White Rock

Koala Management Plan

Prepared for
Ripley Land Holdings Pty Ltd, Northrow (Qld) Pty Ltd and TDC (Qld) Pty Ltd (the proponents)

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Contents

List of figures

List of tables

Abbreviations

Abbreviation	Description
DEHP	Department of Environment and Heritage, Queensland
DotEE	Commonwealth Department of the Environment and Energy
EAR	Ecological Assessment Report
ELA	Eco Logical Australia
EPZ	Environmental Protection Zone
KFTs	Koala Food Trees
KMP	Koala Management Plan
PDA	Priority Development Area

1 Introduction

1.1 Background

This Koala Management Plan has been prepared in support of assessment requirements under the *Environment Protection and Biodiversity Act 1999*.

1.2 Purpose of this report

As the White Rock project is expected to result in an impact to Koala due to construction and ongoing use of the area, the Koala Management Plan has been prepared to:

- **Avoid impacts**: Describe what measures have been included in the design of the project to avoid and minimise impact on koala;
- **Mitigate impacts**: Describe environmental management that will be undertaken during construction to further reduce the impact to koala; as well as on-going measures once the residential estate is established.
- **Offset impacts**: Describe the purpose and proposed management of the koala offset area, which is planned to be established to the north and east of the project.

As well as describing the ecology of the koala for context, this Koala Management Plan also describes management measures, offset measures, key performance indicators, monitoring, reporting and review requirements, and implementation responsibilities.

1.3 Environmental Setting

White Rock is located in the Ripley Valley south of Centenary Highway. It is located 35 km from the Brisbane CBD, 15km from the Ipswich CBD, 4km east of the Ripley urban core and 8 km west from the Springfield Town Centre.

Ripley Valley has also been identified as a PDA under the *Economic Development Act 2012* (Qld). Currently there are plans for the area to be developed into a master planned urban community within the next 20 years and the Queensland Government has released the *Ripley Valley PDA Development Scheme* to guide development in the PDA. Large areas of urban development are now either being planned or constructed, or have been completed in the PDA.

Ripley Valley is also identified in the *South-East Queensland Regional Plan 2009-2031* as a Regional Development Area, and the PDA will significantly support the needs for approximately 118,000 dwellings within the Ipswich City Council local government area by 2031. The development at White Rock is a key component of this long-term growth plan.

Areas within the PDA are zoned as future urban purposes as well as conservation. The conservation zoning is also referred to in the Ripley Valley PDA Development Scheme as the Environmental Protection Zone (EPZ). The conservation areas were put aside as part of a strategic exercise to identify areas of environmental value during PDA planning.

Currently, the project area contains a combination of remnant and regrowth vegetation as well pasture in western sections of the project area. The areas of vegetation are not subject to management for

conservation. The cleared areas are subject to light grazing by several horses, though no intensive grazing activities occur.

2 Project Description

2.1 Project Overview

A detailed description of the project is provided in the Urban Design Report (Roberts Day 2017).

The White Rock development includes five subject lots, which themselves cover a total of 472 ha (**Figure 1**). Three of the subject lots (Lot 2 SP130834, Lot 174 S31238 and Lot 181 S313342) are within the Ripley Valley PDA.

The proposed development covers 223 ha and will result in number of end uses, including residential, commercial, industrial, greenspace, recreation/sporting, educational, roads and easements for internal services. Each component of the development is described within the EPBC Act Preliminary Documentation Report

The development staging at White Rock is currently being finalised, however current plans involve seven stages that will be informed by an estimated lot sales rate of 200 lots/year. The first stage will include the northern access road and the first 200 lots in the north-west of the mixed-use development area. Further stages will progress south, with the final (stage seven) development including the neighbourhood centre.

Two potential development areas are also proposed, both located on Lot 189 SP199797, which is located outside of the Ripley Valley PDA (see Figure 1 and Figure 2). The two areas are comprised of a potential additional urban development area and a potential industrial development area. As the lot is located outside of the PDA and is zoned as Rural/Constrained, the future development will have to go through a rezoning process and separate development application process to allow for the development to occur.

Upgrade works to Barrams Road are planned to be undertaken after the first 200 lots are sold; though these works will be dependent on negotiations with adjacent developments.

2.2 The Project Area

Figure 2 shows the location of the project area. The 'project area' refers to the development footprint of the project. This includes the footprints of the mixed use development area, northern access road, potential urban development area, potential industrial area and proposed recreation trails.

The project area is bounded to the north by the Centenary Highway. The area to the west of the project area has been cleared for agricultural purposes in lowland areas and is likely to transition into urban development in the coming years as part of the Ripley Valley PDA (as mentioned in **Section 2.1**). Remnant vegetation continues to the east of the boundary into White Rock - Spring Mountain Conservation Estate, which is part of a large contiguous area of vegetation associated with the Flinders Karawatha Corridor (DEHP 2014).

