commonwealth EPBC Act Status: Not Listed (NL), Naturalised Exotic (*) flora species.
3. Relative abundance of species was based on the Braun-Blanquet technique cover-abundance scale (Mueller-Dombois & Ellenberg 1974, Whittaker 1975) as follows:
   - **+** = individual specimen recorded
   - **1** = sparse, <5%
   - **2** = any number, <5%
   - **3** = 5 – 24%
   - **4** = 25 – 49%
   - **5** = 50 – 74%
   - **6** = 75 – 100%.

APPENDIX C

KOALA SIGNIFICANCE ASSESSMENT

C1: Koala (*Phascolarctos cinereus*)

Description

The Koala is a tree-dwelling, medium-sized marsupial with a stocky body, large rounded ears, sharp claws and variable but predominantly grey-coloured fur. Males generally are larger than females and there is a gradient in body weight from north to south across their range, with larger individuals in the south and smaller individuals in the north. The average weight of males is 6.5 kg in Queensland, compared with 12 kg in Victoria. In the north of its range, the Koala tends to have shorter, silver-grey fur, whereas in the south it has longer, thicker, brown-grey fur (DoE 2013a, Date accessed 17 December 2013).

Distribution

The Koala is endemic to Australia, and is widespread in coastal and inland areas from north-east Queensland to Eyre Peninsula, South Australia. The range extends over 22° of latitude and 18° of longitude, or about one million square kilometres. The Koala's distribution is not continuous across this range and it occurs in a number of populations that are separated by cleared land or unsuitable habitat.

In Queensland the Koala has scattered populations throughout Queensland, in moist forests along the coast, sub-humid woodlands in southern and central Queensland, and in some eucalypt woodlands along watercourses in the semi-arid environments of the western part of the State. The Koala has also been found to occur in non-riverine communities in semi-arid areas.

The greatest density of the Koala in the State occurs in south-east Queensland, and lower densities occur through central and eastern areas. For example, population densities range from moderately high in south-east Queensland and some parts of central Queensland (e.g. 1–3 koalas/ha) to low in other parts of central Queensland (e.g. 0.01 koalas/ha) (DoE 2013b).

Habitat Preference

Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus. The distribution of Koalas is also affected by altitude (limited to <800m ASL), temperature and, at the western and northern ends of the range, leaf moisture (DoE 2013b).

Threats

The main identified threats to the Koala are loss and fragmentation of habitat, vehicle strike, disease, and predation by the Dog (*Canis lupus familiaris*). Drought and incidences of extreme heat are also known to cause very significant mortality, and post-drought recovery may be substantially impaired by the range of other threatening factors (DoE 2013b).

Within the Study Area, primary threats are:

- Habitat loss
- Increased risk of predation, particularly just after clearing activities

- Vehicle strike, particularly by haul trucks, which cannot slow or break quickly.

However, given the Peak Downs Highway already exists at this location, these threats are already acting on the Koala at this location.

Table C1: Significance Assessment for the Koala

Occurrence within the Project Area
Koalas were recorded at three locations in the Study Area as part of November 2013 field surveys. This species was recorded in RE 8.12.3, 'Lemon-scented Gum (*Corymbia citriodora*) +/- Broad-leaved Stringybark (*Eucalyptus portuensis*) +/- Grey Ironbark (*E. drepanophylla*) (or Narrow-leaved Ironbark (*E. crebra*)) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks' (Queensland Herbarium 2013). It was also recorded calling during spotlighting activities. All REs in the Study Area, except RE 8.12.3 provide suitable habitat for this species. This equates to 80.7 ha.
Important population
The concept of an 'important population' is central to assessing the potential for an action to have a significant impact on a species listed as Vulnerable under the EPBC Act. Each of the key 'important population' aspects is addressed below. *a) Key Source population for breeding or dispersal* The SPRAT profile cites research (Melzer et al. 2000) indicating that the Koala population density in Central Queensland varies from moderately high (e.g. 1-3 koalas/ha) in some parts of Central Queensland to low (e.g. 0.01 koalas/ha) in other parts of Central Queensland. 2010 population estimates for the Wet Tropics and Central Mackay Coast suggest 10 000 Koalas remain, however, the confidence in this population estimate is low (DoE 2013b) Eucalypt open forest throughout the Study Area provides suitable habitat for Koalas as they have been recorded in this location. Given this species was identified at three locations within a relatively small area of habitat (80.7 ha) and over a period of only five days, it is considered the species occurs in high abundance in this local area and disperses throughout the Eton and Connors Ranges. Therefore, the habitat in this area may support a key source population. *b) Populations that are necessary for maintaining genetic diversity* All Koala populations are necessary for maintaining genetic diversity. Although, this species is sufficiently widespread and mobile that risk of reduction in genetic diversity would be low. *c) Populations that are near the limit of the species' range* The Koala is known to occur from north-east Queensland to South Australia. Therefore, the Koalas that occur in the Study Area are not near the limit of the species' range. *Conclusion:* The Koalas that have been recorded in the Study Area have

potential to form part of a key source population for breeding or dispersal. Therefore, the animals that use habitat in the Study Area are potentially part of an important population.

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

a) Lead to a long-term decrease in the size of an important population of a species

Up to 80.7 ha of habitat for the Koala will potential be removed as part of the Project. While Koalas are known to occur in the Study Area, construction of the Project can be undertaken in a manner that avoids significant disturbance, injury or fatality of Koalas.

While there is a risk of vehicle strike of this species along the Peak Downs Highway, the Project is not introducing a new type of activity as the Peak Downs Highway already exists in this area. The Project is unlikely to increase the risk of vehicle strike to Koalas as this section of the highway will remain a low speed zone due to the steep and winding nature of the alignment.

Therefore, the Project is considered unlikely to lead to a long-term decrease in the size of the Koala population within the broader area.

b) Reduce the area of occupancy of an important population

Up to 80.7 ha of habitat for the Koala will potential be removed as part of the Project. However, this is comprised of Least Concern REs, which occur extensively throughout the Eton and Connors Ranges and which are connected to the north-west and south-east of the Study Area.

Therefore, the Project is considered unlikely to reduce the area of occupancy of the Koala in the broader area.

c) Fragment an existing important population into two or more populations

Clearing for the Project will involve 80.7 ha of suitable habitat either side of the existing Peak Downs Highway (Figure 3). Creation of this highway in the past has resulted in fragmenting habitat areas and creating a barrier to movement to some extent.

The Project will not create further fragmentation, but may increase the barrier effect of the existing highway.

Therefore, the Project is considered unlikely to fragment the Koala population in the area.

d) Adversely affect habitat critical to the survival of a species

The habitat in the Study Area comprises largely remnant open forest communities. These habitats are not unique in the local area or broader landscape and all are listed as Least Concern under the Queensland *Vegetation Management Act 1999*, indicating their extent of occurrence in the landscape. While the abundance of the Koala in the Study Area is considered to be high, it is expected this is not unique to the Study Area, but typical of the broader Eton and Connors Ranges. The removal of 80.7 ha of suitable habitat at this location, is considered unlikely to adversely affect habitat critical to the survival of the species as extensive areas of habitat will remain, and the habitat adjacent to the existing Peak

Downs Highway is not as intact as that occurring further away from the Highway in more remote areas of the ranges.

Therefore, the Project is considered unlikely to adversely affect habitat critical to the survival of the Koala..

e) Disrupt the breeding cycle of an important population

The breeding cycle of an important population is unlikely to be disrupted as the Project can be developed in a way that reduces direct and indirect impacts to individuals. For example, in the instance that Koalas are identified during pre-clearance surveys, an exclusion zone will be established to allow the animal to move from the area of their own accord, minimising disturbance and stress to this species.

Therefore, the Project is considered unlikely to disrupt the breeding cycle of the Koala population within the area.

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

The extent of potential habitat proposed to be cleared as part of this Project is 80.7 ha which is likely to account for only a small area of the suitable habitat in the broader landscape. The clearing will not cause isolation of any areas of suitable Koala habitat. This has already occurred with the construction of the existing Peak Downs Highway.

Consequently, disturbance of this relatively small area of habitat is not considered to modify, destroy, remove or isolate or decrease availability or quality of habitat to the extent that the Koala is likely to decline.

g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species, including feral animals such as the fox (*Vulpes vulpes*) and Dog are likely to occur throughout the Eton and Connors Ranges, including within and adjacent the Study Area. These types of predatory species are drawn to areas of disturbance to prey upon mammals and reptiles that are moving away from the disturbance area, therefore, predation by feral animals is a risk to this species during and immediately after clearing activities. Predatory species are also attracted to the prey opportunities presented by cleared linear corridors, i.e. exposure of prey moving across easements, although this cleared linear corridor is already present in the form of the existing Peak Downs Highway.

This Project is considered unlikely to result in invasive species becoming established in potential habitat in the Study Area or adjacent areas, as these invasive and predatory species are already established throughout the wider landscape. Additionally, spotter/catchers will be present during all clearing activities to ensure animals move away from the disturbance area naturally or are safely relocated to suitable habitat nearby the disturbance area, minimising the risk of predation by feral animals to this species as a result of the Project.

Therefore, the Project is considered unlikely to result in an invasive species harmful to the Koala becoming established in the area.

h) Introduce disease that may cause the species to decline, or

Three viruses are known to affect Koalas in the wild, Chlamydia and Koala Retrovirus (KoRV-A and KoRV-B). It is known that Chlamydia is a sexually

transmitted disease in Koalas, however, how the Retrovirus is spread contagiously is unknown. Studies have shown that 100% of Koalas in the wild have the Retrovirus, and the majority of Queensland and New South Wales populations are infected with Chlamydia (Hanger & Loader 2009).

Stress has been suggested to exacerbate the effects of disease on Koala populations in more populated areas. However, the Project does not present a significant mechanism for the introduction or increase in the prevalence of these diseases in the local Koala population, due to the relatively small area of disturbance on wooded vegetation habitat types as a result of this Project.

Therefore, the Project is considered unlikely to result in the introduction of a disease that may cause the Koala to decline in the area.

i) Interfere substantially with the recovery of the species.

A total of 80.7 ha of habitat occurs in the Study Area, which is proposed to be cleared. This area is considered relatively small and therefore is unlikely to interfere substantially with the recovery of Koala in Queensland.

Therefore, the Project is considered unlikely to interfere substantially with the recovery of the Koala in the area.

Conclusion: Despite individuals of Koala occurring in the Study Area, potentially forming part of an important population, the Project is considered unlikely to result in a significant impact to the Koala. This is due to the relatively small size of habitat proposed to be impacted and the persistence of this population despite the existing Peak Downs Highway.

Appendix G: Importance of Koala habitat associated with the Eton Range Realignment Project (Koala Research – CQ, 2015)

Koala Research - CQ

Importance of koala habitat associated with the Eton Range Realignment Project

Dr Alistair Melzer, Koala Research – CQ, School of Medical and Applied Sciences (Conservation Biology), CQUniversity, Rockhampton (a.melzer@cqu.edu.au)

6/11/2015

Summary

Three of the four regional ecosystems associated with the Eton Range realignment project support important koala food species, and these RE's are ranked as of high importance as habitat for koalas.

Regional ecosystems in development area

ESM (2013) identified four regional ecosystems (RE's) within the study area. These were listed as 8.12.3, 8.12.5, 8.12.7 and 8.12.12. Koala Research – CQ checked this against a recently requested search (https://environment.ehp.qld.gov.au/map-request/re-broad-veg-group/ accessed 6/11/2015) revealing a largely consistent result (Table 1). The main differences relate to the contemporary search revealing mapped vegetation communities within each RE at the site.

