

# APPENDIX 3. ECOLOGICAL SUMMARY REPORT

### **Preliminary Documentation**

Cabbage Tree Road Sand Quarry - (EPBC 2016-7852)



# Cabbage Tree Road Sand Quarry







# Williamtown Sand Syndicate

Ecological Assessment – Summary Report Cabbage Tree Road, Williamtown NSW

18 October 2016



# Cabbage Tree Road Sand Quarry

## Ecological Assessment – Summary Report

Cabbage Tree Road, Williamtown NSW

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### Prepared for:

### WILLIAMTOWN SAND SYNDICATE

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## **EXECUTIVE SUMMARY**

Kleinfelder were engaged by Williamtown Sand Syndicate Pty Ltd (WSS) to prepare this Ecological Summary Report for the proposed sand quarry located at Lot 1 DP 224587, Lot 121 DP 556403, Lot 11 DP 629503 and Lot 1012 DP 814078, Cabbage Tree Road, Williamtown NSW (Subject Land; total area of 176.12 ha). This report has been prepared to address ecological issues raised in response to the submission of the Environmental Impact Statement (EIS) for the proposed development.

In order to address the issues raised by Government authorities and the public, parts of the Ecological Assessment (Umwelt 2015) needed to be re-addressed. Primarily the main issues raised were impacts to Eucalyptus parramattensis subsp. decadens and the Koala (Phascolarctos cinereus), the lack of a suitable biodiversity offset strategy, the need for further clarification and information in relation to the vegetation mapping and hollow-bearing trees within the Subject Land. Due to the significant changes to the project scope and the amount of additional survey work required to address these issues, this Ecological Summary Report has been prepared to provide a concise document that details where updates and amendments to the original assessment have been conducted.

This report summaries the survey work conducted as part of the original Ecological Assessment (Umwelt 2015) and the Ecological Constraints and Opportunities Report (RPS 2011) (**Section 3**). All additional survey work conducted by Kleinfelder in 2016 to provide additional information to inform the assessment is detailed within **Section 4**.

Field surveys identified a total of three threatened flora species listed as Vulnerable under both the TSC Act and the EPBC Act; Eucalyptus camfieldii (*Camfield's Stringybark*), Eucalyptus parramattensis subsp. decadens and Grevillea parviflora subsp. parviflora (*Small-flowered Grevillea*). A total of eight threatened fauna species listed as threatened under the TSC Act and/ or the EPBC Act were identified; Eastern Bentwing-bat, Eastern Freetail-bat, Eastern Osprey, Grey-headed Flying-fox, Koala, Little Bentwing-bat, Varied Sittella and Wallum Froglet. Additionally, two species listed as migratory under the EPBC Act were identified; Eastern Osprey and Rufous Fantail.

Six native vegetation communities were identified within the Subject Land, including one which is consistent with the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions *EEC*, listed under the TSC Act.



A total of 101.94 ha of preferred Koala habitat was identified within the Subject Land, of which 19.19 ha occurs within the Development Area, and 82.75 ha will be retained within the Offset Area and residual land. A total area of 21.19 ha of supplementary Koala habitat occurs within the development area and 22.02 ha will be retained within the offset area.

The proposal will directly impact on two threatened flora species and habitat for eight threatened fauna species identified within the Subject Land. The updated impact assessment concluded that the proposal is unlikely to significantly impact on any locally occurring threatened species (**Section 5**). Generally, the updated impact assessment had similar conclusions to the outcomes of the original Environmental Assessment (Umwelt 2015), apart from the following issues:

- Eucalyptus parramattensis subsp. decadens: Kleinfelder conducted an estimate of the location population of the species and estimated that the proposal will impact on 0.57% of local population. Due to small impact on the locally occurring population, the proposal is unlikely to significantly impact on the species;
- Eucalyptus camfieldii: Kleinfelder identified a significantly larger number of individuals within the Subject Land than previously identified. As such the impact assessment was updated. The proposal was assessed as impacting on approximately 10% of the identified local population. As impacts would be occurring to planted individuals, a large number within the Subject Land will be retained (1,641), and the species will be rehabilitated within the disturbance area post extraction, the proposal was assessed as being unlikely to significantly impact on the local population;
- Koala: The proposal was assessed as removing approximately 1.01% of the preferred and 0.78% of the supplementary habitat within the Tomago Sandbeds KMU. The proposal was assessed as having the potential to displace any Koala individuals which home-range occurred within the extraction area. This impact was not assessed as significant as habitat availability is not considered a limiting factor on the Koala population. As such it is likely that there are areas of suitable habitat that are either un-occupied, or could support a higher density of Koalas, to which the individuals could self-relocate. Due to the relatively small area of habitat removal the proposal is unlikely to significantly impact on the local population; and
- Wallum Froglet: The relatively small removal of habitat (0.13 ha core (breeding) and 0.57 ha of supplementary (foraging)) for the species is not considered to be large enough to significantly impact on the long-term survival of the species. Additionally, the proposal will not fragment or isolate any areas of potential habitat for the species. The proposal will create a temporary barrier to potential dispersal routes (through the proposed disturbance area).