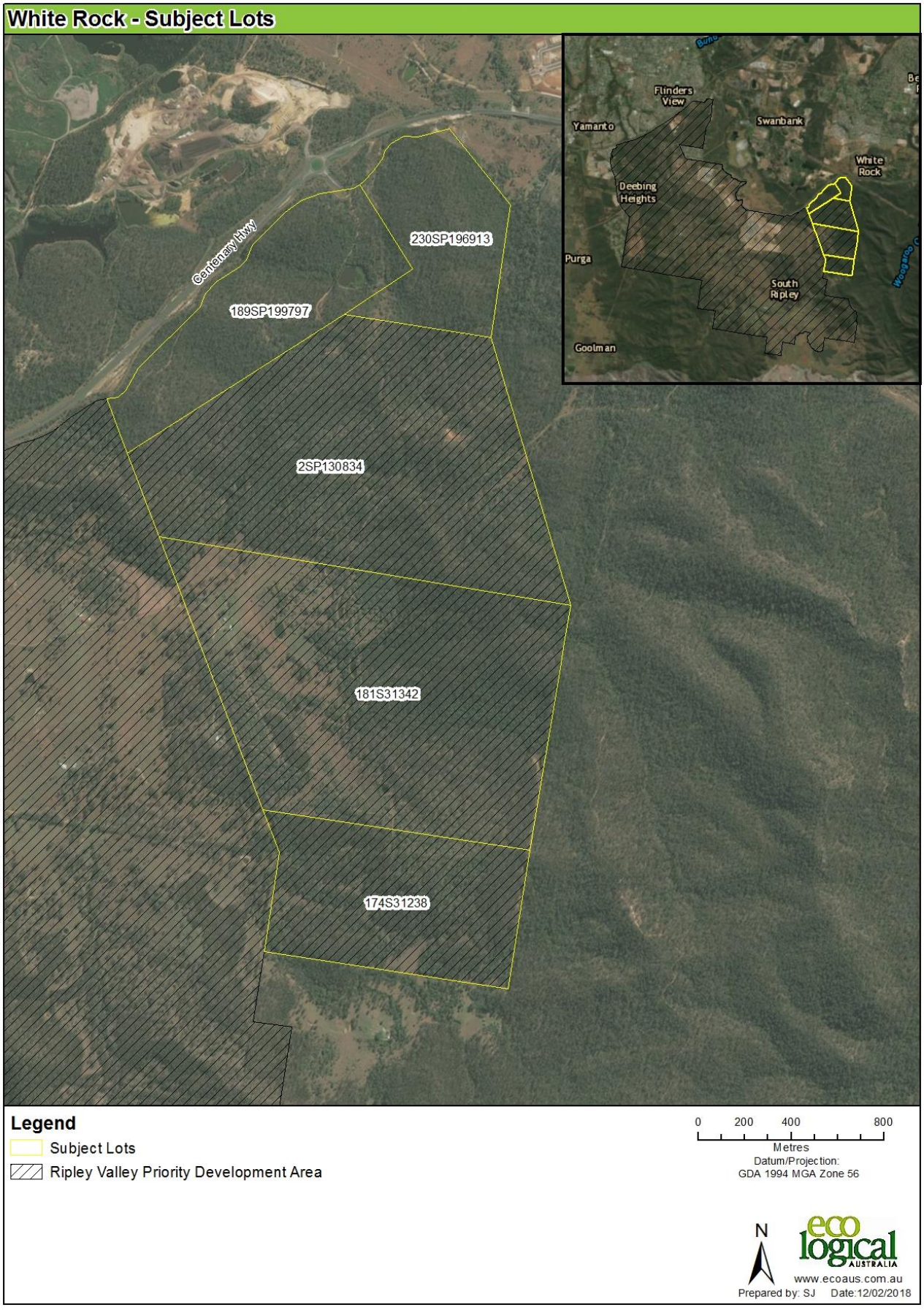

Figure 1: Project area, proposed access and residential precinct

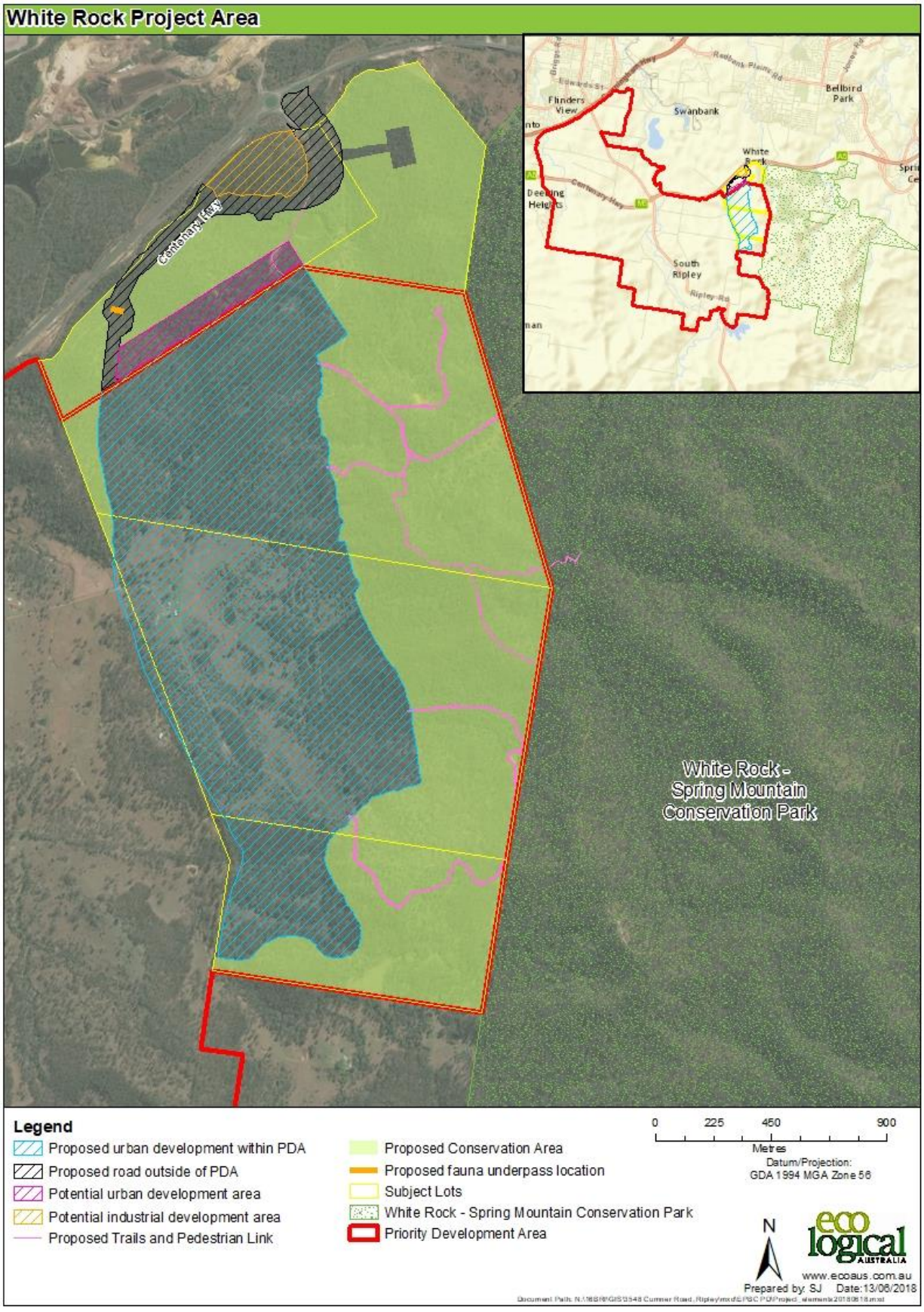

Figure 2: Project Elements

3 Phascolarctos cinereus (Koala) Ecology

3.1 Status and regional populations

The koala population of Queensland, ACT and NSW are listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In Queensland, the species is listed as Vulnerable under the *Nature Conservation Act 1992* (NC Act).

In Queensland, the koala is distributed from about Cairns in the north to the mid-west of the state, but predominantly occurs in SEQ. The 'Koala Coast' refers to the Moreton Bay Regional Council, Noosa Shire Council, Ipswich City Council, Brisbane City Council, Redland City Council, Logan City Council and Gold Coast City Council Local Government Areas, and generally comprises the bulk of the Queensland koala population.

A recent major study commissioned by the Queensland Department of Environment and Heritage Protection (Rhodes et al. 2015) has found that the koala population in the Koala Coast has significantly declined since 1996. This decline was primarily attributed to habitat loss, with secondary major impacts including vehicle strikes and dog attack, but disease (likely to be related to a combination of both habitat loss and other impacts leading to nutritional and behavioural stress) also very high.

A report by the University of Queensland on koalas in Ipswich (Bussey and Ellis 2016) estimates there are approximately 4000 koalas in the Ipswich Local Government Area (LGA), however the authors state that this number should be used with caution. This number is also significantly higher than population numbers published within a 2009 Department of Environment and Resource Management (now DEHP) report, which estimates that the whole of the Koala Coast had a population of around 2279 koalas in 2008.

The average population density of koala in the Koala Coast was predicted to be 0.04 koalas / ha (Rhodes et al. 2015) with some localised high density areas. This is considered to be low density, and can be compared to a high density of up to 2.5 koalas / ha in high-quality habitat in the region (Bussey and Ellis 2016).

Surveys conducted by DEHP during 2011 and 2012 (unpublished data, in Bussey and Ellis 2016) indicated a broad distribution of koalas across bushland areas in the Ipswich LGA, and this is supported by other findings in Bussey and Ellis (2016). Nonetheless, an assessment of population density within the LGA is unknown (Bussey and Ellis 2016); however the project area and surrounds is expected to have low population densities due to the types of vegetation in the area (predominantly secondary food trees). Discussions with Ipswich City Council have also indicated that koalas are likely to be in low densities in the project area and surrounds.

3.2 Habitat requirements

Koalas feed primarily but not exclusively on selected species of the genus *Eucalyptus*. Nationally, they have been observed feeding or resting in about 120 eucalypt species and 30 non-eucalypt species. Koalas have also been observed using trees with dense foliage or retreating to rainforest during adverse weather such as high temperatures, strong wind or heavy rain (Jurskis and Potter 1997).

Research by the Australian Koala Foundation (AKF) suggests that usage of habitat by Koalas may be a function of the abundance of the present species. The AKF describes Primary Habitat as areas where the dominant tree species are preferred browse species, with their usage being independent of the

species' density. However, in some areas, a species considered a secondary browse species may be preferentially used as a primary tree, often where its occurrence in the area is infrequent.

A Koala food tree is usually identified by a significant number of scats at its base, though such trees may also be used for roosting. Contrary to a long held assumption, observation of Koalas resting in a tree does not always indicate that it is a feed tree (Phillips 2000b, NPWS 2003).

Koalas appear to prefer young leaves rather than mature leaves, and preferred foliage usually has a threshold for minimum moisture content (which may vary seasonally) and nitrogen content (Jurskis and Potter 1997, Pahl and Hume 1990). Other studies have also shown threshold levels for essential oils, with preferred species having more volatile oils and less heavy oils (Hume 1995); preferences for higher concentrations of crude protein, phosphorous and potassium, and lower concentrations of fibre (Ullrey et al 1981); and more simple sugars and less complex sugars (Osawa 1993). These components all vary interspecifically and intraspecifically, and factors such as species, age, size and crown condition also influence the physiological processes that ultimately affect nutritional quality and palatability, especially in a suboptimal environment (Jurskis and Potter 1997).

Usage may also be determined by site-dependant edaphic factors e.g. soil type (Sharp and Phillips 1999, Biolink 2013), which affects the nutrient quality of forage. A gradient in nutrient concentration in soils and foliage is a major determinant of the distribution of arboreal fauna (Anon 1999, Gibbons and Lindenmayer 2002).

3.3 Breeding ecology

Koalas are solitary, and territorial (particularly males), yet live in established, sedentary polygynous breeding aggregates arranged in matrix of overlapping home ranges, whose size varies according to sex (males tend to be larger so that they overlap the ranges of several females), and carrying capacity of the habitat (usually measured in terms of density of primary browse species) (Phillips and Callaghan 1995). These aggregates basically consist of an alpha (dominant) male, with his harem of at least 2-4 females and their offspring (juveniles and/or sub-adult Koalas) of varying stages of maturity and independency (Phillips 1997).

A Koala may live for around 15 years (especially females), with breeding for most females occurring at 3 years, and for males about 4 years (when they reach a sufficient size to defend a territory) (Martin and Lee 1984). Young remain in the pouch for 5-6 months, and associate with the mother until at least about 11 months (and up to 2 years), after which they disperse into a population (generally coinciding with reaching sexual maturity).

Female Koalas do not necessarily breed every year; perhaps due to the dependence on quality foraging resources (dependant on a variety of factors, such as seasonality and condition of habitat), density of other breeding females/competition for resources, demand for high site philopatry (movement is restricted to known areas within their home range with high quality forage potential required for lactation), and the physiological demand of raising offspring (Phillips 1997).

Young, sub-dominant and senescent males are often forced into secondary habitats by dominant males. Such habitat is generally located on the outer periphery of the core breeding/high quality habitat, and characterised by poorer soils, greater disturbance, and lower frequency/poorer condition of preferred browse species (Martin and Lee 1984). These animals have more ephemeral home ranges and sometimes move between established populations, which is desirable for maintaining genetic flow, but results in a higher mortality rate (Phillips 1997).

4 Koala and Koala Habitat in the Study Area

4.1 Observation of Koala

Figure 2 shows koala records listed in the locality. Records are most common and densest in or adjacent to urban and peri-urban areas, with sparse records in proximity to the site. This is considered more likely to reflect observer distribution and density than koala distribution, abundance and density (Rhodes et al 2015).