Ranking the koala habitat value of the listed regional ecosystems

An initial koala habitat value ranking is provided based on the generic descriptions in the Queensland Government Regional Ecosystem Description Database (REDD) (Table 1, column 3). This ranking is then revised after consideration of the ground survey data provided in ESM (2013), Appendix B page 56. ESM (2013) used a rank of species relative abundance based on the Braun-Blanquet cover-abundance scale (Wikum and Shanholtzer 1978). The revised rank is provided in Table 1 Column 5. Potential koala food tree species confirmed by ESM (2013) are listed in table 2. These were associated with RE's 8.12.3, 8.12.5, 8.12.7, 8.12.12. The results indicate that, apart from the rainforest community (RE 8.12.3a) the remaining three RE's are ranked as high value koala habitat.

Approach to ranking central Queensland's koala habitats

The ranking of central Queensland's koala habitats is based on Melzer (2014) appended. This approach is a qualitative classification based on (a) published accounts of koala diet and habitat usage, used in conjunction with (b) unpublished regional natural history observations.

Koala Research - CQ

Table 1: A desk-top analysis of the importance of regional ecosystems as koala habitat within and around the proposed Eton Range highway upgrade. Short descriptions are extracted and modified from the Queensland Government's Regional Ecosystem Description Database (REDD) (https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/about/#redd) accessed 6/11/2015.

RE	Short description	Habitat rank **0 – not value; 5 – high value**	Note	Revised rank
8.12.3a	Evergreen notophyll to microphyll vine forest	0	Koalas may shelter here, but contains no food resources	0
8.12.5a	*Lophostemon confertus* and/or *Eucalyptus portuensis* (or *E. exserta*) open forest. Occasional co-dominant or associated species include *E. drepanophylla*.	1	Importance may increase to 4 if *E. drepanophylla* is locally dominant. ESM (2013) indicate this species may have up to 24% relative abundance. Also E. exserta has a relative abundance between 25 and 49%.	4
8.12.7a	*Corymbia citriodora* and *Eucalyptus portuensis* open forest /woodland. *E. drepanophylla, E. tereticornis*, *E. exserta* may be associated canopy species.	1	If *E. drepanophylla, E. tereticornis*, or *E. exserta* are significant elements locally, then ranking may increase to 4 or 5.ESM (2013) indicate that *E. drepanophylla* has a relative abundance of between 25 and 49%. Also *E. exserta* is present along with two other, minor, seasonal food sources	4
8.12.12a	*Corymbia intermedia+/- Eucalyptus platyphylla* open forest/woodland with co-dominant eucalypts including *E. drepanophylla*, *E. tereticornis* amongst others.	1	If *E. drepanophylla and or E. tereticornis*, are significant elements locally, then ranking may increase to 4 or 5. E. *platyphylla* is eaten but usually only where it is part of or abuts more highly ranked food species. *E. platyphylla* is dry-season deciduous and, hence, provides a potential food source for only a few months. ESM (2013) indicate that *E. drepanophylla* has a relative abundance of between 25 and 49%, and *E. tereticornis* from 5 to 49%.	5

Table 2. Koala food tree species associated with RE's within the Eton Range Realignment Project area. The modified Braun-Blanquet cover-abundance rankings for each species from ESM (2013) are provided for comparison.

RE	Food species	Cover-abundance rank	Notes
8.12.3a	*Lophostemon confertus*	3	Limited seasonal food resource
8.12.5a	*Eucalyptus drepanophylla*	3	Important staple food resource
	E. exserta	2-4	Highly preferred food species
8.12.7a	*Eucalyptus drepanophylla*	4	Important staple food resource
	E. exserta	2	Highly preferred food species
	E. platyphylla	1	Seasonal food source
	Lophostemon confertus	5	Limited seasonal food resource
	Melaleuca viridiflora	4	Very minor seasonal food source
8.12.12a	*Eucalyptus drepanophylla*	4	Important staple food resource
	E. tereticornis	3-4	Important staple food resource
	Melaleuca fluviatilis	1	Minor seasonal food source

References

ESM(2013*) Eton Range Realignment Project, Fauna Assessment Report*. A report for the Department of Transport and Main Roads. Ecological Survey and Management, Brendale, Qld.

Melzer, A. (2014) Ranking koala habitat using Queensland's mapped regional ecosystems. Central Queensland Environmental Surveys, Cawarral, Qld.

Wikim, D.A. and Shanholtzer, G.F. (1978) Application of the Braun-Blanquet Cover-Abundance scale for vegetation analysis in land development studies. *Environmental Management* **2 (4)** 323-329.

Koala Research - CQ

Appendix 1:

Ranking koala habitat using Queensland's mapped regional ecosystems.

Dr Alistair Melzer

Central Queensland Environmental Surveys

August 2014

Introduction

This is a qualitative classification based on published accounts of koala diets and habitat usage as well as unpublished natural history observations.

Base mapping

Queensland's (Qld) mapped regional ecosystems (RE's) were selected as the basis for the koala habitat modeling as state-wide mapping is complete and readily available. Further, modeling of the pre-clearing extent of the RE's provides some guide to (a) the likely occurrence of regrowth suitable to support koalas, and (b) areas that can be targeted as potential sites for habitat restoration.

Identifying potential koala habitat

Regional ecosystems with the potential to support koalas are identified by the presence of known koala food species listed in either the short or long RE descriptions. A koala food tree species is a species of tree that has been identified as a koala food source by (a) direct observations of koala feeding (in the wild or in captivity) (*e.g*. Melzer 1995), or (b) faecal pellet analysis and identification of the species from cuticular fragments in the koala's faeces (*e.g*. Melzer *et al*. 2014). However, by definition, regional ecosystems are the association of plant communities and land zones – the latter categorising the underlying geology and associated landforms and geomorphic processes. It is the underlying land zone that will influence the potential habitat's characteristics in relation to fertility (and hence the nutritional value of the foliage), drought (and hence the seasonal variation in available leaf moisture), and fire (and hence catastrophic events limiting koala numbers directly and/or altering the availability of suitable habitat – structure or composition). So, the koala habitat potential of a landscape requires the consideration of both the presence of koala food species and the underlying land zone.

Ranking potential koala habitat

Ranking food species

Koala food tree species are ranked in importance based on the amount of that species usually found in a koala's diet. Consequently, *Eucalyptus tereticornis*, *E. camaldulensis* and *E. crebra*/*E. drepanophylla* are species that can form the bulk of the diet at any one location and are ranked

highly, while *Lophostemon confertus* and *Melaleuca* spp. are usually eaten in trace amounts (often seasonally) and are on the lowest rank. Species such as *E. melanophloia* receive an intermediate ranking. **Table 1** lists some of Qld's common food species and their ranking. There is some complexity, however, and in these cases the landscape context needs to be considered. For example: (1) *E. orgadophylla* is eaten as part of an edible landscape where other koala food species are juxtaposed, however koalas rarely occur in *E. orgadophylla* dominated downs without these additional species. So, an extensive RE where *E. orgadophylla* is the sole koala food species will be ranked below a similar RE of limited extent closely associated with RE's supporting other food species or where an additional koala food species is co-dominant; (2) *E. platyphylla* is a seasonally available koala food tree species that loses its foliage in the dry season. As a consequence, relatively extensive landscape elements may receive limited attention from koalas even where such elements lie within a widespread koala population. As a consequence this species is ranked lower than a highly utilized evergreen species such as *E. tereticornis* or intermediately ranked species such as *E. melanophloia*; (3) Some species are eaten in captivity but seem to receive little or no attention in the wild. In the case of *E. mollucana*, this species is eaten when presented to captive koalas; however, we have not observed wild koalas utilizing this species. With *E. exserta*, the species is highly preferred by captive species; in the field the species usually occurs as a minor element in most eucalypt communities or occurs in landscapes that are rarely used by koalas (*e.g*. mountainous rocky landscapes on Minerva Hills, Springsure). As a result, this species' contribution to a koala landscape is usually limited.

Ranking land zones

Land zones are ranked on the basis of their capacity to provide a viable habitat for a koala population; in particular the capacity to support a plant community dominated by food tree species and resistance/susceptibility to seasonal water deficits. Evidence of koalas having moved through a land zone is not sufficient to indicate that the land zone has potential as koala habitat. Each of the 12 land zones are considered below.

Land zone 1: Unconsolidated Quarternary marine sediments (mangroves and salt flats); Koalas traverse this land zone and occasionally roost in mangrove trees by day. No mangrove species are known to be eaten. **Habitat value:- 0.**

Land zone 2: Quarternary coastal dunes and beach ridges; Koalas use these landscapes where soil formation and hydrology supports important food species (*e.g*. Stradbroke Island), however the underlying very low fertility, tendency towards seasonal water deficits over most of the landscape, and inherent fire characteristics (periodic intense fires) limits koala population extent and density. **Habitat value:- 2.**

Land zone 3: Quarternary alluvium associated with rivers and streams; Over most of the koala's distribution in Qld this land zone forms the core of most local koala populations. It is commonly characterized by key food species *E. tereticornis*, *E. camaldulensis* and *E. coolibah*. The land zone is relatively fertile and usually has good underlying aquifers. **Habitat value: - 5.**

Land zone 4: Old alluvial clay plains and undulating rises; commonly supporting *Acacia* spp. forests, this land zone may support a very low level koala population where food species occur (Melzer and Lamb 1994). **Habitat value: - 2.**

Land zone 5: Old alluvial sands and loams on plains, rises and low hills; Used occasionally by koalas when in juxtaposition to a koala population on higher ranked land zones (*e.g.* site 5 in Melzer *et al*. 2014). **Habitat value:- 2.**

Land zone 6: Old inland sands and dunes; Not koala habitat. **Habitat value:- 0**.

Land zone 7: Duricrusted, deeply weathered sediments; commonly supporting *Acacia* shrublands and forests. Koalas are known to use this land zone where it abuts land zones of higher habitat ranking and where suitable tree species occur. However, utilization is probably associated with koalas moving from one high value land zone to another. **Habitat value:- 1**

Land zone 8. Plains, low scarps and hills of Cainozoic igneous rock (flood basalts and associated volcanic vents and plugs); Relatively fertile landscapes, with cracked rock aquifers, supporting a number of koala food species. Subject to seasonal water deficits. Koalas are known to occur widely across these landscapes. **Habitat value:- 4**.

Land zone 9: Low hills and undulating plains of fine grained sedimentary rock; koalas are known to roost in, or traverse this land zone where it occurs in association with more highly valued land zones. Limited utilisation of suitable food species may occur where they abut koala populations (generally along land zone 3) – but usually during relatively mesic conditions. **Habitat value:- 1.**

Land zone 10: Hills and ranges of coarse grained sedimentary rock; koalas are known from this land zone (especially in the Carnarvon Ranges) where they are associated with the colluvial slopes and drainage systems and aquifers. The low fertility, propensity to seasonal droughting and characteristic fire regimes probably act in concert to maintain an extensive, but sparse koala population. **Habitat value:- 2.**

Land zone 11: Lowlands, hills and ranges of moderately to strongly deformed metamorphic rock; koalas are known to utilise this land zone where suitable species are present and adequate aquifers are available. The low fertility, propensity to seasonal droughting , and, in places, characteristic fire regimes probably act in concert to maintain an extensive, but sparse koala population. **Habitat value:- 2.**

Land zone 12: Lowlands, hills and ranges of Mesozoic and Proterozoic intrusive and volcanic rocks; known to support wide ranging sparse to moderate koala populations depending on tree species, propensity for seasonal droughting, and characteristic fire regimes. **Habitat value:- 4.**

Ranking RE's

The importance of an RE as potential koala habitat takes account of the tree species present but also the land zone. Land zones that are of relatively high fertility and have better water availability are ranked above systems that are inherently infertile (*e.g*. aeolian sands) or are frequently subject to

severe moisture deficits (*e.g*. sandstone ranges). However, a suitable assemblage of food species on the most infertile of base materials can still support a koala population where local conditions provide suitable nutrients and water (*e.g*. Stradbroke Island). Despite that, a koala landscape needs to be assessed on a local regional basis. Consequently, when considering potential koala habitat on a landscape such as Stradbroke Island, the ranking should be constrained to the Stradbroke Island landscape.