The proposal was assessed as being consistent with the performance criteria detailed in the Port Stephens CKPoM (**Section 5.1**).

Approved major projects within 20 km of the Subject Land were considered when assessing cumulative impacts on the Koala. The proposal was not assessed as significantly contributing to impacts on the Koala in the locality (**Section 5.2**).

Koala specific mitigation measures have been detailed in Section 6.

A Biodiversity Offset Strategy has been prepared for the proposal. The details of this strategy are summarised in **Section 7**.



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# 1. INTRODUCTION

Kleinfelder were engaged by Williamtown Sand Syndicate Pty Ltd (WSS) to prepare this Ecological Summary Report for the proposed sand quarry located at Lot 1 DP 224587, Lot 121 DP 556403, Lot 11 DP 629503 and Lot 1012 DP 814078, Cabbage Tree Road, Williamtown NSW (Subject Land; 176.12 ha). This report has been prepared to address ecological issues raised in response to the submission of the Environmental Impact Statement (EIS) for the proposed development.

## 1.1 **PROJECT MODIFICATION**

Based on the responses to the public exhibition and government authority review of the EIS documentation, changes were made to the proposed development to reduce its potential impact on the environment and community. These changes include:

- Reduction of the maximum extraction rate to, up to 530,000 tonnes per annum, or the equivalent of over 2,100 trucks on the road per annum when at maximum extraction;
- Change of the predominant extraction method to portable electric conveyors fed by front end loaders. The existing method of dozer push, loader, and articulated trucks would remain, but used only when conveyors are under maintenance. This will reduce noise sources and diesel consumption;
- Change to electric processing (stackers, screens and air separator) that will be predominantly powered by mains power (Note: in the event of unforeseen outages or mains connection issues a diesel generator may be used as backup);
- Removal of a tub grinder from operations;
- Inclusion of a slip lane on the eastbound lane of Cabbage Tree Road at the intersection to the site to improve emergency avoidance of static right turning private vehicles;
- Reduction in the resource footprint of 22.5% based on a range of additional avoidance and optimisation measures; and
- Extraction and rehabilitation sequencing that will limit the area exposed during operations to active quarrying blocks. Rehabilitation will commence in each extraction block once quarrying is completed in each respective block. This will result in a progressive rehabilitation plan for the life of the Project.



# 2. JUSTIFICATION FOR REVISED ASSESSMENT

In order to address the issues raised by Government authorities and the public, areas of the Ecological Assessment (Umwelt 2015) needed to be re-addressed. Primarily the main issues raised were impacts to *Eucalyptus parramattensis* subsp. *decadens* and the Koala (*Phascolarctos cinereus*), the lack of a suitable biodiversity offset strategy, the need for further clarification and information in relation to the vegetation mapping and hollow-bearing trees within the Subject Land. Due to the significant changes to the project scope (detailed in **Section 1**) and the amount of additional survey work required to address these issues, this Ecological Summary Report has been prepared to provide a concise document that details where updates and amendments to the original assessment have been conducted.

A summary of the previous ecological survey works is provided in **Section 3** and a summary of the impact assessment within the Ecological Assessment (Umwelt 2015) is provided in **Section 5**. The following sub-sections detail why additional survey and assessment works were conducted and where they are addressed within this report.

### Eucalyptus parramattensis subsp. decadens

The original EIS did not fully describe the impacts of the project on the local population of the species. To further inform the Assessment of Significance for this species, Kleinfelder have conducted additional surveys within the locality to determine the extent of the local population, detailed in **Section 4.2.2**. As such the impact assessment for this species has been readdressed (**Section 5**). The offset strategy details how suitable offsets for this species will be secured (**Section 7**).