Past surveys undertaken by Natural Solutions (2008), RPS (2010) and Enviro-Studio (2013) on site failed to detect koalas. Several koala scats were recorded to the east in White Rock-Spring Mountain Conservation Estate as part of Ipswich City Council's koala surveys undertaken in September 2015.

Evidence of koalas on site was detected by Eco Logical Australia in September 2016 in the form of scats in three of the nine Spot Assessment Technique (SAT) assessments, and a koala sighting. All observations were in forest in the north of the site (**Figure 3**), which aerial photographs from 1950 show was once largely cleared (see EAR). Please also refer to the EAR (ELA 2017) for details of the survey methodology.

Given their ecology and the geology of the area, the population of koalas in the locality would be expected to be low density (Rhodes et al 2015). The failure of previous surveys to detect koalas, habitat quality (determined by a combination of soil fertility, and distribution and abundance of koala food trees), and known ecology of other local koala populations suggests a low density population, with locally higher density on the higher nutrient soils i.e. basalt and alluviums.

Koalas that inhabit the site would be part of a broader population that exists within the large tract of vegetation to the east, south and south-east; with possible outlier populations in the fragmented habitat to the west and north of the Centenary Highway. The population size and landscape usage on site is not yet known but further survey is recommended in **Section 6.4** to determine this to inform management of the EPZ.

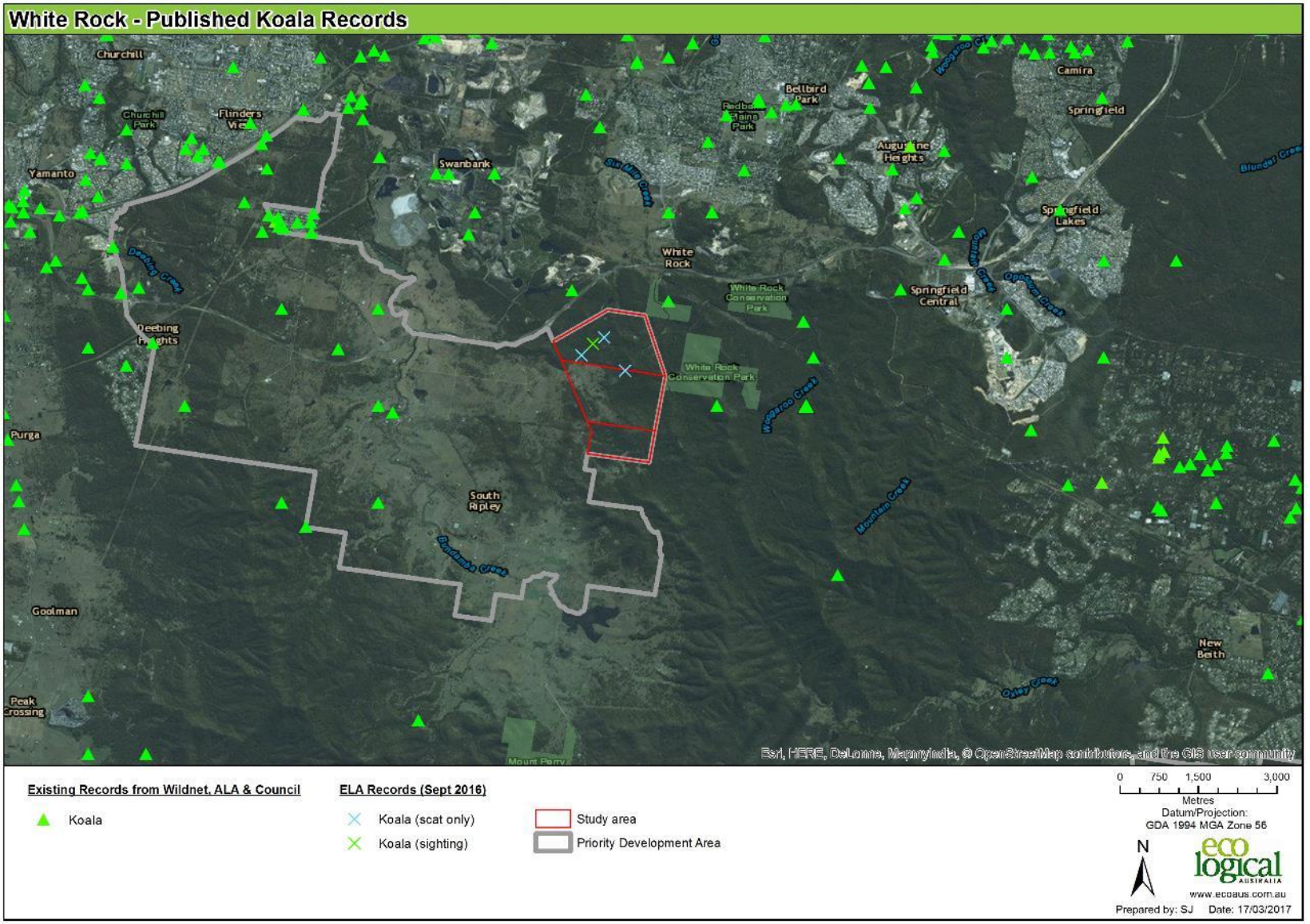

Figure 3: Local and site koala records

4.2 Habitat in the project area

The *EPBC Act referral guidelines for the vulnerable koala* defines koala habitat as:

> *Any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. This can include remnant and non-remnant vegetation in natural, agricultural, urban and peri-urban environments. Koala habitat is defined by the vegetation community present and the vegetation structure; koalas do not necessarily have to be present.*

With this definition, koala habitat (at varying qualities) is considered to be present across most of the study area and koalas or evidence of koalas have been recorded within and surrounding the study area However, koala habitat values across the study would vary depending on several characteristics such as distance to water, size/structure of tree, topography, presence of koala food trees, leaf nutrition, tree size, weed invasion, fire and logging history (Hindell and Lee 1987, Moore et al. 2004; McAlpine et al. 2006; Moore et al. 2010). Full consideration of all these factors in combination to determine habitat quality in the study area would be complex. Nonetheless, for the purpose of this plan the following factors were determined to be most significant and therefore directly considered in habitat mapping:

- The presence of koala food tree species. Koalas exhibit a strong preference for certain tree species. Primary food species include *Eucalyptus biturbinata*, *E. major, E. melliodora*, *E. microcorys*, *E. moluccana*, *E. propinqua*, *E. racemosa*, *E. seeana* and *E. tereticornis*, whilst all other *Eucalyptus*, *Corymbia*, *Lophostemon* and *Angophora* species are considered secondary species (ICC 2018; QPWS 2001). *Eucalyptus crebra*, *E. fibrosa, Corymbia citriodora* subsp. *variegata*, *C. intermedia* and *Lophostemon confertus* in particular, are considered by ICC (2018) as being important shelter and secondary food trees. Within the project area, *E. tereticornis* was the only primary food tree in abundance (in specific areas), whilst other species of secondary species were also present and abundant throughout the project area.
- The presence of large trees. Koalas prefer larger trees (Hindell and Lee 1987) and tree size has been shown by Moore et al (2010) to strongly affect where koalas can be found. That is, larger trees offer more foliage and thus attractive resources for koala, whilst they may also provide more shade and greater safety from perceived dangers on the ground (Moore et al 2010). Most of the White Rock Project's impact area has been subject to clearing in the past (see Ecological Assessment Report prepared by ELA 2017). Due to this, the site has limited large trees and is mostly comprised of trees with narrow stems as pictured in figures throughout this report.
- Weedy shrub abundance. Although koalas can navigate around patches of weeds, woody weeds such as *Lantana camara* (lantana) can hinder koalas from accessing food trees (see **Section 4.3.8**). During the site survey, it was observed that lantana infestation was common and would be significantly reducing habitat values in some areas. See **Section 4.3.8** for more information.

A koala habitat quality map has been developed and is provided in **Figure 4**. In **Figure 4**, six habitat categories have used and mapped. The six categories have been adapted from McAlpine et al. (2006). **Table 1** describes each of the six habitat categories as well as the condition of the habitat for koala. Representative photos are provided in **Appendix A**.

Four habitat categories in **Table 1** are designated as "habitat critical to the survival of the koala". This is consistent with the definition within the Koala Referral Guideline, which defines Habitat critical to the survival of the koala as:

"*Koala habitat that is considered to be important for the species long-term survival and recovery. An impact area that scores five or more using the habitat assessment tool for the koala in Table 4 of the guidelines is highly likely to contain habitat critical to the survival of the koala*."