Likely potential population extent and density

Generally Qld koala populations are of low density. There may be widespread populations where individuals or small groups are scattered across a large area, or populations with a restricted/limited distribution where individuals or small groups are effectively isolated within available habitat.

Landscapes with extensive high ranked food species and fertile and well watered land systems are likely to have the potential to support more widespread populations and at higher densities. However, lesser ranked landscapes support extensive koala populations, usually at much lower densities. These lower density populations may occupy landscapes that are more resilient than those on better watered and more fertile landscapes, and hence have increased conservation importance.

Landscape context is important

In any one location koalas will range over a number of plant communities, RE's and land zones (*e.g*. Ellis *et al.* 1995, Melzer and Lamb 1996). Considering only the highest ranked koala RE's will be misleading. For example a property where only the stream fringing vegetation has been retained may show an extensive but very narrow network of highly ranked potential koala habitat within a broader landscape with little or no koala habitat potential (*e.g.* Springsure Creek subcatchment); consequently the landscape would be very lowly ranked as potential koala habitat.

The importance of refugia

Isolated or low density koala populations within intact landscapes should not be dismissed as unimportant. It is important to consider whether such populations represent regional refugia and, hence, have heightened importance in conservation terms. Of particular importance are populations that have persisted despite intense drought, heat wave and fire over the last two decades. In the Mitchell Grass Downs, persistent water holes along major streams have been considered refugia. However, the most recent drought and heat waves (2013/14) saw the unprecedented drying of water holes that were previously considered permanent and defoliation of riverine *Eucalyptus camaldulensis*. Consequently, koala populations dependent on those waterways are now lost. Despite that koalas have persisted in the hills and ranges and colluvial slopes of the Carnarvon ranges and around Blackdown Tableland. Further, in the coastal ranges from Collinsville to St Lawrence a low density but widespread population has prospered. These regions represent refugia from the climate variability experienced over the last 25 years, at least.

References

Ellis W.A.H., Melzer A., Green B., Newgrain K., Hindell M.A. and Carrick F.N. (1995) Seasonal variation in water flux, field metabolic rate and food consumption of free-ranging koalas (*Phascolarctos cinereus*). *Aust. J. Zool*. **43**, 59-68.

Melzer A. (1995) *Aspects of the ecology of the koala Phascolarctos cinereus (Goldfuss, 1817) in the sub-humid woodlands of Central Queensland.* PhD Thesis, University of Queensland, Brisbane, Qld.

Melzer, A., Ellis, W., FitzGibbon, S., Cristescu, R and Manno, G. (2014) The habitat and diet of koalas *Phascolarctos cinereus* in Queensland. *Australian Mammalogy* http://dx.doi.org/10.1071/AM13032.

Melzer A. and Lamb D. (1994) Low density populations of the koala (*Phascolarctos cinereus*) in Central Queensland. *Proc. R. Soc. Qld*, **104**, 89-93.

Melzer A. and Lamb D. (1996) Habitat utilisation by central Queensland koala colony. In: *Koalas - Research for management* (editor G. Gordon). Proceedings of the Brisbane Koala Symposium, 22-23 September 1990. World Koala Research Incorporated, Brisbane.

Wilson, P.R. and Taylor, P.M. (2012) *Land zones of Queensland*. Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and Arts. Brisbane.

Table 1. A qualitative ranking of some common koala food species (5-high, 1-low, 0-not habitat)

Species	Ranking	Notes
Eucalypus camaldulensis	5	
Eucalyptus tereticornis	5	
Eucalyptus coolibah	5	Usually utilized as part of a larger koala landscape with a range of food species; one report of a mono-specific forest supporting a koala population, however.
Eucalyptus crebra/drepanophylla	4	These two species are considered as a single koala food entity.
Eucalyptus populnea	3	Consideration of land zone is important. In some situations this species is subject to seasonal water deficits and, hence cannot support a koala population. Generally consumed where the plant community abuts higher ranked koala RE's
Eucalyptus melanophloia	3	Consideration of land zone is important. In some situations this species is subject to dieback with seasonal water deficits and, hence cannot support a koala population.
Eucalyptus orgadophylla	3	Consideration of land zone is important. In some situations this species is subject to dieback with seasonal water deficits and, hence cannot support a

		koala population. Generally consumed where the plant community abuts higher ranked koala RE's
Eucalyptus platyphylla	3	Seasonally consumed, at times in large amounts. Generally consumed where the plant community abuts higher ranked koala RE's
Eucalyptus exserta	2	Highly preferred in captivity, availability limited in the wild
Eucalyptus mollucana	1	Eaten in captivity, not observed to be used in the wild
Lophostemon confertus	1	Seasonally consumed in trace amounts
Melaleuca spp.	1	Seasonally consumed in trace amounts

Appendix H: Field Survey Report for Matters of National Environmental Significance (SMEC, 2015)

Eton Range Realignment Project

Field Survey Report for Matters of National Environmental Significance

August 2015

IMPORTANT NOTICE

This report is confidential and is provided solely for the purposes of providing supplementary information on matters of national environmental significance for the Eton Range Realignment Project. This report is provided pursuant to a Consultancy Agreement between SMEC Australia Pty Limited ("SMEC") and Department of Transport and Main Roads under which SMEC undertook to perform a specific and limited task for Department of Transport and Main Roads. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

This report must be read as a whole. The executive summary is not a substitute for this. Any subsequent report must be read in conjunction with this report.

The report supersedes all previous draft or interim reports, whether written or presented orally, before the date of this report. This report has not and will not be updated for events or transactions occurring after the date of the report or any other matters which might have a material effect on its contents or which come to light after the date of the report. SMEC is not obliged to inform you of any such event, transaction or matter nor to update the report for anything that occurs, or of which SMEC becomes aware, after the date of this report.

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1. ABBREVIATIONS AND ACRONYMS

Table 1 Abbreviations and Acronyms

Abbreviation/ Acronym	Description
DBH	Diameter at Breast Height
DoE	Department of the Environment
EcoSM	Ecological Survey and Management
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ERRP	Eton Range Realignment Project
GPS	Geographical Positioning System
KSAT	Koala Spot Assessment Technique
MNES	Matter of National Environmental Significance
RE	Regional Ecosystem
SMEC	Snowy Mountains Engineering Corporation
TMR	Department of Transport and Main Roads

2. INTRODUCTION

2.1. Background

The Department of Transport and Main Roads (TMR) Mackay are currently managing the planning, procurement and construction of the Eton Range crossing, a realignment of Peak Downs Highway (33B) through Spencer's Gap between Ch. 49,800 – 53,062 m (herein referred to as the Eton Range Realignment Project (ERRP). The ERRP is located between Mackay and Nebo and comprises tight curves and a very steep grade, increasing 130m altitude in less than 1.5km of road. The realignment is aimed at improving safety, accessibility and freight efficiency on the Peak Downs Highway, particularly for future mining operations.

The ERRP involves the construction of two dual lane carriageways for approximately 1.7km, and the widening of the existing carriage to four lanes with 3m shoulders for approximately 1.2km.

Ecological investigations conducted during the design stage of the ERRP identified a Koala (*Phascolarctos cinereus*) population in the Project area. Koalas are listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and thereby constitute a matter of national environmental significance (MNES). As such, a significant impact on Koala populations, or any other MNES, as a result of the Project will trigger a referral to the Department of Environment (DoE) for assessment under EPBC Act.

Preliminary investigations and the preparation of a draft referral have been previously undertaken for the Project. This report and associated field work was commissioned to gather supplementary information on the MNES within the ERRP and surrounding area, largely with regards to the existing Koala population and activity levels through on-ground assessments and review of existing information. The results will assist with the quantification of potential impacts, development of mitigation measures and amendments to the referral documentation.

2.2. Justification for Supplementary Field Work

Additional field work was required to support the EPBC Referral for the following reasons:

- Ecological investigations and significant impact assessment conducted previously were undertaken prior to the release of the *EPBC Act referral guidelines for the vulnerable Koala*. The supplementary investigation was required to capture information gaps in accordance with these guidelines; and
- Surveys of the Koala population and suitable habitat for threatened species under the EPBC Act have not previously been undertaken outside the Project area. This is required to enable assessment of ERRP impacts at a regional scale.

3. METHDOLOGY

3.1. Desktop Assessment

A review of desktop information was conducted to identify gaps in the existing ERRP investigations. The review included the following sources:

- Existing studies undertaken for the Project;
- Desktop searches, including but not limited to, a Protected Matters Search under the EPBC Act, Wildlife Online search, Flora Survey Trigger Map and Remnant Vegetation Map to identify regional ecosystems (REs) present; and
- Any other literature relating to Koala populations in the vicinity of the ERRP and in non-urban areas.

The results of this assessment were provided to the field team to assist with the on-ground survey and also utilised to inform the assessment of threatened and migratory species under the EPBC Act against the significant impact criteria guidelines.

3.2. Field Investigation

A survey of the ERRP and vegetation immediately outside the proposed clearing area (herein referred to as the "Project Area") was conducted over two days on 14 and 15 July, 2015. The Koala Spot Assessment Technique (KSAT) was utilised to determine the presence/absence of Koalas across the Project Area (Phillips and Callaghan 2011). This method was selected as it provides data on the distribution of the Koala while providing an insight into the importance of different areas of use by assessing relative activity levels.

The number of KSATs conducted was determined on site, based on the site accessibility, vegetation condition and time availability. As such, ten (10) KSATs were conducted at representative locations across the Project area, including six impact sites and four control sites. These were located at approximate intervals of 200-300m, unless otherwise deemed appropriate e.g. where site conditions did not allow due to steep terrain. This approach was considered to systematically assess the clearing area and adjacent habitat while making no a priori assumptions about which areas may be used by the Koala and enabled both the steep escarpment and flatter ridgeline to be assessed. Moreover, the potential impacts of the ERRP are both habitat loss and the increased risk of vehicle strike which is a major source of Koala mortality. This systematic approach may provide a better indication of likely Koala road crossing points.

The KSAT methodology employed (Phillips and Callaghan, 2011) involves the selection of a focal tree (a koala habitat tree[1] or tree where Koalas are known to occur) at each KSAT site and surveying the nearest 29 Koala habitat trees as described below.

At each of the 30 trees, the base was searched within a 1m radius for two person-minutes or until a scat was identified, whichever came first. This included a visual search on top of the ground layer, followed by removal of the leaf litter if required. The GPS location of the site was determined and the species, height, diameter at breast height (DBH) and presence of Koalas was recorded for each tree.

Where 30 suitable trees were not present within the clearing footprint, or it was deemed otherwise appropriate, trees just outside the footprint were also surveyed. Surveying trees outside the footprint was considered necessary to provide an indication of general presence within the area and potential corridors of movement.

[1] Koala habitat trees are >4m tall or >10cm DBH from the genera *Eucalyptus, Angophora, Lophostemon, Corymbia and Melaleuca*

Photographs were taken to show the surrounding habitat. The standard KSAT datasheet used by SMEC requires a description of the vegetation community, including the dominant species, size and height of the vegetation.