### Koala

As the Ecological Assessment (Umwelt 2015) did not include a detailed vegetation mapping survey using floristic quadrats, the Koala habitat map produced as part of this assessment was not accurate for the Subject Land. As such, Kleinfelder have re-mapped the Koala habitat within the Subject Land based on the vegetation mapping surveys, in accordance with the CKPoM. The updated habitat mapping is provided in **Section 4.3.1**. Additionally, the results of the Koala SAT surveys conducted across the site in 2015 were not presented in original assessment, these data have been provided in **Section 3.2.2.1**.



The modification of the extraction area has reduced impact on Koala habitat. The extraction area has been re-designed to ensure that no areas of habitat are isolated and movement corridors through the site are maintained.

A revised impact assessment, based on the updated mapping and reduction of the extraction area, has been conducted and addressed in **Section 5**. Specific mitigation measures for the species are detailed in **Section 6**, and the offset strategy details how suitable land-based offsets will be secured (**Section 7**).

### Vegetation Mapping

The Ecological Assessment (Umwelt 2015) did not conduct vegetation mapping surveys to the standard required under relevant guidelines (DEC 2004 or OEH 2014). Additionally, the vegetation communities mapped within the Subject Land were not assigned to their appropriate OEH Plant Community Types, which is required for consistency with appropriate quantitative based assessment tools (i.e. biobanking). As such, Kleinfelder were engaged to conduct vegetation mapping across the Subject Land in accordance with these relevant guidelines. The methods and results of these surveys are outlined in **Section 4.1**.

### Biodiversity Offsets

The requirement for a biodiversity offset package was outlined in the Ecological Assessment (Umwelt 2015). However, no offset strategy was provided with the original submission and no timeline on the delivery of an offset package was provided. As such, Kleinfelder were engaged to prepare an offset strategy for the proposal. A separate offset strategy report has been prepared, and a summary of the proposal is outlined in **Section 7**.

### **Hollow-bearing Trees**

The Ecological Assessment (Umwelt 2015) did not provide an assessment of the impacts to hollow-bearing trees. As such, Kleinfelder have subsequently mapped hollow-bearing trees within the Subject Land (**Section 4.4**). The data collected during these surveys was used to inform the modification of the extraction area, and reduce the impacts on hollow-bearing trees.



# 3. PREVIOUS ECOLOGICAL SURVEYS

This sections outlines the previous survey methodologies and results. The following information has been collated from the previous Ecological Assessment Report (Umwelt 2015), the Ecological Constraints and Opportunities Report (RPS 2011) and correspondence from Umwelt regarding responses to submissions.

In correspondence regarding the proposal (DOC15/49126-2), OEH acknowledged that the survey effort undertaken and methodologies used for both the flora and fauna survey complements of the EIS appear to be adequate. The Office of Environment and Heritage only required clarification on several matters: fauna survey stratification; presentation of the SAT survey data, clarification of vegetation community names; and, assigning the vegetation communities to appropriate PCTs. These calcifications have been addressed in this section of the report and **Section 4**.

## 3.1 SURVEY METHODOLOGY

## 3.1.1 Flora Field Surveys

### 3.1.1.1 Vegetation Mapping

Vegetation mapping surveys were conducted across the Subject Land by RPS (2011) and Umwelt (2015). These results have not been discussed further in this report as Kleinfelder have subsequently updated the vegetation mapping for the Subject Land. The methodology and results of these surveys is provided in **Section 4.1**.

### 3.1.1.2 Threatened Flora Surveys

Meandering transects were used to conducted threatened flora searches across the Subject Land, focusing on the impact area. These searches were conducted by Umwelt in 2013, 2014 and 2015. A list of targeted species was generated from those known to occur in or near the project area (based on records) or species that were considered likely to occur based on the species known distribution and presence of habitat within the Subject Land. Where threatened flora species were identified, their location was recorded using a hand-held GPS. The species targeted during field surveys and the survey timing is outlined in **Table 1**.



Target Species	Optimal Survey Period	Survey Timing
<i>Allocasuarina defungens</i> (Dwarf Heath Casuarina)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015
<i>Angophora inopina</i> (Charmhaven apple)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015
Callistemon linearifolius (Netted bottle brush)	September — March	10 and 12 February 2015 28 September 2015
Corybas dowlingii (Red Helmet Orchid)	June —August	28 - 29 August 2013 25 — 26 August 2014
Cryptostylis hunteriana (Leafless Tongue Orchid)	Cryptostylis hunteriana (Leafless Tongue Orchid) December — February	
<i>Diuris arenaria</i> (Sand Doubletail)	August — September	28 - 29 August 2013 25 — 26 August 2014 28 September 2015
<i>Diuris praecox</i> (Rough Doubletail)	July —August	28 — 29 August 2013 25 — 26 August 2014
<i>Eucalyptus parramattensis</i> subsp. <i>decaden</i> s (Earp's Gum)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015
<i>Eucalyptus camfieldii</i> (Camfield's Stringybark)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 28 September 2015
Maundia triglochinoides	November— March	10 and 12 February 2015
<i>Melaleuca biconvexa</i> (Biconvex Paperbark)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015
<i>Melaleuca groveana</i> (Groves Paperbark)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015