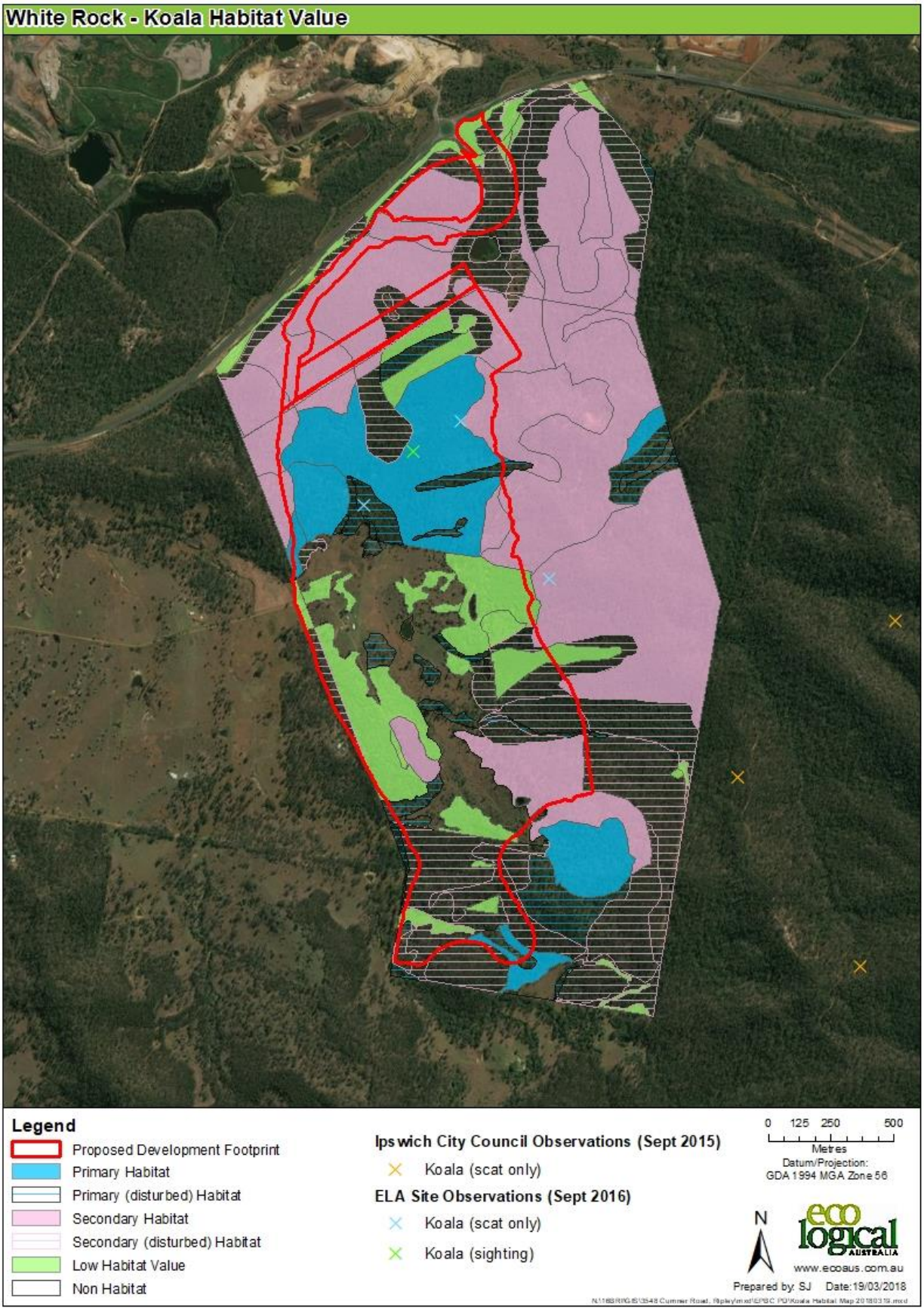

Figure 4: Koala Habitat Map

Table 1: The six koala habitat categories and associated condition

Habitat Category	Criteria	Condition	Critical Habitat?*	Area in Project Area (ha)
Primary Habitat	Woodland or forest where > 30% of overstorey tree species are primary food species. The vegetation contains less than 30% cover of lantana.	Within the project area, this includes areas of RE 12.8.17 and 12.10.7a. The habitat has moderate levels of lantana infestation (5% to 30% ground cover) and primary koala habitat trees (mostly *Eucalyptus tereticornis*) were subdominant. These areas are regrowth and is characterised by a high tree stem density dominated by trees with relatively narrow diameters. Large mature trees, which koala prefer, are rare due to previous clearing.	Yes	52.1
Primary Habitat (significantly disturbed)	Woodland or forest where > 30% of overstorey tree species are primary food species; however the vegetation is significantly disturbed by woody weeds (i.e. >30% of the ground is covered by lantana). This area is often dominated by young eucalypts with small stem diameters (i.e. it is regrowth vegetation)	Within the project area, this includes areas of RE 12.3.3, 12.8.17 and 12.10.7a. These areas are regrowth and support a high tree stem density dominated by trees with relatively narrow diameters. Large mature trees are rare due to previous clearing. These areas are also have high levels of lantana infestation, hindering movement of koalas and access to the base of tree trunks.	Yes	28.45
Secondary Habitat	This is other woodland or forest comprising secondary food species +/- primary species (< 30% cover). The vegetation contains less than 30% cover of lantana	These areas are predominately remnant and significantly dominated by *Corymbia citriodora*, with *Eucalyptus crebra* sub-dominant (RE 12.10.2). There are also areas in the north that contain *Eucalyptus acmenoides*, *Eucalyptus major* and *Corymbia citriodora* (RE 12.10.17). These species are considered secondary koala tree species. Primary koala tree species are absent in most areas. Lantana infestation varied from low to moderate.	Yes	197.55
Secondary Habitat	Woodland or forest comprising secondary food species +/- primary species (< 30% cover). The vegetation in this class is also	These areas are significantly dominated by *Spotted Gum*, with *Eucalyptus crebra* sub-dominant (RE 12.10.2). These areas are regrowth and contain a high tree stem density dominated by trees with	Yes	120.39

Habitat Category	Criteria	Condition	Critical Habitat?*	Area in Project Area (ha)
(significantly disturbed)	significantly disturbed by woody weeds (i.e. >30% of the ground is covered by lantana).	relatively narrow diameters. Large mature trees are rare due to previous clearing. These areas are also have high levels of lantana infestation, significantly hindering movement of koalas and access to the base of tree trunks.		
Low Quality Habitat	Acacia or other shrub dominated regrowth, young emergent koala food trees (canopy approx. 10m to 15m tall, with diameter at breast height averaging approx. 20cm) at low stem densities.	These areas have been previously cleared and are regrowing as shrubland. They are overwhelmingly dominated by Acacia species and often with moderate to high levels of lantana infestation (5% to >30% cover). In most areas the scattered trees are relatively young. Large/mature koala food trees are largely absent.	No	49.53
Cleared areas	Koala food trees absent	These areas do not provide habitat for koala (breeding, foraging or shelter) due to the absence of trees (see definition of 'Koala habitat' within the koala referral guidelines).	No	40.89

* *Habitat critical to the survival of the koala* as per the Koala Referral Guidelines.

As per **Figure 4**, there are two large areas in the project area that are considered to be primary habitat – one in the mid-northern area whilst the other in the south atop of the basalt hill. A more significant proportion of the project area consists of secondary habitat, particularly in the east and north-west of the area.

The project area also includes large areas of shrubland with emergent koala food trees and cleared areas, particularly in the west (**Figure 4**).

Surveys have confirmed Koala presence on site, with one confirmed sighting in September 2016 (**Figure 3**). It is likely the species uses the area for foraging as well as moving between White Rock-Spring Mountain Conservation Estate and other suitable habitat areas across the wider area.

4.3 Current Threats and Predicted Impacts

4.3.1 Habitat loss and fragmentation

Habitat loss and fragmentation are recognised as the primary threatening process to the koala, and has been identified as a key influence in the documented decline of koalas in SEQ (Rhodes et al 2015, DERM 2009) and Ipswich (Bussey and Ellis 2016).

Historically, the site was largely cleared as discussed in the EAR (ELA 2017). Most of the current vegetation is thus regrowth, with site inspection noting a predominantly small girth. Koalas prefer larger trees (Hindell and Lee 1987) and tree size has been shown by Moore et al (2010) to strongly affect where koalas can be found. That is, larger trees offer more foliage and thus attractive resources for koala, whilst they may also provide more shade and greater safety from perceived dangers on the ground (Moore et al 2010). Emerging research has also highlighted that younger trees may be beneficial foraging (though not sheltering) resources because of higher nitrogen concentrations.

As shown in **Figure 1**, the site is currently largely forested aside from the middle-west where pastoralism prevails.

The proposal will see loss/modification of approximately 188.04 ha of koala habitat (see **Table 2**). Of this, 146.03 ha is considered to be habitat critical to the survival of the Koala, as defined under the EPBC Act.

Approximately 21% of the clearing will occur in cleared pasture areas / areas with scattered trees. A further 67% of the clearing is occurring in regrowth vegetation. Only 12% of the impacted area contains remnant vegetation.

Table 2: Impact area statistics

Habitat type	Habitat Score	Area of habitat in Project area (ha)	Impact Area (ha)
Primary	8	52.10	39.67
Primary (significantly disturbed)	7	28.45	13.88
Secondary	6	197.55	45.59
Secondary (significantly disturbed)	5	120.39	46.63
Low	4	49.53	42.22
Total	**NA**	**488.91**	**188.04**

The development will also increase local fragmentation via establishing urban development in the east. This will reduce current connectivity to other smaller remnants to the west, however fragmentation increases significantly in this direction due to current rural land uses and a developing urban area. These areas are also likely to be subject to future residential development and hence in the long term, connectivity west is expected to reduce.

The Environmental Protection Zone (EPZ) in the east of the property will retain connectivity north, south and south south-west.

4.3.2 Disease

Chlamydia is a disease that effects almost all koala in SEQ but symptoms are not always present.

Chlamydia and other diseases may develop when koalas are under stress, of which one cause is habitat loss/disturbance (DECC 2008, Catling 1991, McFarland 1999, AKF 2017, Port Stephens Council 2001). Chlamydia infections may lead to urinary tract and reproductive tract infections which can cause female infertility. The disease may also be transferred via infected males to other females within a koala aggregate, with negative implications for fecundity and recruitment e.g. sterile koalas occupying home ranges which could be utilised by fertile koalas.