Incidental observations of fauna or suitable habitat for other threatened species were noted, though no other MNES were specifically targeted during the survey.

4. RESULTS

4.1. Koala Activity Levels

No direct observations of Koalas were recorded during the survey. However, of the ten (10) KSATs conducted, nine (9) detected Koala scats, thereby indicating presence of Koala across the ERRP area. A summary of the results is provided in Table 2 and displayed in Figure 1 and Graph 1. Figure 1 (the sites are numbered 1-10 within the point symbol) also provides an indication of the level of activity (high, medium or low) determined for each site in accordance with the Phillips and Callaghan methodology. This is further discussed in Section 6.

KSAT 1, an impact site, detected the highest activity level of Koalas with 57% of the 30 trees determined to have scats within 1m of the tree base (Plate 1). The second highest activity level observed was within KSAT 4, a control site, with 40% of trees determined to have scats within 1m of the tree base. Data for all trees surveyed, including GPS location of each KSAT, is provided in Appendix A.

KSAT 5 is an isolated patch of vegetation which is to become the median strip between two proposed roads associated with the ERRP. Koala sightings had been reported in this vegetation previously, but recent evidence of Koalas is minimal. Scats were observed under a small percentage of trees, though they were largely considered to be older scats. However, relatively fresh scats were found under the White Mahogany (*Eucalyptus portuensis*) in which a Koala was previously observed, indicating that this tree continues to be used.

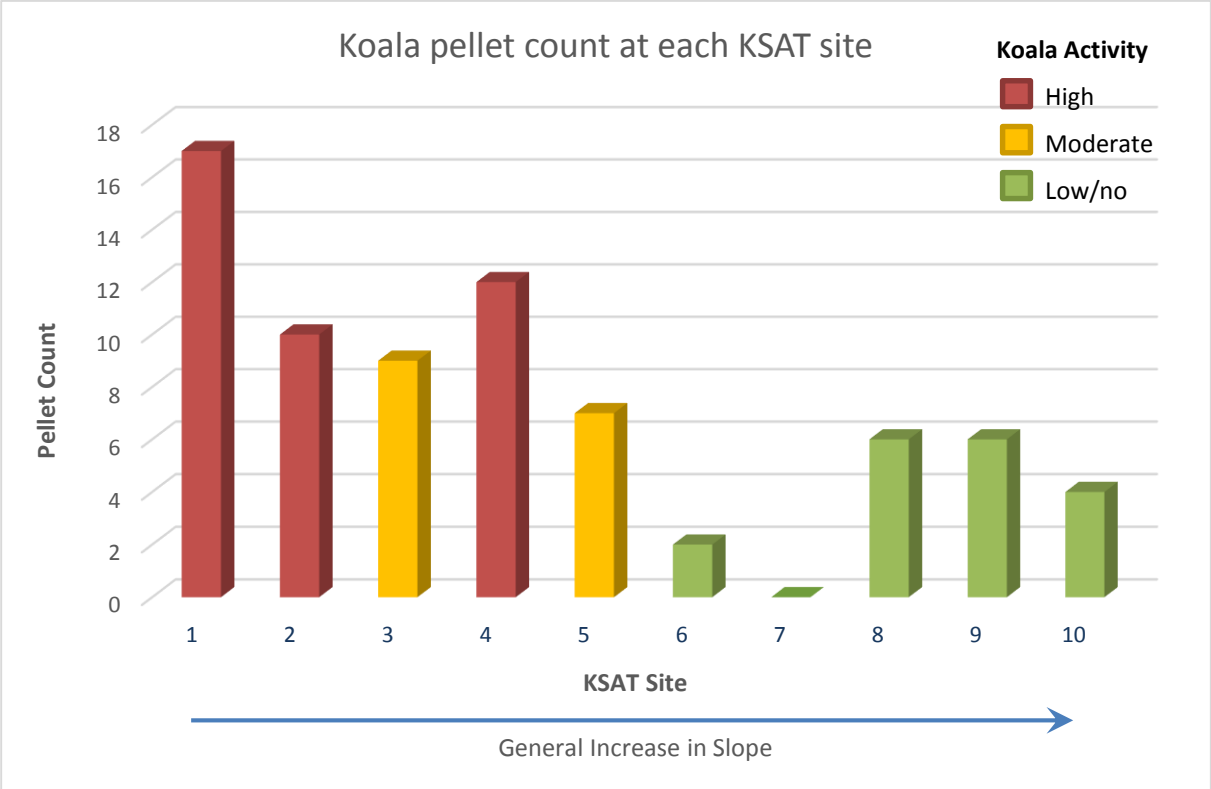
KSAT 7, the only KSAT in which scats were not detected, was the steepest slope of all sites, had a dense groundcover of Lantana (*Lantana camara*) and contained a limited diversity of Eucalypt species. A significant cover of Lantana was also noted across the western side of the existing Peak Downs Highway, observed in the majority of KSATs.

Across the ten (10) KSATs, scats were detected beneath a total of 73 trees. 29% of these were *Corymbia citriodora*, 26% were *Eucalyptus drepanophylla* and 23% were *Eucalyptus portuensis*. No scats were identified beneath *Eucalyptus platyphylla* which is a common species within the ERRP area.

The control sites were surveyed to provide an understanding of the Koala population outside the proposed footprint. A comparison of the mean activity level between impact and control sites found no variation; the mean activity level was calculated to be 24% activity for impact sites and 24% for control sites. Variation in Koala density was related to topography. Medium to high activity levels were found on gentle terrain, with activity declining eventually to zero as slope steepness increased (Figure 1). Representative site photographs are shown in Plates 2 – 5.

Table 2 KSAT Results Summary with activity level according to Phillips and Callaghan (2011) relative to a high density east coast population.

KSAT ID Number	Impact/Control	Number of Trees with Scats	Level of Activity (% of trees with scats)	Activity Level
1	Impact	17	57	High
2	Impact	10	33	High
3	Control	9	30	Medium
4	Control	12	40	High
5	Impact	7	23	Medium
6	Control	2	7	Low
7	Impact	0	0	Zero
8	Impact	6	20	Low
9	Control	6	20	Low
10	Impact	4	13	Low



Graph 1: Koala Pellet Count at each KSAT Site

Plate 1: Koala scats at the base of a *Eucalyptus drepanophylla* at KSAT 1.

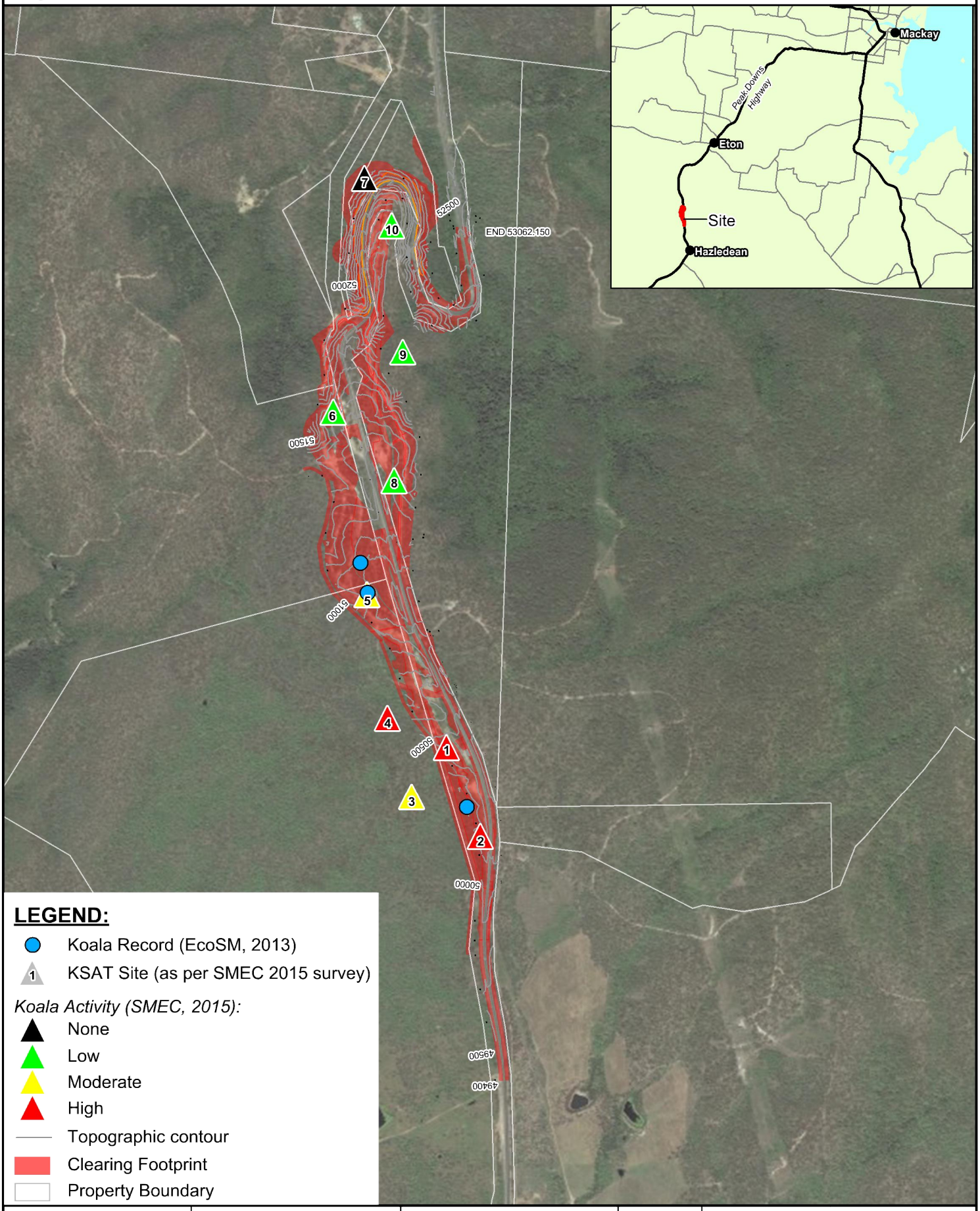
Plate 2: KSAT 3 showing undisturbed habitat typical of gentle topography (but noted the presence of *Lantana camara*) associated with medium to high activity levels.

Plate 3: Habitat remaining at KSAT 5, which will become isolated within the split road corridor.

Plate 4: KSAT 6 showing topography of increasing steepness associated with low activity levels.

Plate 5: KSAT 10 recorded low Koala activity; notice the very steep drop off to the left of photo.

Figure 1: KSAT results



LEGEND:

- Koala Record (EcoSM, 2013)
- 1 KSAT Site (as per SMEC 2015 survey)

Koala Activity (SMEC, 2015):

- None
- Low
- Moderate
- High
- Topographic contour
- Clearing Footprint
- Property Boundary

FIGURE Results	**PROJECT NO.** 30031488	0 250 500m	N	**CONSULTANT** SMEC Australia
CREATED BY AM11482	**PROJECT TITLE** ERRP EPBC	Scale: 1:15,000 @ A4		
REVISION 2				
STATUS FINAL	**COORDINATE SYSTEM** GDA 1994 MGA Zone 55			**CLIENT** DTMR
DATE 18/08/2015	**SOURCE** DEHP, Copyright 2015; Digital Globe Copyright 2015			
ISSUED FOR INFORMATION	**PATH** I:\Projects\MISCELLANEOUS PROJECTS\30031488\007_Spatial\Eton Range.wor			

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4.2. Assessment of Significance for EPBC Act listed Species

A likelihood of occurrence assessment has been undertaken for all species listed under the EPBC Act, as determined through the protected matters search tool. This returned a list of 25 threatened species, 13 migratory species (including those which are also threatened) and two (2) marine species within a 20km radius of the ERRP.

The likelihood of occurrence assessment has been taken from the Fauna Assessment Report (EcoSM, 2013) and amended as appropriate, based on further desktop assessment and observations in the field. This assessment is provided in Table 3. None of the threatened species provided in this list were directly observed during the recent field investigation. Potentially suitable habitat for two (2) species, in addition to the Koala, has been identified with these species being assigned a moderate likelihood of occurrence. These species are Grey-headed Flying-fox and the Northern Quoll.

A likelihood of occurrence assessment has also been undertaken for migratory and marine species, provided in Table 4. One (1) species, the Spectacled Monarch, has been identified on site previously (EcoSM, 2013) while four (4) others have been assigned either a moderate or high likelihood of occurrence.

Table 3 Threatened Species Likelihood of Occurrence Assessment (adapted from EcoSM, 2013)

Name of Species	EPBC Status	Habitat Requirements	Likelihood of Occurrence
Amphibians			
Eungella Day Frog *Taudactylus eungellensis*	E	Occurs in upland rainforest streams in the ranges west of Mackay, between Clarke Range and Finch Hatton Gorge. It inhabits exposed, steep sections within the splash zones of waterfalls and cascades (DoE 2015).	Low - This species is associated with streams in wet tropical rainforest, which do not occur within the ERRP area.
Birds			
Red Goshawk *Erythrotriorchis radiatus*	V	The Red Goshawk is generally found in open woodland, the edges of rainforest, and in dense riverine vegetation of coastal and subcoastal forests (Marchant and Higgins 1993). This species relies on tall trees for nesting and permanent water.	Low - The Red Goshawk may occasionally forage within the ERRP area, though the lack of permanent water suggest it is unlikely to nest in the area.
Australian Painted Snipe *Rostratula australis*	E	This species occurs in shallow, inland wetlands that are temporary or permanently inundated. This includes either fresh or brackish waters. It nests amongst vegetation near the waters edge.	Low – There is no suitable habitat for this species present in the ERRP area.
Squatter Pigeon *Geophaps scripta scripta*	V	This species inhabits open forests to sparse, open woodlands and scrub that contain *Eucalyptus, Corymbia, Acacia* or *Callitris* species and occur within 3km of water. These are typically remnant, regrowth of partly modified vegetation communities (DoE, 2015). It appears to favour sandy soil dissected with low gravely ridges and is less common on heavier soils with dense grass cover.	Low - This species may occasionally occur within the woodland vegetation types of the ERRP area, though the soil type is not typically sandy as required by the species.
Star Finch *Neochmia ruficauda ruficauda*	E	The Star finch occurs only in central Queensland, usually inhabiting low, dense damp grasslands bordering wetlands and waterways. In Queensland this species' range has largely contracted to the southern Cape	Low – There is no suitable habitat within the ERRP area.

Name of Species	EPBC Status	Habitat Requirements	Likelihood of Occurrence
		York. There have not been any confirmed records from the Cairns to Townsville region for some time and none were recorded during the Birds Australia Atlas project (Higgins *et. al.* 2006).	
Black-throated Finch *Poephila cincta cincta*	E	This species typically occurs in dry, open grassy woodlands and forests containing *Eucalyptus, Corymbia* and *Melaleuca* species, generally in the vicinity of water (DoE, 2015). It is also thought to require a mosaic of different habitat in the wet season to find seed (Mitchell 1996). This species has undergone a significant range contraction from the southern parts of its former distribution. It has not been recorded in south-east Queensland since the early 80s and is now thought to be extinct in NSW (Higgins *et al.* 2006).	Low - The ERRP area contains limited suitable habitat for this species as the correct forests are present, though they are not within the vicinity of water. This species has not previously been recorded in any of the regional ecosystems present across the ERRP area.
Masked Owl *Tyto novaehollandiae kimberli*	V	This species occurs in riparian forests, rainforest, open forest, *Melaleuca* swamps and mangroves in northern Australia (DoE, 2015). It is thought to only occur in three main populations across the Kimberley, Northern Territory and Cape York (Garnett *et al.* 2011).	Low – Some vegetation is potentially suitable habitat for this species, however there are no known records in the vicinity of the ERRP.
Mammals			
Northern Quoll *Dasyurus hallucatus*	E	The Northern Quoll is usually associated with dissected rocky escarpments but also known from eucalypt forest, sandy lowlands, grasslands, beaches and woodlands, around human settlement and occasionally rainforest. The areas where the Quoll persist in Queensland tend to be steep, rocky areas close to water that have not been recently burnt. Home range up to 35 ha.	**Moderate** – Vegetation and the rocky escarpments within the ERRP area suggest suitable habitat for Northern Quoll to occur. This species has previously been sighted in the surrounding area. Paucity of breeding habitat.
South-eastern Long-eared Bat *Nyctophilus timoriensis / corbeni*	V	In Queensland, this species is mainly in the Brigalow belt south bioregion. It inhabits various woodland vegetation types, including box and ironbark.	Low - This species is generally not considered to occur as far north as Mackay. The ERRP is outside the Brigalow Belt bioregion.
Koala *Phascolarctos cinereus*	V	This species is widespread in Sclerophyll forest and woodlands on foothills and plains on both sides of the Great Dividing Range from about Chillagoe, Queensland to Mt Lofty ranges in South Australia (Menkhorst and Knight 2011).	**Present -** This species was recorded at three locations in the Study area in regional ecosystem (RE) 8.12.7. All areas of the Study area, except RE 8.12.3 are considered to provide habitat for this species. No to low Koala activity levels (0% to 22.52%) were recorded along the steep slopes at the northern end of the Project and medium (22.53 - 32.84%)

Name of Species	EPBC Status	Habitat Requirements	Likelihood of Occurrence
			and high (>32.84%) activity levels were recorded at the southern end, where the terrain was more gentle.
Greater Large-eared Horseshoe Bat *Rhinolophus philippinensis (large form)*	E	This is restricted to a broad strip of coastal and near-coastal habitat in north-eastern Queensland from Iron Range on Cape York Peninsula south to Townsville. It may occur south of Townsville at Mt Elliot and Cape Cleveland. Habitat includes lowland rainforest along gallery forest-lined creeks within open eucalypt forest, *Melaleuca* forest with rainforest understorey and tall riparian woodland comprising *Eucalyptus tereticornis* and *Eucalyptus tessellaris* (DoE, 2015). Roosts in caves and possibly tree hollows, dense foliage and large bridge culverts (Van Dyck and Strahan 2008).	Low - The ERRP area is outside the known distribution of this species and there have been no records in the vicinity of the Project. Suitable habitat in the ERRP area is limited.
Grey-headed Flying-fox *Pteropus poliocephalus*	V	This species prefers forests with fruiting or flowering trees, and roosts in forest near water (including mangroves). Although the northern limit of the species range was previously thought to be Rockhampton, recent years have seen apparent range expansions as far north as Innisfail (CSIRO, 2015; DoE 2015.)	**Moderate** – Flowering trees, including winter flowering ironbarks, are present across the ERRP area which may be utilised for foraging. However water is not in close proximity to the site, therefore roosting is unlikely to occur.
Water Mouse *Xeromys myoides*	V	The Water Mouse is known in mangrove communities and adjacent sedgelands, grasslands and freshwater wetlands.	Low – There is no suitable habitat within the ERRP area.
Reptiles			
Yakka Skink *Egernia rugosa*	V	The Yakka Skink is a ground-dwelling reptile found in dry open forests, woodlands and rocky areas of the Brigalow Belt, landzones 9 and 10. It is often found under dead timber and in deep rock crevices (Wilson, 2005).	Low - This species is usually found further inland and from drier habitats.
Ornamental Snake *Denisonia maculata*	V	The Ornamental Snake is found in close association with frogs which form the majority of its prey. It prefers woodlands and open forests and Brigalow dominated vegetation communities. It is also associated with moist areas, particularly gilgai mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways (DoE, 2015).	Low – There is no Brigalow or gilgai habitat present in the ERRP area.
White-throated Snapping Turtle *Elseya albagula*	CE	This species is found only in the Fitzroy, Mary and Burnett Rivers and tributaries of these. It requires clear, flowing and well-oxygenated waters (TSSC, 2014).	Low – There is no suitable habitat present in the ERRP area.
Fitzroy River Turtle *Rheodytes leukops*	V	Known from the Fitzroy River and its tributaries (Cogger 2000).	Low - There is no suitable habitat for this species within the ERRP area.
Plants			

Name of Species	EPBC Status	Habitat Requirements	Likelihood of Occurrence
Three leaved-Bosistoa *Bosistoa transversa / selwynii*	V	This species is known to grow in lowland subtropical rainforest up to 300m in altitude.	Low – The ERRP area is largely absent of lowland subtropical rainforest.
Black Ironbox (*Eucalyptus raveretiana*)	V	Black Ironbox occurs on the banks of rivers, creeks and moderate sized watercourses on clayey or sandy loam. It is often associated with *Melaleuca leucadendra* and/or *Melaleuca fluviatils* fringing open forest. Endemic to Central and North Queensland and known from Nebo to Ayr and Aps Creek to Rockhampton (Halford 1997).	Low - Suitable habitat absent. No records within the immediate vicinity.
Holly-leaved Graptophyllum *Graptophyllum ilicifolium*	V	The populations of this species are localised, within Mount Blackwood and Mount Adder national parks and Mount Jukes. The habitat consists of tall to very tall mixed notophyll forest.	Low – The ERRP is outside the identified localities of this species.
Omphalea celata	V	Occurs along watercourses with steep sided gullies on granitic or heavily weathered metamorphic soils. *O. celata* has also been recorded in semi-evergreen vine thicket and vine forest. *Omphalea celata* is known from three sites in central east Queensland - Hazlewood Gorge, near Eungella; Gloucester Island, near Bowen; and Cooper Creek in the Homevale Station area, north-west of Nebo (TSSC, 2008).	Low – There are three known locations in central east Queensland, the closest record being 42km east in Homevale National Park (Atlas of Living Australia, 2015). There is no suitable habitat within the ERRP area.
Lesser Swamp-orchid *Phaius australis*	E	The swamp-orchid is found in coastal wet heath/sedgeland wetlands, swampy grasslands or swampy forests. Populations are largely across southern Queensland, with one population known near Rockhampton (DoE, 2015).	Low – No suitable habitat within the ERRP area.
Native Moth Orchid *Phalaenopsis rosenstromii*	E	This orchid occurs in humid rainforest areas, near waterfalls or streams, on sheltered slopes or gullies in notophyll vine thickets, deciduous vine thickets or in open forest (DoE, 2015).	Low – No suitable habitat within the ERRP area.
Cycas ophiolitica	E	*Cycas ophiolitica* grows on hills and slopes in sparse, grassy open forest at altitude ranges from 80–400 m above sea level. It is often found on sandstone and serpentinite in shallow, infertile soils. *Cycas ophiolitica* is endemic to Queensland, occurring from Marlborough to Rockhampton in central-eastern Queensland (DoE, 2015).	Low - Outside known distribution of this species. Nearest record is 136km south of project area (Atlas of Living Australia, 2015). There is no suitable habitat within the ERRP area.