The disease status of koalas on site or in the study area is not known, and monitoring proposed in **Section 6.4** will aim to detect if any resident koalas show signs of Chlamydia or develop such symptoms as a result of habitat loss.

4.3.3 Pets and feral predators

Domestic Dogs

Dog attack is a major cause of koala mortality, and is generally associated with human settlement encroaching into koala habitat. Domestic dogs are the main source of dog attack mortality near residential areas (Wilkes and Snowden 1998, Lunney et al 1999, Port Stephens Council 2001, Connell Wagner 2000, State Forests 2000).

The proposal will see establishment of a residential precinct with dogs kept as pets. Dogs most often encounter koalas when habitat is retained or created within an area inhabited by pet dogs e.g. backyards. As detailed in **Section 5**, landscaping is to be selected to minimise attraction to the koala and food trees will not be retained within yards to minimise this risk. Controls on dogs entering the EPZ are also proposed.

Domestic Cats

Domestic cats are not considered a serious predator to the koala (NSWSC 2000a, Dickman 1996, Wilkes and Snowden 1998, DECC 2008, Lunney et al 1999, Connell Wagner 2000b, etc). Hence no specific prescription is provided in this KMP.

Feral Cats, Wild Dogs and Foxes

Feral cats and foxes are not considered a significant threat to koalas, though there is the potential for attack on sick, injured or juvenile koalas (DECC 2008). These pest animals are also a serious threat to native species i.e. recognised as Key Threatening Processes (NSWSC 2000a, 2000b, Dickman 1996).

Wild dogs are known predators of the koala (DECC 2008), and their impact may be increased by fragmentation which increases the time spent on the ground crossing between trees. Dog numbers are also known to increases with small scale fragmentation e.g. installation of tracks.

The local koala population is likely to be subject to occasional predation from the wild dog and foxes. During surveys in September 2016, evidence of wild dog and fox was observed, including direct observation on a motion sensor camera (see **Plate 1**) and footprints. Controls on these feral predators are detailed in **Section 5.1** and are described further in the Conservation Area Management Plan.

Plate 1: Wild dog and fox observations on site.

4.3.4 Roads and vehicle interactions

Traffic collision (usually resulting in death due to trauma) is a major threatening process to the koala (DECC 2008, DERM 2009, Rhodes et al 2015). Traffic collision risk is highest when the following factors combine:

- Speed is >40 km/h;
- Road traverses koala habitat;
- Line of sight is limited by obstructions or road curvature;
- Insufficient artificial lighting (urban and peri-urban areas);
- Koala activity is highest from dusk; and
- Koala breeding season.

The Centenary Highway to the north currently poses the major risk of vehicle strike in proximity to the site, however the risk is mitigated by existing koala fencing.

The proposal will introduce new roads and hence traffic to the site, the most significant being the new northern access road which will traverse through retained habitat in the north. As detailed in **Section 5.2.2**, this alignment is to be fenced with koala-proof fencing and serviced with an underpass to allow koala movement.

Other local roads on the perimeter of the future residential area adjacent to the EPZ and internally adjacent to greenspace areas which may contain koala food trees are also potential collision risk areas. Measures to mitigate this risk are detailed in **Section 5**.

4.3.5 Climate Change

Climate change is a potential threat to the koala, as it is expected to lead to increased frequency of high temperatures, changes to rainfall, increasing frequency and intensity of droughts, and increased fire risk over much of the koala's range.

These impacts are likely to affect the White Rock project area, though the significance of these effects and their direct impact to the local population is difficult to predict.

The proposal aims to mitigate the risk via enhancement of habitat within the EPZ, as detailed in **Section 5.3**, and fire management (see **Section 5.3.3**).

4.3.6 Fire

Bushfires, particularly intense, crown-burning fires, are a major threat to wildlife and threatened fauna such as koalas (DECC 2008). Extensive fires that burn out a large extent of habitat – particularly habitat that is isolated or fragmented, and thus limited in escape, refuge or re-colonisation potential, are particularly damaging if not catastrophic via direct mortality or indirectly (e.g. insufficient resources left to support the population).

Less intense fires may also cause secondary problems such as smoke-inhalation/breathing disorders, loss of food supply, stress and displacement (e.g. via complete burning of an individual's home range).

Altered fire frequency can also ultimately simplify or alter the character of vegetation communities by removing fire sensitive species (e.g. convert wet sclerophyll to dry), and even develop fire-prone communities e.g. promote development of a grassy groundcover (NSWSC 2000).

Fire management in the EPZ is critical to the long term survival of the koala, with measures detailed in **Section 4.8** to mitigate this risk.

4.3.7 Drowning in pools

Koalas can swim, but have been recorded drowning in pools where they could not climb out. Koalas may enter the pool via falling from overhanging branches or attempting to drink, or walking in by mistake (DECC 2008).

Implementation of property fencing, child-proof fencing around pools and avoiding retaining KFTs in backyards adjacent to pools is the key to minimising this risk. Measures to ensure this are provided in **Section 5.2.4** and **5.2.5**.

4.3.8 Exotic species

The entire study area is heavily impacted by weeds. Almost 25% of all species recorded during the April 2016 survey were exotic. Many of these species occurred in the cleared areas in the western parts of the site. However, weeds were also common in the treed areas, where there is often a dense (> 30% projected foliage cover) Lantana shrub layer.

Lantana is by far the dominant weed in the area. **Figure 5** shows the density of lantana observed during the field survey in April 2016, with **Plate 2** showing examples of high levels of infestation. Approximately one third of the site has high lantana infestation (>30% lantana ground cover), whilst one third also has moderate levels of lantana infestation (5-30% lantana ground cover). The remaining one third has low (<5% lantana ground cover) or nil levels of infestation.

Lantana is listed as a Weed of National Significance (WoNS) and is a restricted invasive plant under the *Biosecurity Act 2014* (Qld). A national plan to protect native ecosystems from Lantana has also been developed by Biosecurity Queensland (2010).

Lantana has also been listed as a Key Threatening Process under the NSW Threatened Species Conservation Act 1995. One of the reasons for this listed is that Lantana retards the movement of Koalas between trees (NSWOEH – Listing of lantana camera as a key threatening process, 2016). Removal of Lantana is a prime objective of many Koala habitat restoration projects (e.g. Tregeagle Landcare 2016, Envite 2016).

It was observed during the April 2016 survey that Lantana has formed dense thickets at many locations within the study area and its abundance is limiting the growth of other native species as well as limiting wildlife movement.

Measures to control this threat are detailed in **Section 5.1**.

4.3.9 Barriers to movement

Development may result in physical and behavioural barriers that impair koala usage of the site or access to adjacent areas.

Fences offer the main physical barrier. Koalas can climb sturdy chain mesh, wooden paling or solid-type fences with wooden fences on both sides (Port Stephens Council 2001, Wilkes and Snowden 1998). Busy roads, barking or aggressive dogs, and adverse human contact may pose behavioural barriers (DECC 2008).

Future residential development will dominate the eastern side of the site, with fencing in both the construction and operational phases posing barriers to koalas. The retained green space areas will offer some connectivity through the residential precincts to the east, however KFTs will not be planted as part of landscaping here to discourage koalas using this as habitat and hence exposure to other threats.

The perimeter road and lack of habitat / KFTs will help to discourage koalas entering the residential precinct.

Plate 2: Examples of lantana infestation limiting access to trees in primary habitat (Photo 1) and secondary koala habitat (Photo 2)