Note: CE = Critically Endangered, E = Endangered, V = Vulnerable and NT = Near Threatened

Table 4 Likelihood of Occurrence Assessment for Migratory Species (adapted from EcoSM, 2013)

Species	EPBC Status	Habitat	Likelihood
Migratory Marine Birds			
Fork-tailed Swift *Apus pacificus*	Migratory and Marine	Aerial over open habitat sometimes over forests and cities (Pizzey *et al*. 2012).	Low – The ERRP area does not contain suitable open habitat for this species.
Migratory Marine Species			
Saltwater Crocodile *Crocodylus porosus*	Migratory and Marine	Occurs in coastal waters, estuaries, freshwater sections of lakes, inland swamps and marshes in all coastal areas north of Rockhampton, west to King Sound (near Broome) in Western Australia (DoE, 2015).	Low - The ERRP area does not contain suitable estuarine habitat for this species.
Migratory Terrestrial Species			
White-throated Needletail *Hirundapus caudacutus*	Migratory and Marine	Aerial over forests, woodlands, farmlands, plains, lakes and towns (Pizzey *et al.* 2012). Breeds in Asia.	**Moderate** - Likely to forage over the ERRP occasionally.
Barn Swallow *Hirundo rustica*	Migratory and Marine	Open forests, woodlands, grasslands, caves, ledges, offshore rocky islands, farmlands, grain stubbles, rail yards and towns, particularly near water. Occasionally roosts in old buildings. Is widespread in Australia and coastal islands (Pizzey *et al.* 2012).	Low – the ERRP area does not provide suitable open habitat or substantial waterbodies.
Rainbow Bee-eater *Merops ornatus*	Migratory and Marine	Woodlands, beaches, rainforest and mangroves (Pizzey *et al.* 2012).	**Moderate** - Suitable habitat is present in or immediately adjacent to the ERRP area.
Black-faced Monarch *Monarcha melanopsis*	Migratory and Marine	Rainforest, eucalypt woodlands and forest, coastal scrubs, rainforest gullies (Pizzey *et al.* 2012).	**High** – The ERRP area contains suitable habitat for this species.
Spectacled Monarch *Monarcha trivirgatus*	Migratory and Marine	Rainforest, thickly wooded gullies, waterside vegetation (Pizzey *et al.* 2012).	**Present** - This species was identified in the ERRP area during a bird survey in RE 8.12.3 (EcoSM, 2013).
Satin Flycatcher *Myiagra cyanoleuca*	Migratory and Marine	Heavily vegetated gullies in forests and taller woodlands and during migration coastal forests, woodlands, mangroves, gardens and open country (Pizzey *et al*. 2012).	**Moderate** – The ERRP area contains suitable habitat for this species, including heavily vegetated gullies.
Rufous Fantail *Rhipidura rififrons*	Migratory and Marine	Rainforest, wet eucalypt forests, monsoon forests, paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks (Pizzey *et al.* 2012).	**Moderate** - All vegetated areas within the ERRP area provide potentially suitable habitat for this species.
Migratory Wetlands Species			
Great Egret *Ardea alba*	Migratory and Marine	Shallows of rivers, estuaries, tidal mudflats, freshwater wetlands, sewage ponds, larger dams (Pizzey *et al.* 2012).	Low – the ERRP area does not contain suitable habitat for this species.

Cattle Egret *Ardea ibis*	Migratory and Marine	Stock paddocks, pastures, croplands, garbage dumps, wetlands, tidal mudflats and drains (Pizzey *et al*. 2012).	Low – The ERRP area does not contain suitable habitat for this species.
Latham's Snipe *Gallinago hardwickii*	Migratory and Marine	Soft wet ground or shallow water with tussocks, wet paddocks, seepage below dams, irrigated areas, scrub or open woodland (Pizzey *et al*. 2012).	Low – The ERRP area does not contain suitable habitat for this species.
Eastern Osprey *Pandion haliaetus*	Migratory and Marine	Coasts, estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs and lagoons (Pizzey *et al.* 2012).	Low – The ERRP area does not contain suitable habitat for this species.
Marine Species			
White-bellied Sea-eagle *Hiaeetus leucogaster*	Marine	Coasts, islands, estuaries, large rivers, lakes and reservoirs (Pizzey *et al*. 2012).	Low – The ERRP area does not contain suitable habitat for this species.
Magpie Goose *Anseranas semipalmata*	Marine	Large seasonal wetlands and well vegetated dams with rushes and sedges, wet grasslands and floodplains (Pizzey *et al.* 2012).	Low – The ERRP area does not contain suitable habitat for this species.

5. DISCUSSION

The KSAT methodology adopted from Phillips and Callaghan (2011) categorises the activity levels into low, medium (normal) or high use, based on the mean activity level. This is further broken down into activity categories, based on the density of the area. The ERRP area has been identified as an East Coast (med-high) use 'activity category', whereby the following categorisation of activity levels applies:

1. Low use = less than 22.52%;
2. Medium use = more than or equal to 22.52% and less than or equal to 32.84%; and
3. High use = more than 32.84%.

Within the ERRP area (the impact sites), three (3) KSATs were determined to have low use, one (1) had medium use while two (2) had high use. The control sites identified two (2) KSATs with low use, one (1) with medium use while one (1) had high use. One low activity site at each of the impact and control areas recorded a scat beneath 20% of trees, so they were close to the threshold of medium activity. This suggests that the Koala population extends across the ERRP area but also into adjacent habitat.

In general, the sites within the southern extent of the Project area recorded the highest Koala activity levels. The previous sightings of Koalas were also largely within this area of the ERRP which is relatively flat in elevation but has been recently subject to vegetation clearing due to trial embankment works. On the contrary, the northern extent of the Project area recorded the lowest evidence of Koala activity. These locations were also noted to have the steepest gradient.

Significant areas of Lantana, a declared pest, were observed across the western side of the existing Peak Downs Highway. Lantana has the potential to inhibit Koala access to the base of a tree, depending on the density of the weed invasion. Where Koala activity was lowest, Lantana was considered to be a contributing factor. As part of the mitigation and/or offsets for the ERRP, removal of weeds to improve the habitat value of vegetation adjacent to the realignment works should be considered.

With the exception of the vine thicket community represented by RE 8.12.3, the habitat across and adjacent to the ERRP area is suitable for Koalas. A significant portion of the vegetation is Eucalypt species and related genera. The entire ERRP area is therefore considered to be Koala habitat that will be removed for the Project. In addition, this vegetation has been identified as suitable habitat for several other threatened and migratory species, Grey-headed Flying-fox, Northern Quoll, Rufous Fantail, White-throated Needletail, Satin Flycatcher, Rainbow Bee-eater, Spectacled Monarch and Black-faced Monarch.

The proposed road realignment will adversely impact on Koala habitat, through the direct loss of habitat, creation of a barrier to movement and fragmentation of habitat patches between the old and new highway. Due to the life history of the Koala (long lived, slow breeding), small increases in mortality can have disproportionate effects on the viability of its populations. Although there appears to be large areas of similar habitat in the locality, the size of the Koala population is not known. Therefore, any factor that increases mortality should be of concern.

It is likely that Koalas cross the existing Peak Downs Highway, given that scats were observed on both sides of the Highway. There is a known koala movement corridor 10 km south-west of the project area where a significant number of koala fatalities have been recorded on a stretch of the Peak Downs Highway. However, based on Koala home range size (White 1999, Ellis *et al.* 2009, Mitchell 1990), it is unlikely that the Koala population in the Project Area would be crossing at that location. The important crossing points are expected to be in the flatter sections of the Highway at the top of the range (Ch 49,800 – 51, 200 m), where Koala activity levels were highest.

Fauna movement structures and associated furniture to assist in Koala movement should be considered as vehicle strike is a major source of Koala mortality. The installation of concrete barriers to prevent head-on collisions may inhibit Koala movement across the road and further contribute to

mortality. However, the concrete barriers will be installed in areas with a steep gradient and where speed limits will be restricted to 60km/hr. Prevett et al. (1995) found that road kills occurred where vehicle speed exceeded 80km/hr and where wider habitat corridors or linear forests occurred on both sides of the road. A large majority of the proposed road (Ch. 50900 – 53000 m northbound, Ch. 51500 – 53000 m southbound) will be restricted to 60km/hr due to the steep and winding nature of the alignment.

6. CONCLUSIONS

The results of the assessment indicate the Koala population occurs across the majority of the ERRP area and into adjacent habitat. Suitable habitat is present, previous sightings have been recorded and it is likely that Koalas move across the highway.

The proposed road realignment may adversely impact on the Koala population, through direct loss of habitat, creation of a barrier to movement, fragmentation of habitat patches between the old and new highway and the potential increased vulnerability to vehicle strike. The potential impacts of the Project on the Koala are expected to be significant and as such, a referral is to be prepared and submitted to DoE to determine whether the Project will constitute a 'controlled action'. The Project is not expected to result in significant impacts to any other MNES, though this is to be confirmed in the referral.

While the large areas of potential habitat for the Koala in the locality suggest that direct offsets in the immediate area are likely to be of marginal benefit, other mitigation measures should be considered and incorporated into the Project, such as opportunities for fauna movement structures at higher risk areas of the Peak Downs Highway and Lantana control.

7. REFERENCES

Cogger, H.G. (2000). *Reptiles and Amphibians of Australia* - 6th edition. Sydney, NSW: Reed New Holland.

CSIRO Land and Water Flagship (Westcott, D.A, Heersink D. K, McKeown, A and Caley, P) (2015). Status and Trends of Australia's EPBC-listed Flying-foxes. A report to the Commonwealth Department of Environment

Department of the Environment (2015). *Crocodylus porosus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:. Accessed Fri, 31 Jul 2015

Department of the Environment (2015). *Cycas ophiolitica* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Denisonia maculata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Geophaps scripta scripta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Phaius australis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Rhinolophus robertsi* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Taudactylus eungellensis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Department of the Environment (2015). *Tyto novaehollandiae kimberli* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 30 Jul 2015

Ecological Survey and Management (2013). *Eton Range Realignment Project – Fauna Assessment Report*. For Department of Transport and Main Roads, December 2013.

Ellis, W.A.H., Melzer, A. and Bercovitch, F.B. (2009) Spatiotemporal dynamics of habitat use by koalas: the checkerboard model. *Behavioral Ecology and Sociobiology* **63**: 1181-88.

Garnett, S., Szabo, J., Dutson, G. (2011) *The Action Plan for Australian Birds.*

Halford, D. (1997). *Eucalyptus raveretiana*. Species Management Profile. Flora and Fauna Information System. Brisbane: Queensland Department of Natural Resources.

Higgins, P.J., Peter, J.M. & Cowling, S.J., (2006). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 7 Boatbill to Starlings*, Oxford University Press, Melbourne.

Marchant, S. & Higgins, P.J., (1993). *Handbook of Australian, New Zealand & Antarctic Birds, Volume 2*, Oxford University Press, Melbourne.

Menkhorst, P. & Knight, F., (2011). *Field Guide to Mammals of Australia*, Oxford University Press, Melbourne.

Mitchell, P. (1990) The home ranges and social activity of koalas - a quantitative analysis. Pages 171-87 in A.K. Lee, K.A. Handasyde, and G.D. Sanson (Eds.) *Biology of the Koala*. Surrey Beatty and Sons, Sydney.

Mitchell, D.F. (1996). *Foraging Ecology of the Black-throated Finch Poephila cincta cincta*. M.Sc. Thesis. Townsville: James Cook University of North Queensland.

Pizzey, G., Knight, F. & Pizzey, S., (2012). *The Field Guide to the Birds of Australia*, HarperCollins Publishers, Sydney.