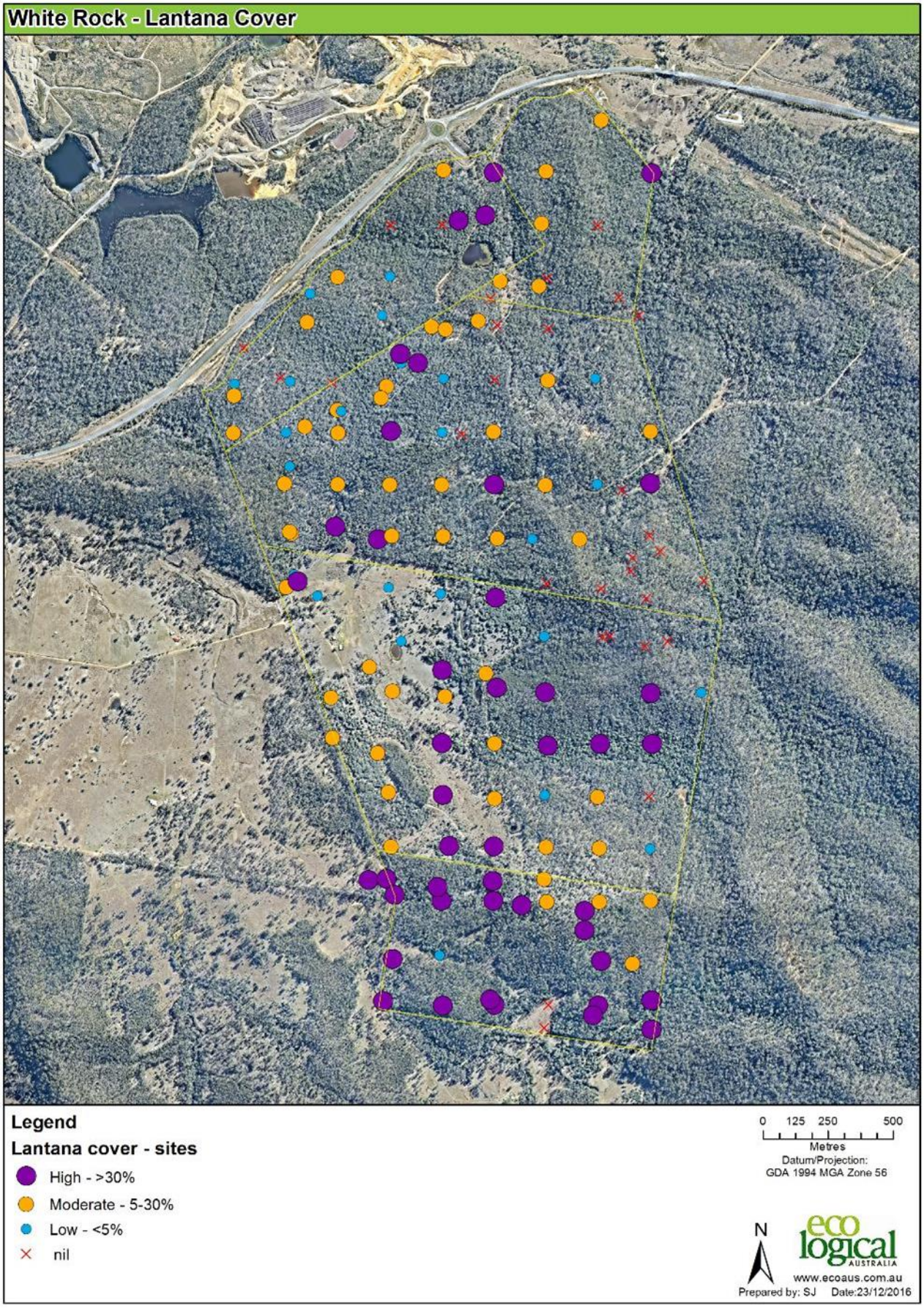

Figure 5: Lantana density mapping

5 Management Measures

5.1 Avoidance measures

5.1.1 Preliminary design for the northern access road

During the design phase, an initial environmental assessment was undertaken to understand the potential impact of the proposed northern access road alignment and to minimise impacts via alignment refinement. Several elements were considered in the environmental assessment, including barriers to connectivity, fragmentation, patch size, the potential for effective fauna sensitive road design and minimisation of impacts to remnant vegetation.

In determining the preferred alignment, the project team also considered topographic, geometric road design constraints, bushfire and amenity issues related to an 'entrance statement' for the future road users entering White Rock.

To reduce impacts on overall terrestrial connectivity, it is important to maximise contiguous areas of vegetation. As such, the alignment has been located as far west and as close to the existing Centenary Highway as possible. This alignment also minimises the area of bushland to the west that would have a resultant reduced habitat value due to the connectivity barrier associated with the proposed road.

By locating the alignment as close to the Centenary Highway as possible, the impact to remnant vegetation is also reduced.

This design outcome is therefore of benefit to the koala.

5.2 Mitigation measures

5.2.1 Construction Mitigation and Management

Clearing

The following measures will be implemented during vegetation clearing activities to avoid or minimise the extent and severity of impacts.

- Preclearing inspections of vegetation immediately prior to clearing will occur to ensure trees are not felled whilst koalas (and other wildlife) are within them. Where koalas are spotted, the site foreman will be notified and the presence of the koala will be monitored.
- No vegetation removal is to be carried out while any koala is present in the area of operation unless a 50m buffer is established.
- Supervision of clearing will be undertaken by a qualified fauna-spotter catcher;
- A report by the spotter-catcher is to be provided within 7 days of the clearing event detailing methods and results of the supervision.
- Koalas will be provided enough time to move out of the site without human intervention;
- Sequential clearing will occur. This means that clearing will occur in stages so that:
    - no more than 50 per cent of the area of a site is cleared at one time for clearing areas that are six hectares or smaller; and

  - no more than three hectares or three per cent of the area of a site that is cleared at one time for clearing areas that are larger than 6 hectares;

- There will be at least one 12-hour period that starts at 6 pm on one day and ends at 6 am on the following day during which no trees are cleared on the site.
- Any tree in which a koala is present, or which has a crown overlapping a tree in which a koala is present, will not be cleared until the koala has moved on.
- Appropriate habitat links will be maintained within the clearing site and between the site and its adjacent areas, to allow koalas living on the site to move out of the site.
- Trenches will not be left open overnight.
- Contact details for the local approved koala carer will be held by the site foreman. Staff will report any koalas are observed acting abnormally, with wet bottom and/or blindness (symptoms of chlamydia), or in a situation where they are at risk (e.g. wandering into the construction site).

Vehicle collision risk during construction

To avoid or minimise impacts associated with vehicle movements during construction when formal speed zoning may be absent, the construction site will be required to contain measures to address traffic related issues as follows:

- Appropriate speed limits should be sign-posted, included in staff inductions and enforced;
- Vehicles to be limited to traversing approved roads and tracks, unless under special circumstances approved by the site supervisor;
- No unauthorised access by vehicles unless required for construction, operation, maintenance or inspections;
- All personnel operating vehicles in and adjacent to the project area should be made aware of the potential for any threatened and migratory species that may occur on-site (including the koala) or may be encountered on vehicle tracks.

Construction Fencing

Alignment of any fences (generally temporary) is to avoid bisecting or enclosing koala habitat, or otherwise posing a barrier to movement between contiguous areas of habitat, unless necessary to prevent koalas coming into harm e.g. falling into a trench. In the case of the latter, fencing is to be koala exclusive where practical.

Otherwise, construction fencing must have a gap of 30 cm at the bottom at some point to allow koala movement. No fence is to include barbed wire or similar which has the potential to injure or entangle a koala.

Landscaping provisions

Landscaping within the new residential precinct, including within the greenspace areas nominally shown in **Figure 1** will not include koala food tree species in the planting palette. This is intended to discouraging koalas from moving into the urban area and establish home ranges which will place them at elevated risk of associated threats of vehicle strike and dog attack.

5.2.2 Vehicle strike

Fencing and fauna underpass

The northern access is to be fenced with koala proof fencing to TMR standards on both sides to prevent koalas attempting to cross this road which poses the highest risk of collision. Fencing along northern access road will be required to have escape mechanisms to allow koalas to leave the road corridor if they were to circumvent fencing.

One fauna underpass will also be constructed across the northern access road to maintain connectivity. The location of the underpass is shown in **Figure 2**. The underpass will be designed to accommodate macropods and the koala (e.g. via provision of wood refuge poles similar to that shown in **Figure 6**) in accordance with Transport and Main Roads' (TMR) Fauna Sensitive Road Design Manual. The sizes of the underpass will be maximised (with engineering constraints in mind) and will have an entrance with a minimum of 3m x 3m with provision for dry passage and fauna exclusion fencing. Coupled with wildlife fencing (to TMR specification), this will enable fauna to move between the two areas whilst mitigating vehicle strike.

Underpass design

The design of an underpass is critical to the success in facilitating safe fauna movement and therefore mitigating habitat fragmentation effects and reducing direct fauna mortality associated with linear infrastructure. Appropriately designed underpasses incorporate features that encourage fauna to travel through the structure. Studies have found that generally culverts that are larger and more closely resemble the surrounding landscape are more likely to be utilised by fauna (TMR, 2000; TMR, 2010). Other critical factors include the provision of dry passage, the presence of vegetation at entrances to culverts which provide habitat connectivity and availability of refuge habitat including rocks and logs for ground dwelling fauna and poles for arboreal fauna (DEHP, 2008).

Figure 6 shows a typical design for fauna underpasses, which has been used to assist in the design of the proposed underpasses along the proposed northern access road.

The proposed western fauna underpass will function as a fauna movement passage only, with separate culverts constructed for drainage (to allow for dry access). The topography of the culvert and adjoining roadside will also be designed to avoid water ponding within and at the entrances to the culvert.

The substrate of the culvert will be as natural as possible. Suitable treatments include rocks embedded in the cement base of the culvert or a layer of gravel or sand on the dry passage of the culvert. A slight gradient is suitable for small mammal species. Steep gradients will be avoided so as not to impact habitat visibility through the culvert (TMR, 2000). The installation of large rocks and mulch at the lead up to and overlapping with the entrance to the underpass will provide shelter for small mammals and reptiles, as well as helping to stabilise the slope.

The entrance to a culvert is an important factor in encouraging use by fauna. Underpasses that have large cleared areas on either side are less likely to be utilised by native fauna, particularly small mammals and arboreal species (Marangelo, 2017; Ecologia Environmental Consultants, 1995). Therefore, the area leading up to the culvert entrance will be vegetated as close as possible to the entrance so that vegetation is contiguous with the surrounding habitat. Macropods prefer a more simple vegetation structure at the entrance to an underpass with an open or closed forest and mixed vegetation structure recommended, while other native fauna prefer dense, complex vegetation that is contiguous with adjoining habitat (TMR, 2000)

Practicality will be considered when selecting flora species for revegetation at the approach to the culvert. Plantings will include native shrub and ground cover species on the slopes near the culvert entrance with larger trees set back from the road. The species selected should be similar to the vegetation in habitat surrounding the underpass. Vegetation that is palatable to the species being targeted to use the underpass should be utilised, for example Eucalyptus species will provide habitat and forage for Koala.