Phillips, S. and Callaghan, J. (2011). The *Spot Assessment Technique*: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*. *Zoologist* 35(3). Pp. 774-780

Prevett, P. T., Pope, R., Callaghan, J., and Bailey, L. The Management and Research of No-urban Koala Populations p 94-97. Central Queensland University

Threatened Species Scientific Committee (2014). Approved Conservation Advice for *Elseya albagula* (White Throated Snapping Turtle). http://www.environment.gov.au/biodiversity/threatened/species/pubs/81648-conservation-advice.pdf

Threatened Species Scientific Committee (2008). Approved Conservation Advice for *Omphalea celata*. Approved on 16/12/2008.

Van Dyck, S. & Strahan, R., (2008). *The Mammals of Australia*, New Holland Publishers, Sydney.

White, N.A. (1999) Ecology of the koala (*Phascolarctos cinereus*) in rural south-east Queensland, Australia. *Wildlife Research* **26**: 731-44.

Wilson, S.K. & D.G. Knowles (1988). *Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia*. Australia: Collins Publishers.

APPENDIX A SURVEY RESULTS

KSAT no.	Tree no.	Species	Ht(m)	DBH(cm)	Scats Observed
1	1	*Corymbia citriodora*	20	25	X
1	2	*Eucalyptus exserta*	18	25	X
1	3	*Corymbia citriodora*	18	30	
1	4	*Corymbia citriodora*	16	15	
1	5	*Corymbia citriodora*	20	30	
1	6	*Corymbia citriodora*	16	15	
1	7	*Eucalyptus exserta*	10	10	
1	8	*Eucalyptus exserta*	13	15	
1	9	*Corymbia citriodora*	22	30	X
1	10	*Corymbia citriodora*	17	20	X
1	11	*Corymbia trachyphloia*	9	20	X
1	12	*Corymbia trachyphloia*	9	20	X
1	13	*Eucalyptus drepanophylla*	25	40	X
1	14	*Eucalyptus drepanophylla*	20	40	X
1	15	*Lophostemon suaveolens*	9	20	
1	16	*Corymbia citriodora*	20	30	
1	17	*Lophostemon suaveolens*	9	25	
1	18	*Corymbia citriodora*	28	30	
1	19	*Lophostemon suaveolens*	10	15	
1	20	*Corymbia citriodora*	20	20	
1	21	*Corymbia trachyphloia*	20	20	X
1	22	*Eucalyptus drepanophylla*	18	20	X
1	23	*Eucalyptus exserta*	13	90	X
1	24	*Lophostemon suaveolens*	15	45	X
1	25	*Corymbia citriodora*	28	30	X
1	26	*Eucalyptus drepanophylla*	9	15	X
1	27	*Corymbia citriodora*	17	20	X
1	28	*Eucalyptus portuensis*	25	30	X

1	29	*Lophostemon confertus*	15	30	
1	30	*Eucalyptus portuensis*	18	35	X
2	1	*Corymbia clarksoniana*	12	20	
2	2	*Eucalyptus drepanophylla*	25	35	
2	3	*Corymbia citriodora*	22	25	
2	4	*Corymbia citriodora*	33	50	
2	5	*Eucalyptus drepanophylla*	15	25	X
2	6	*Corymbia clarksoniana*	8	15	
2	7	*Eucalyptus drepanophylla*	27	30	
2	8	*Corymbia clarksoniana*	20	30	
2	9	*Corymbia citriodora*	22	35	
2	10	*Corymbia citriodora*	9	15	
2	11	*Eucalyptus exserta*	7	20	
2	12	*Eucalyptus exserta*	8	15	
2	13	*Corymbia citriodora*	17	30	
2	14	*Eucalyptus portuensis*	18	45	X
2	15	*Eucalyptus portuensis*	15	30	X
2	16	*Corymbia citriodora*	15	15	
2	17	*Corymbia citriodora*	28	40	X
2	18	*Eucalyptus exserta*	22	50	X
2	19	*Corymbia citriodora*	14	15	X
2	20	*Corymbia citriodora*	17	20	
2	21	*Corymbia citriodora*	35	60	X
2	22	*Corymbia citriodora*	30	55	
2	23	*Corymbia citriodora*	18	20	
2	24	*Eucalyptus exserta*	16	45	
2	25	*Corymbia citriodora*	18	20	
2	26	*Corymbia citriodora*	18	20	X
2	27	*Melaleuca quinquenervia*	9	20	

2	28	*Corymbia citriodora*	22	25	
2	29	*Eucalyptus drepanophylla*	18	40	X
2	30	*Eucalyptus exserta*	14	40	X
3	1	*Corymbia citriodora*	15	15	X
3	2	*Corymbia clarksoniana*	17	25	X
3	3	*Corymbia citriodora*	18	25	
3	4	*Corymbia citriodora*	30	45	
3	5	*Corymbia citriodora*	33	40	
3	6	*Lophostemon suaveolens*	10	15	
3	7	*Corymbia citriodora*	23	45	
3	8	*Corymbia citriodora*	35	40	X
3	9	*Lophostemon suaveolens*	10	20	X
3	10	*Corymbia citriodora*	17	20	X
3	11	*Corymbia citriodora*	35	65	
3	12	*Corymbia citriodora*	8	15	
3	13	*Corymbia citriodora*	22	20	
3	14	*Eucalyptus drepanophylla*	17	20	X
3	15	*Corymbia citriodora*	31	35	
3	16	*Corymbia citriodora*	18	20	
3	17	*Corymbia citriodora*	27	25	
3	18	*Corymbia citriodora*	30	20	
3	19	*Corymbia clarksoniana*	18	25	
3	20	*Corymbia citriodora*	32	35	
3	21	*Corymbia clarksoniana*	8	15	
3	22	*Corymbia citriodora*	15	15	
3	23	*Eucalyptus drepanophylla*	15	25	X
3	24	*Corymbia citriodora*	18	20	X
3	25	*Corymbia citriodora*	18	20	
3	26	*Corymbia citriodora*	16	20	

3	27	*Corymbia citriodora*	25	30	X
3	28	*Corymbia citriodora*	16	15	
3	29	*Eucalyptus drepanophylla*	25	30	
3	30	*Corymbia citriodora*	26	30	
4	1	*Eucalyptus platyphylla*	15	20	
4	2	*Eucalyptus platyphylla*	8	20	
4	3	*Eucalyptus drepanophylla*	15	25	X
4	4	*Corymbia citriodora*	18	25	
4	5	*Corymbia citriodora*	18	25	
4	6	*Corymbia citriodora*	9	15	
4	7	*Corymbia citriodora*	25	45	
4	8	*Corymbia citriodora*	20	25	
4	9	*Corymbia citriodora*	17	35	
4	10	*Eucalyptus exserta*	15	20	X
4	11	*Eucalyptus exserta*	18	30	X
4	12	*Eucalyptus drepanophylla*	20	45	X
4	13	*Eucalyptus drepanophylla*	25	40	
4	14	*Eucalyptus drepanophylla*	15	15	X
4	15	*Corymbia citriodora*	18	20	X
4	16	*Eucalyptus drepanophylla*	19	25	
4	17	*Eucalyptus exserta*	10	25	X
4	18	*Eucalyptus drepanophylla*	16	20	X
4	19	*Eucalyptus exserta*	12	20	
4	20	*Corymbia citriodora*	25	30	X
4	21	*Eucalyptus drepanophylla*	18	20	X
4	22	*Eucalyptus drepanophylla*	15	20	
4	23	*Eucalyptus drepanophylla*	28	35	X
4	24	*Eucalyptus exserta*	12	16	
4	25	*Eucalyptus drepanophylla*	18	20	

4	26	*Eucalyptus drepanophylla*	26	45	X
4	27	*Lophostemon suaveolens*	14	50	
4	28	*Lophostemon suaveolens*	15	45	
4	29	*Lophostemon suaveolens*	15	30	
4	30	*Lophostemon suaveolens*	16	25	
5	1	*Corymbia citriodora*	28	35	
5	2	*Corymbia citriodora*	25	45	X
5	3	*Eucalyptus drepanophylla*	12	20	
5	4	*Corymbia citriodora*	10	20	
5	5	*Corymbia clarksoniana*	23	30	
5	6	*Eucalyptus drepanophylla*	25	50	X
5	7	*Eucalyptus exserta*	18	30	
5	8	*Corymbia citriodora*	17	20	X
5	9	*Corymbia citriodora*	33	35	
5	10	*Eucalyptus drepanophylla*	22	25	X
5	11	*Corymbia citriodora*	18	25	
5	12	*Corymbia clarksoniana*	25	30	
5	13	*Eucalyptus drepanophylla*	18	20	
5	14	*Eucalyptus exserta*	15	25	
5	15	*Eucalyptus portuensis*	32	75	X
5	16	*Eucalyptus portuensis*	30	40	X
5	17	*Corymbia citriodora*	12	20	
5	18	*Eucalyptus portuensis*	18	20	
5	19	*Eucalyptus portuensis*	8	15	
5	20	*Corymbia citriodora*	18	15	
5	21	*Eucalyptus exserta*	10	15	
5	22	*Eucalyptus drepanophylla*	18	25	
5	23	*Corymbia citriodora*	30	25	
5	24	*Eucalyptus exserta*	10	15	

5	25	*Corymbia citriodora*	25	35	
5	26	*Eucalyptus exserta*	16	25	
5	27	*Eucalyptus exserta*	25	25	X
5	28	*Eucalyptus exserta*	8	15	
5	29	*Corymbia citriodora*	7	10	
5	30	*Eucalyptus exserta*	10	20	
6	1	*Corymbia citriodora*	38	45	X
6	2	*Eucalyptus portuensis*	18	30	X
6	3	*Lophostemon confertus*	18	35	
6	4	*Lophostemon confertus*	12	35	
6	5	*Eucalyptus portuensis*	10	15	
6	6	*Eucalyptus portuensis*	8	30	
6	7	*Corymbia citriodora*	35	55	
6	8	*Eucalyptus portuensis*	14	35	
6	9	*Corymbia citriodora*	20	25	
6	10	*Eucalyptus platyphylla*	10	15	
6	11	*Corymbia clarksoniana*	12	15	
6	12	*Corymbia clarksoniana*	8	20	
6	13	*Eucalyptus platyphylla*	10	15	
6	14	*Eucalyptus platyphylla*	10	25	
6	15	*Eucalyptus platyphylla*	9	20	
6	16	*Eucalyptus platyphylla*	12	20	
6	17	*Corymbia citriodora*	18	20	
6	18	*Eucalyptus exserta*	17	20	
6	19	*Corymbia clarksoniana*	8	15	
6	20	*Eucalyptus platyphylla*	8	15	
6	21	*Corymbia citriodora*	22	20	
6	22	*Corymbia citriodora*	18	15	
6	23	*Eucalyptus platyphylla*	9	15	

6	24	*Corymbia citriodora*	30	35	
6	25	*Corymbia citriodora*	18	25	
6	26	*Eucalyptus exserta*	18	20	
6	27	*Eucalyptus drepanophylla*	22	25	
6	28	*Corymbia citriodora*	12	20	
6	29	*Eucalyptus platyphylla*	7	15	
6	30	*Corymbia citriodora*	25	45	
7	1	*Corymbia tessellaris*	22	25	
7	2	*Eucalyptus platyphylla*	20	40	
7	3	*Eucalyptus platyphylla*	8	15	
7	4	*Eucalyptus platyphylla*	15	25	
7	5	*Eucalyptus platyphylla*	20	35	
7	6	*Eucalyptus platyphylla*	15	20	
7	7	*Eucalyptus platyphylla*	20	45	
7	8	*Eucalyptus platyphylla*	10	15	
7	9	*Corymbia tessellaris*	18	15	
7	10	*Eucalyptus platyphylla*	22	95	
7	11	*Corymbia tessellaris*	30	25	
7	12	*Corymbia tessellaris*	12	20	
7	13	*Corymbia tessellaris*	35	30	
7	14	*Corymbia tessellaris*	10	15	
7	15	*Corymbia clarksoniana*	20	65	
7	16	*Corymbia clarksoniana*	20	40	
7	17	*Eucalyptus platyphylla*	15	35	
7	18	*Eucalyptus platyphylla*	17	30	
7	19	*Corymbia tessellaris*	15	30	
7	20	*Corymbia tessellaris*	35	40	
7	21	*Corymbia tessellaris*	18	20	
7	22	*Corymbia tessellaris*	10	15	

7	23	*Eucalyptus platyphylla*	16	25	
7	24	*Corymbia tessellaris*	38	50	
7	25	*Eucalyptus platyphylla*	8	15	
7	26	*Corymbia clarksoniana*	20	30	
7	27	*Eucalyptus platyphylla*	15	30	
7	28	*Corymbia tessellaris*	16	30	
7	29	*Corymbia tessellaris*	15	15	
7	30	*Corymbia clarksoniana*	20	35	
8	1	*Corymbia citriodora*	20	40	
8	2	*Corymbia citriodora*	12	25	
8	3	*Eucalyptus exserta*	22	35	
8	4	*Eucalyptus portuensis*	12	30	
8	5	*Eucalyptus exserta*	26	50	
8	6	*Eucalyptus drepanophylla*	30	35	X
8	7	*Eucalyptus exserta*	22	35	
8	8	*Eucalyptus exserta*	17	25	
8	9	*Eucalyptus portuensis*	18	20	X
8	10	*Eucalyptus exserta*	10	20	
8	11	*Corymbia citriodora*	30	25	
8	12	*Eucalyptus exserta*	15	30	
8	13	*Eucalyptus exserta*	20	25	
8	14	*Eucalyptus exserta*	16	20	
8	15	*Corymbia citriodora*	28	30	
8	16	*Eucalyptus drepanophylla*	26	35	
8	17	*Eucalyptus drepanophylla*	25	30	
8	18	*Eucalyptus portuensis*	20	45	
8	19	*Eucalyptus portuensis*	18	20	
8	20	*Eucalyptus drepanophylla*	22	40	
8	21	*Eucalyptus drepanophylla*	35	40	

8	22	*Eucalyptus exserta*	15	20	
8	23	*Corymbia citriodora*	32	30	
8	24	*Eucalyptus portuensis*	15	30	X
8	25	*Corymbia citriodora*	30	40	X
8	26	*Eucalyptus drepanophylla*	28	30	
8	27	*Eucalyptus exserta*	15	25	X
8	28	*Eucalyptus exserta*	25	30	
8	29	*Corymbia citriodora*	25	25	
8	30	*Eucalyptus portuensis*	22	40	X
9	1	*Eucalyptus portuensis*	24	60	
9	2	*Corymbia citriodora*	25	20	
9	3	*Eucalyptus portuensis*	14	15	
9	4	*Corymbia citriodora*	25	45	
9	5	*Eucalyptus drepanophylla*	20	45	
9	6	*Eucalyptus portuensis*	18	20	
9	7	*Eucalyptus portuensis*	25	45	
9	8	*Eucalyptus portuensis*	22	50	
9	9	*Eucalyptus exserta*	12	25	X
9	10	*Eucalyptus drepanophylla*	25	50	
9	11	*Corymbia citriodora*	30	25	
9	12	*Corymbia clarksoniana*	10	20	
9	13	*Corymbia citriodora*	28	25	X
9	14	*Eucalyptus portuensis*	25	50	X
9	15	*Eucalyptus portuensis*	18	20	
9	16	*Corymbia citriodora*	35	30	
9	17	*Eucalyptus portuensis*	18	20	
9	18	*Lophostemon confertus*	8	20	
9	19	*Eucalyptus portuensis*	17	25	X
9	20	*Eucalyptus portuensis*	20	40	

9	21	*Eucalyptus drepanophylla*	16	25	X
9	22	*Eucalyptus drepanophylla*	25	25	
9	23	*Eucalyptus drepanophylla*	22	30	
9	24	*Eucalyptus drepanophylla*	20	25	
9	25	*Eucalyptus portuensis*	28	50	
9	26	*Eucalyptus portuensis*	28	55	X
9	27	*Corymbia citriodora*	35	40	
9	28	*Eucalyptus portuensis*	25	30	
9	29	*Eucalyptus portuensis*	28	45	
9	30	*Corymbia clarksoniana*	18	45	
10	1	*Eucalyptus portuensis*	30	35	
10	2	*Eucalyptus portuensis*	18	20	
10	3	*Eucalyptus portuensis*	28	30	
10	4	*Eucalyptus portuensis*	30	70	
10	5	*Eucalyptus portuensis*	12	15	
10	6	*Eucalyptus portuensis*	23	25	
10	7	*Eucalyptus portuensis*	18	20	X
10	8	*Eucalyptus portuensis*	18	25	X
10	9	*Eucalyptus platyphylla*	15	20	
10	10	*Eucalyptus portuensis*	18	25	X
10	11	*Eucalyptus portuensis*	18	50	
10	12	*Eucalyptus portuensis*	20	80	
10	13	*Eucalyptus portuensis*	12	20	
10	14	*Lophostemon confertus*	12	35	
10	15	*Eucalyptus portuensis*	12	15	
10	16	*Eucalyptus platyphylla*	10	25	
10	17	*Eucalyptus portuensis*	20	30	
10	18	*Eucalyptus platyphylla*	10	20	
10	19	*Lophostemon confertus*	10	25	

10	20	*Eucalyptus portuensis*	24	45	
10	21	*Eucalyptus portuensis*	12	20	
10	22	*Eucalyptus portuensis*	14	15	X
10	23	*Lophostemon confertus*	8	40	
10	24	*Corymbia tessellaris*	13	20	
10	25	*Corymbia citriodora*	38	95	
10	26	*Eucalyptus portuensis*	28	40	
10	27	*Eucalyptus portuensis*	30	70	
10	28	*Eucalyptus portuensis*	9	25	
10	29	*Eucalyptus platyphylla*	7	12	
10	30	*Eucalyptus portuensis*	22	35	

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01	31/07/15	K. Meldrum	D. Sharpe A. Marsden	J. Alexander
02	14/08/15	A. Marsden	J. Alexander	J. Alexander

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Appendix I: Direct Offsets Assessment

Project area

Habitat Site Assessment Unit (EcoSM, 2013)	Mapped RE Present (EcoSM, 2013)	Koala habitat 'Importance' score (Melzer, 2015)	Modified BioCondition Score	Individual BioCondition Scores for Landscape Attributes			Lack of Threats[1] (Max Score = 10)	KSAT Results (SMEC, 2015	**Site Condition[2]**	**Site Context[3]**	**Species Stocking Rate[4]**	**Total Habitat Quality Score**
				Size of Patch (Max Score = 10)	*Connectivity* (Max Score = 5)	*Context* (Max Score = 5)						
HAB1	8.12.12	5	2	10	5	5	2	KSAT 7 = 0%	10	7.33	1	6.11
HAB3	8.12.7	4	2	10	5	5	2	KSAT 9 = 20%	8	7.33	3	6.11
HAB7	8.12.5	4	2	10	5	5	2	KSAT 10 = 13%	8	7.33	3	6.11
HAB8	8.12.7	4	2	10	5	5	2	KSAT 8 = 20%	8	7.33	3	6.11
HAB9	8.12.7	4	2	10	5	5	2	KSAT 5 = 23%	8	7.33	4	6.44
HAB10	8.12.12	5	3	10	5	5	2	KSAT 9 = 20%	9	7.33	3	6.44
HAB11	8.12.7	4	2	10	5	5	2	KSAT 6 = 7%	8	7.33	1	5.44
HAB12	8.12.7	4	2	10	5	5	2	KSAT 5 = 23%	8	7.33	4	6.44
HAB13	8.12.7	4	3	10	5	5	2	KSAT 2 = 33%	7	7.33	8	7.44
HAB14	8.12.7	4	4	10	5	5	2	KSAT 4 = 40%	7	7.33	9	7.78
HAB16	8.12.7	4	4	10	4	4	2	KSAT 2 = 33%	7	6.67	8	7.22
HAB17	8.12.7	4	2	10	5	5	2	KSAT 1 = 57%	8	7.33	10	8.44

Average	6.68
Total Averaged Habitat Quality Score	7

[1] Threats considered include fragmentation of habitat, vehicle strike, predation by dogs, weed incursion and bushfires. All assessement units exist immediately adjacent to the existing Peak Downs Highway which currently has no fauna sensitive mitigation. Habitat is fragemented by this existing infrastructure. Wild dogs are known to inhabit the area as identified in EcoSM's 2013 Assessment. A standard score of 2 has therefore been applied across all assessment sites

[2] Site Condition has been determined using Table 5

[3] Site Context Score =[((Size of Patch+Connectivity+Context+Lack of Threats)$_{measured}$)/(Size of Patch+Connectivity+Context+Lack of Threats)$_{max}$]×10

[4] Species Stocking Rate has been determined using Table 6

Offset Site Area

Habitat Site Assessment Unit (Kleinfelder, 2015)	Mapped RE Present (Kleinfelder, 2015)	Koala habitat 'Importance' score (Melzer, 2015b)	Modified BioCondition Score	Individual BioCondition Scores for Landscape Attributes				KSAT Results (Kleinfelder, 2015)	**Site Condition[2]**	**Site Context[3]**	**Species Stocking Rate[4]**	**Total Habitat Quality Score**
				Size of Patch (Max Score = 10)	*Connectivity* (Max Score = 5)	*Context* (Max Score = 5)	Lack of Threats[1] (Max Score = 10)					
Q3	11.12.3	5	4	10	4	4	5	KSAT 3 = 37%	9	7.67	8	8.22
Q4	11.3.9	4	2	10	4	4	5	KSAT 4 = 7%	8	7.67	2	5.89
Q5	11.3.25	4	2	10	4	4	5	KSAT 5 = 30%	8	7.67	6	7.22
Q6	11.12.3/11.3.4/11.3.9	4	2	10	4	4	5	KSAT 6 = 43%	8	7.67	9	8.22
								Average	8.25	7.67	6.25	

[1] Threats considered include fragmentation of habitat, vehicle strike, predation by dogs, weed incursion and bushfires. A standard score of 5 has been applied across all assessment sites due to the threats identified in the ecological assessment of the site (Kleinfelder, 2015).

[2] Site Condition has been determined using Table 5

[3] Site Context Score =[((Size of Patch+Connectivity+Context+Lack of Threats)$_{measured}$)/(Size of Patch+Connectivity+Context+Lack of Threats)$_{max}$]×10

[4] Species Stocking Rate has been determined using Table 6

Total Average	7.39
Habitat Quality	7

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Koala low
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes		**Area**	30.87	Hectares	Field Verified, GIS Mapping
			Quality	**7**	Scale 0-10	
			Total quantum of impact	21.61	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	21.61	Adjusted hectares	Land Owned by TMR	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	75.17	**Risk of loss (%) without offset**	50%	**Risk of loss (%) with offset**	0%	37.59	80%	30.07	28.89	23.23	107.51%	Yes	$195,000.00	
									Future area without offset (adjusted hectares)	37.6	**Future area with offset (adjusted hectares)**	75.2								
					Time until ecological benefit	0	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**7**	1.00	80%	0.80	0.80				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	21.6069	23.23	107.51%	**Yes**	$195,000.00	N/A	$195,000.00
Area of community	0				$0.00		$0.00
					$195,000.00	**$0.00**	**$195,000.00**