The installation of 'furniture' or fauna specific habitat features within the underpass will encourage entry and through movement of fauna. Furniture will include upright refuge poles at the entrance to the underpass to provide opportunity for escape from predators for semi-arboreal fauna such as Koala. Refuge poles for Koala will be 3m tall and 200mm in diameter (TMR, 2000). A series of horizontal poles will also be installed within the culvert to encourage through movement of Koala as well as providing escape from predators while inside the culvert. Furniture will be constructed from logs with the bark retained to provide adequate footing. The logs will be installed at least 1m from the floor of the culvert and will form a continuous passage, extending beyond the end of the culvert at each end.

Artificial light near the underpass will be avoided as much as possible (TMR, 2000). The underpass will be situated between road light poles, rather than directly underneath road lighting and that no artificial lighting is provided within the culvert.

It will take time for fauna to habituate to the structure, with rates of use increasing with time since construction, however, relatively early use of structures has been recorded within Australia (Bond and Jones, 2008).

As part of the Conservation Area Management Plan, use of the underpass will be monitored and reported on. Due to the location of the culvert (to the far west of the large patch of vegetation), future urban development plans and the low density of koalas in the area, future usage of the underpass by koalas is predicted to be low.

Figure 6: A simplified entrance drawing with dry passage and furniture design for koala (from TMR's Fauna Sensitive Road Design Manual, Vol 2). Note: The underpass provided along the northern access road will be larger than that shown here as it will also be designed for macropods.

Figure 7: Example underpass design with raised dry access ledge, wooden shelf and log railing (from TMR's Fauna Sensitive Road Design Manual, Vol 2).

Speed zoning and residential road design

The esplanade road (adjacent to the EPZ) has been designed to provide short stretches of road to calm traffic. Furthermore, street designs have ensured that the bulk of the traffic does not need to pass near the EPZ in the east. Traffic calmers will also be installed at key locations along the esplanade road. The locations of which will be determined during detailed design of each development stage.

Speed along the esplanade road (adjacent to the EPZ) will be limited to 50 km/h, as will all residential roads. Koala / wildlife signage will also be erected along the esplanade road to reduce risk of vehicle strike.

The northern access will support a higher speed limit due to wildlife exclusion fencing.

5.2.3 Domestic dogs

Domestic dogs are to be excluded from the offset area with advisory signage detailing a prohibition enforceable by Council compliance officers with a fine. This is to protect wildlife but to also reduce the risk of domestic dogs being impacted by any potential 1080 baiting campaigns that may be implemented to manage wild dogs.

Dogs are to remain on lead and under control when moving through parkland areas, with advisory signage detailing a prohibition enforceable by Council compliance officers with a fine. This will reduce the risk of roaming dogs preying on native fauna, such as koalas and possums.

5.2.4 Residential Fencing

In addition to fencing along the northern access road, koala exclusion fencing is required on properties adjacent to the offset area or for any residential property that adjoins a greenspace area. For most of the development, there is an esplanade road that interfaces with the conservation area. This provides an additional buffer to Koalas entering yards, with the yard fencing of these properties specifically designed to exclude koalas.

The following will apply and will be integrated into design guidelines for the project:

- 1.8m high rear yard and side fencing is required where blocks back onto the proposed green space areas.
- 1.8m high side fencing is required for yards that face the proposed esplanade road (directly west from the conservation area).
- Side fences must return to the side of the house. The return fences are to be setback a minimum of 1m from the front face of the house;
- The only material permitted for side and rear fencing is sheet metal (e.g. Colorbond) fencing to prevent koalas climbing fences; and
- There are to be no gaps at the base of the fence (to prevent both koala entry into yards and entry of dogs into the offset area).

5.2.5 Pools

Pools are expected to be fenced with child-proof fencing which should effectively mitigate this risk. Engineering requirements are expected to see removal of existing vegetation, hence food trees are not expected to be retained in back yards adjacent to pools.

5.2.6 Education and Awareness

As part of moving in, new residents will be provided with an information package that describes the environmental assets in the area and how they can help to maintain conservation values in the area.

Residents will be educated on the impacts of domestic pets on koalas (and other wildlife) and how they can help. This will help to reduce wildlife attacks and feralisation. This package will also identify the restrictions on fire in the offset area, caution regarding wildlife on roads, koalas drowning in pools, symptoms and emergency contact details for sick and injured koalas, and dog controls.

5.3 Offset measures

5.3.1 Offset location

The proposed offset area includes land to the north of the masterplan footprint outside of the PDA boundary as well as land to the east, most of which is mapped as EPZ area within the Ripley Valley PDA Scheme. This is shown in **Figure 8**.

Land surrounding the proposed development presents the best option for provision of an offset. This is because it is:

- owned by the proponents;
- includes land mapped as Environmental Protection within the Ripley Valley PDA Scheme;
- has scope to be managed to provide a conservation gain; and
- Is connected to vast tracts of habitat to the east.

The offset area will aim to increase koala habitat value and will therefore increase the local koala population whilst also supporting a healthy population. Some conservation gains can be achieved almost immediately whilst others will be achieved over the life of management (approx. 20 years). There is a high level of confidence that a conservation gain can be achieved in a short time. This is due to the following factors:

- Koala habitat requirements are well known;
- The species is mobile, has large home ranges and can re-colonise improved habitat areas without human assistance;
- There have been many projects undertaken in South-east Queensland to establish koala habitat (i.e. QTFN's Peak Crossing property). This provides many lessons learnt to draw on and provides evidence of feasibility.
- Management of woody weeds is highly feasible via chemical or mechanical/hand control methods and will significantly improve the quality of habitat;
- Where required, plantings and natural regeneration of primary and secondary species is highly feasible. This can be managed in order to achieve outcomes-based performance indicators (i.e., replacement planting if stock dies).
- The White Rock project is a major urban development project that can help to generate adequate funds to support the management actions.
- There is evidence that the area is capable of natural regeneration (based on historical aerial photography) and as such the management regime intends to utilise and enhance the natural processes.
- Both Intrapac Property Pty Ltd (the proponent's developer) and ICC are large and stable financially secure organisations that are making a legally secured commitment to undertaking the improvement works.

A Conservation Area Management Plan has been prepared to address offset requirements under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *1999*, and Ipswich Council's requirements.

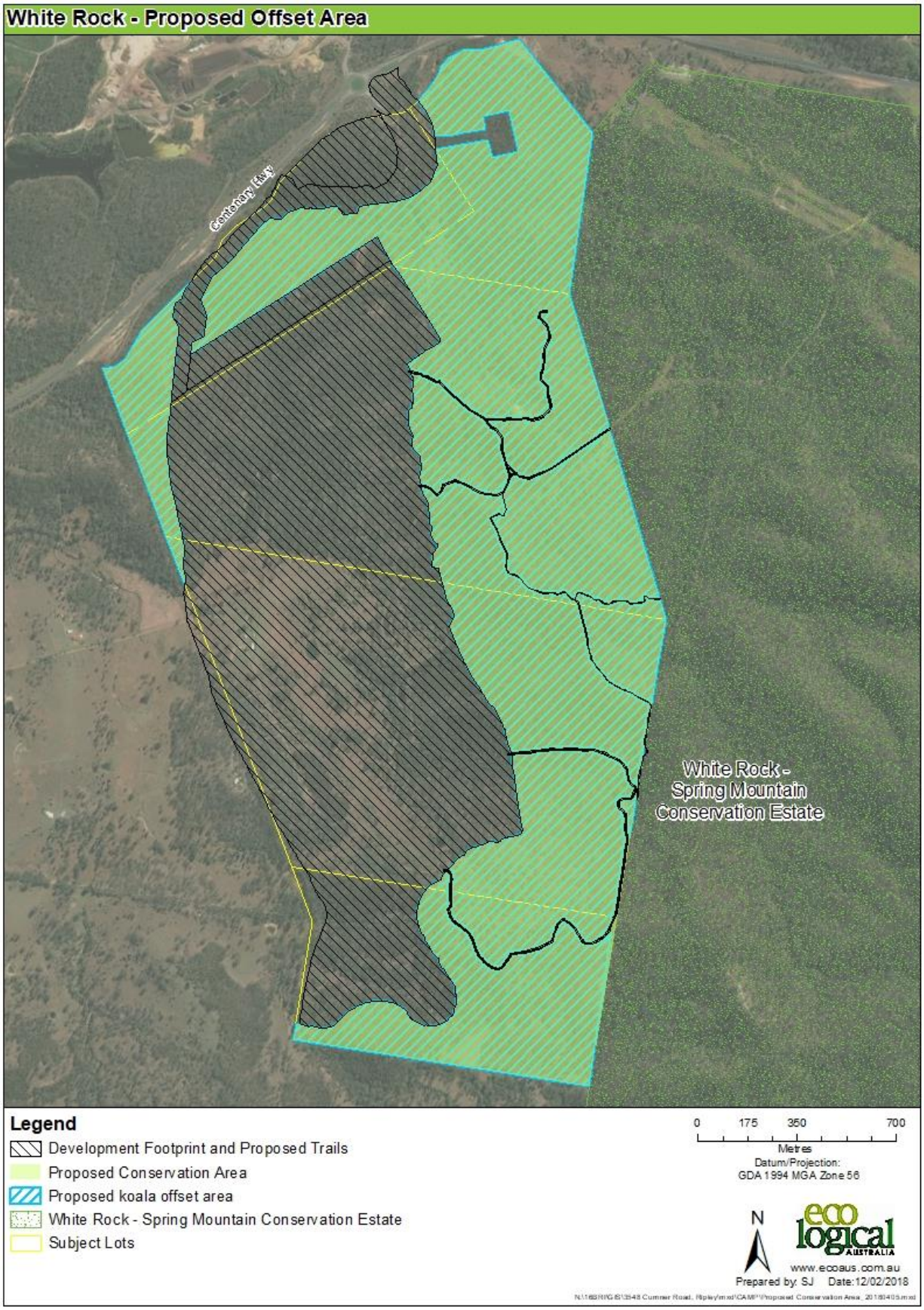

Figure 8: Proposed offset area

5.3.2 Offset management

The proposed offset area has a relatively high level of disturbance (due to weed incursion, previous clearing and pest fauna) which can be managed to improve the habitat value from baseline conditions.

The proposed offset area is to be enhanced via:

- **Planting and assisted regeneration** of koala food trees in areas dominated by *Acacia* trees/shrubs and weeds.
- **Fire management:** As detailed in section 5.3.3, fire is to be managed to minimise the risk of catastrophic events.
- **Weed control**: The condition of the offset area is to be improved via control of key weeds. This includes Lantana which was recorded over large areas at high levels of infestation. This will be implemented and monitored under the Conservation Area Management Plan.
- **Feral species management:** Feral cats, wild dogs and foxes are to be subject to periodic control programs to maintain low populations. As these species will continually migrate to the site from other habitats (e.g. to the east), total elimination is not possible. Such control programs should be in cooperation with other land management authorities (e.g. DEHP) and landholders in the locality to suppress the landscape population of these feral predators.
- **Physical barriers** to prevent trail motorcycle riders from accessing the area.

Additionally, signage at the entry points to the EPZ will detail:

- Prohibition of dogs;
- Fire restrictions; and
- Emergency phone number to report sick, injured or otherwise at risk koalas.

Further detail of these management measures are included in the Conservation Area Management Plan.

5.3.3 Fire management

Periodic fuel reduction will be required for vegetation within the offset area to protect the adjacent residential precinct but also to minimise the risk of catastrophic wildfire. Fuel reduction will also have the aim of managing biodiversity, as part of measures detailed within the Conservation Area Management Plan.

The future manager of the offset area is to coordinate and undertake burning with the Rural Fire Service (RSF) and ICC (as manager of the adjacent Conservation Estate).

The fire regime should not exceed the recommended frequency to maintain biodiversity for each remnant ecosystem type. Mosaic burning is also to be planned to ensure the majority of habitat is unburnt at any given time so that koalas always have a refuge.

Signage is also to advise that campfires or other fires in the EPZ are prohibited with appropriate warnings of legal penalties to discourage arson and unauthorised fuel reduction burns by neighbouring residents.

6 Management Plan Monitoring and Reporting

Management and the associated monitoring is to occur through all stages of the development, including construction and ongoing use. Except where otherwise stated below, Intrapac Property Pty Ltd (the proponent's developer) will be responsible for implementation of the plan until management for the urban areas and conservation areas are transferred to Council. After such time, the management measures and monitoring established as part of this plan will be wrapped up into standard Council management arrangements.

The offset area will also be monitored over time, with measures described below also included within the Conservation Area Management Plan.

6.1 Monitoring objectives

The monitoring objectives are:

- Ensure that clearing is restricted to the allowable area during construction;
- Identify any indication of increased disease incidence in the local koala population.
- Track any benefits to the local koala population from conservation management of the offset area; and
- Identify usage of the fauna underpass.

6.2 Performance indicators

Table 3 indicates performance indicators for each phase of the project.

Table 3: Performance indicators

Issue	Performance indicator	Timeline	Monitoring method
Construction			
Clearing management / Clearing monitoring	• Clearing limited to approved area per stage. • Sequential clearing strategy implemented. • No koala injuries or mortalities.	• Per development stage.	• Site foreman to monitor compliance • Cross-correlation with stage plans. • Post-clearing reports by spotter-catcher. • Records maintained by site foreman and local koala carers.
Construction Fencing	• No barrier to habitat by temporary fencing.	• Per development stage.	• Site foreman to monitor compliance • Post-clearing reports by spotter-catcher. • Records maintained by site foreman and local koala carers

Issue	Performance indicator	Timeline	Monitoring method
Landscaping	• No koala Food Trees planted in landscaping within residential area.	• Per development stage.	• Site foreman to monitor compliance • Post-construction inspection by landscape architect / ecologist
Vehicle strike	• No vehicle strikes during construction. • Underpass suitable for koala provided.	• Per development stage. • Underpass completed before sale of lots	• Records maintained by site foreman and local koala carers • Inspection during reporting.
Post-construction			
Offset Area	• Conservation Area Management Plan to be implemented. • Bushfire planning implemented.	• Within 12 months of approval; and then as per relevant plans.	• Monitoring against Conservation Area Management Plan targets • Maps of any fuel reduction planning or fire management undertaken
Vehicle strike	• Exclusion fencing along northern access way prevents koala access to the roadway. • Speed control measures installed on esplanade. • No koala vehicle strike incidents. • Demonstrated use of underpass by koala.	• As per development stage and then biannually	• Inspection during reporting. • Review of Council and carer records. • Review of monitoring of the underpass.
Fencing	• Exclusion fencing erected along northern access road prior to public use. Koala exclusion fencing around yards as per design guidelines	• Prior to sale of lots. • Per relevant dwelling construction.	• Defects / completion inspection
Domestic dogs	• Fencing around house yards at initial house construction as per White Rock design guidelines • Signage prohibiting dogs from offset area	• Per relevant dwelling construction. • At commencement of construction of stage 1	• Defects / completion inspection • Standard council enforcement
Pools	• Child exclusion fencing around all pools	• Per pool construction	• Defects / completion inspection • Council compliance / development approval.

Issue	Performance indicator	Timeline	Monitoring method
Public Awareness	• Information package provided with sales contract. • Signage placed at recreational trail entry points.	• Per dwelling sale.	• Copy of package provided. • Defects / completion inspection
Population and health assessment	• Resident population of koala retained in EPZ. • Monitoring shows population maintained over 20 year maintenance phase due to habitat enhancement, fire management and feral predator controls. • Disease incidence at baseline levels remain consistent.	• Baseline survey in year 1 • Survey every 2 years over 20 year maintenance phase (10 surveys)	• Re-sample RGSAT • Koala survey as per Dique et al (2004) methodology.

6.3 Monitoring program and reporting

The following reporting will be undertaken:

- A baseline assessment comprising the koala population and health assessment detailed in **Section 6.4**.
- An annual report is to be produced detailing the monitoring results against the performance criteria in **Table 3**.

This baseline population assessment is essential to measure the order of magnitude of the impacts associated with the proposal, and the effect of mitigation measures, in subsequent reports.

The next report is to be undertaken by the developer 12 months after commencement of construction, and is to assess the key performance indicators detailed in **Table 3**.

A koala population and health assessment survey is to be undertaken biennially over the offset area maintenance period to monitor trends in the local koala population, and identify if further actions are required.

6.4 Population and health assessment

The objectives of this assessment are to:

- Confirm the population size on site via a systematic survey.
- Identify the landscape usage, and hence important areas of habitat for foraging, breeding and connectivity.
- Identify the incidence / severity of disease, especially Chlamydia.

This is to be achieved via the following:

1. **Regularised grid Spot Assessment Technique (RGSAT) survey**: A RGSAT is recommended to be undertaken over the proposed offset area to identify areas of major activity. Cross-correlated with

koala food tree density and soil landscape (a surrogate indicator of fertility), this can be used to identify key foraging areas and corridors. This information is to be fed into bushfire management.

2. **Standard koala survey**: In line with the methodology of Dique et al (2004), a koala survey is to be undertaken to identify the population size and / or density. Survey techniques will include belt transects using experienced observers coupled with nocturnal call playback and spotlighting. Survey should be undertaken in the koala breeding season when koalas are most active. Koalas detected are to be inspected with binoculars by experienced observers for signs of stress and disease e.g. blindness and dirty/wet bottoms.

Subsequent monitoring using re-sampling of the RGSAT is recommended to monitor for any changes in the population over the 20 year maintenance phase of the offset area (see Conservation Area Management Plan), which will correlate with development of the residential precinct and associated impact of the habitat loss and fragmentation.

6.5 Adaptive management

All measures detailed in this KPM are to be considered adaptive according to the site situation, unforeseen circumstances and other stochastic influences e.g. landscape scale bushfire.

Monitoring of the key performance indicators as per the program in **Section 6** is intended to detect adverse trends and trigger appropriate responses according to the significance of the issue. These are detailed in the Conservation Area Management Plan.

Failure to reach or maintain compliance with key performance indicators should also initiate a review of mitigation measures for their effectiveness, and where necessary, upgrade or replace these measures to achieve the performance indicator by the next monitoring event.

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Appendix A Habitat Photos

Figure 9: Examples of Primary Habitat (note small stem size and lantana)

Figure 10: Examples of Primary Habitat (significant disturbance)

Figure 11: Examples of Secondary Habitat (note small stem size and lantana)

Figure 12: Examples of Secondary Habitat (significant disturbance)

Figure 13: Examples of Low Quality Habitat

Figure 14: Examples of Non-habitat

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