### Table 1: Threatened Flora Species Targeted During Surveys.



Target Species	Optimal Survey Period	Survey Timing
Pterostylis chaetophora	September — November	28 — 29 August 2013 25 — 26 August 2014 28 September 2015
Persicaria elatior (Tall Knotweed)	December — May	10 and 12 February 2015
<i>Commersonia prostrata</i> (Dwarf Kerrawang)	All year	28 — 29 August 2013 25 — 26 August 2014 10 and 12 February 2015 24 April 2015 28 September 2015
<i>Tetratheca juncea</i> (Black-eyed Susan)	July — December	28 — 29 August 2013 25 — 26 August 2014 28 September 2015

Locations of threatened species were also recorded during the 2008 and 2011 surveys conducted by RPS (2011).

## 3.1.2 Fauna Field Surveys

### 3.1.2.1 Site Stratification

Fauna surveys were conducted by RPS in 2011 and Umwelt in 2013, 2014 and 2015. The survey design for fauna surveys was based on vegetation formations, with vegetation communities grouped into the following stratification units:

- Woodland/ Forest (total 106.35 ha):
  - o Coastal Sand Apple Blackbutt Forest (72.64 ha);
  - o Coastal Sand Wallum Woodland Heath (29.96 ha); and
  - o Tomago Sand Swamp Woodland (3.75 ha).
- Swamp Forest (total 40.29 ha):
  - o Swamp Mahogany Paperbark Swamp Forest (40.29 ha).
- Heath (total 25.36 ha):
  - o Coastal Sand Wallum Heath (10.26 ha); and
  - o Coastal Wet Cyperoid Heath (15.10 ha).

### 3.1.2.2 Fauna Survey Components

The following survey methods were undertaken within the Subject Land:

• Diurnal herpetofauna searches;



- Diurnal bird surveys;
- Nocturnal call-playback (mammals and birds);
- Targeted winter bird surveys;
- Arboreal and terrestrial mammal trapping (Elliot A and Elliot B traps, and hair tubes);
- Microchiropteran bat surveys (Anabats and harp trapping);
- Spotlighting (mammals, nocturnal birds and herpetofauna);
- Remote cameras;
- Koala SAT surveys; and
- Opportunistic surveys.

**Table 2** outlines the fauna survey effort undertaken within each stratification unit, the dates of each survey component and the adequacy of these surveys in relation to the *Threatened Biodiversity Survey and Assessment: Guidelines of Developments and Activities (working draft)* (DEC 2004).



#### Table 2:Fauna Survey Effort within the Subject Land.

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Amphibians	Diurnal herpetological searches	One hour per stratification unit	Eight person hours of diurnal searches were undertaken across four sites during one survey period (10 and 26 February 2015). Eight person hours of opportunistic wallum froglet ( <i>Crinia tinnula</i> ) surveys were undertaken from 28-29 August 2013 and 25-26 August 2014.	Woodland/Forest Swamp Forest Heath	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate
Reptiles	Diurnal herpetological searches	30 minute search on two separate days targeting specific habitat per stratification unit	Eight person hours of diurnal searches were undertaken across four sites during one survey period (10, 12 and 26 February 2015).	Woodland/Forest Swamp Forest Heath	Adequate
	Spotlighting surveys	30 minute search on two separate nights targeting specific habitat	Two nights of spotlighting transects, each of 2 person-hours was undertaken throughout the Project Area (10 and 26 February 2015). Eight person hours of spotlighting surveys was undertaken over two nights across the Project Area (24 and 26 May 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate



Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Diurnal Birds	Area search	Per stratification unit	Diurnal bird surveys were undertaken at five sites across the project area, each of 1 person-hour, (10 and 26 February 2015). Note that the survey methodology has been updated as part of this report for diurnal bird surveys as there was an error in the Ecological Assessment (Umwelt 2015). In addition to this, targeted winter bird surveys, each of 0.6 person-hour duration, were undertaken at 18 locations in and around the Project Area over two survey seasons (28-29 August 2013 and 25-26 August 2014).	Woodland/Forest Swamp Forest	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate
Nocturnal Birds	Call playback surveys	<ul> <li>Sites should be separated by 800 metres – 1 km, and each site must have the playback session repeated as follows:</li> <li>At least 5 visits per site, on different nights are required for the Powerful Owl, Barking Owl and the Grass Owl;</li> <li>At least 6 visits per site for the Sooty Owl, and 8 visits per site for the Masked Owl are required.</li> </ul>	Two sessions of call playback were undertaken at two locations over two nights within the Project Area for powerful owl, sooty owl, masked owl and barking owl (10 and 26 February 2015). Two sessions of call playback were undertaken at one location over two nights for powerful owl, masked owl, barking owl and bush stone-curlew (24 and 26 May 2011).	Woodland/Forest Swamp Forest	Adequate



Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
	Spotlighting surveys	Spotlighting for plains wanderer and bush stone-curlew by foot or from a vehicle driven in first gear.	Two nights of spotlighting transects, each of 2 person-hours was undertaken throughout the Project Area (10 and 26 February 2015). Eight person hours of spotlighting surveys was undertaken over two nights across the Project Area (24 and 26 May 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate
	Small Elliot traps	100 trap nights over 3-4 consecutive nights	Terrestrial trapping was undertaken using 10 Elliott A at 6 trapping transects for four nights, resulting in 240 trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Large Elliot traps	100 trap nights over 3-4 consecutive nights	Terrestrial trapping was undertaken using 10 Elliott B at 6 trapping transects for four nights, resulting in 240 trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate
Mammals (excluding bats)	Wire Cage traps	24 trap nights over 3-4 consecutive nights	Terrestrial trapping was undertaken using 2 cage traps at 6 trapping transects for four nights, resulting in 48 trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Arboreal Elliot traps	24 trap nights over 3-4 consecutive nights	Arboreal trapping was undertaken using 10 Elliott B size traps per trapping transect set for four nights. A total of six trapping transects were undertaken within the site, resulting in 240 arboreal trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate



Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
	Hair tubes	10 large and 10 small tubes in pairs for at least 4 days and 4 nights	Hair funnel surveys were undertaken using 20 Faunatech hair funnels and wafers over four nights at four trapping transects, resulting in 160 arboreal and 160 terrestrial trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Spotlighting surveys	2 x one hour and 1 km of spotlighting up to 200 hectares of stratification unit, walking at approximately 1 km per hour on 2 separate nights	Two nights of spotlighting transects, each of 2 person-hours was undertaken throughout the Project Area (10 and 26 February 2015). Eight person hours of spotlighting surveys was undertaken over two nights across the Project Area (24 and 26 May 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Remote camera surveys	-	Remote camera surveys were undertaken in 10 locations across the Project Area. The cameras were installed for 16 nights, totalling 160 nights of remote camera survey (10 to 26 February 2015).	Woodland/Forest Swamp Forest Heath	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate
	Koala SAT surveys	-	10 SAT surveys sampled across the Project Area (28 September 2015).	Throughout the Project Area	Adequate

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Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Bats	Ultrasonic call recording (Anabat)	Two sound activated recording devices utilised for the entire night (a minimum of four hours), starting at dusk for two nights	A total of two full nights of ultrasonic call recording was undertaken at six survey locations within the Project Area (10 and 11 February 2015). A total of four full nights of ultrasonic call recording was undertaken at two survey locations within the Project Area (May 2011 – specific dates not detailed in the RPS constraints report).	Woodland/Forest Swamp Forest Heath	Adequate
	Harp trapping	Four trap nights over two consecutive nights (with one trap placed outside the flyways for one night)	A total of two harp traps were placed along a track within the open forest habitats within the site for a total of four consecutive nights, resulting in eight trap nights (3 May 2011 to 3 June 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Spotlighting surveys	2 x one hour spotlighting on two separate nights	Two nights of spotlighting transects, each of 2 person-hours was undertaken throughout the Project Area (10 and 26 February 2015). Eight person hours of spotlighting surveys was undertaken over two nights across the Project Area (24 and 26 May 2011).	Woodland/Forest Swamp Forest Heath	Adequate
	Opportunistic observations	_	Opportunistic observations were made throughout all surveys (23 May 2011 to 3 June 2011, 28-29 August 2013, 25-26 August 2014, and 10, 12 and 26 February 2015).	Throughout the Project Area	Adequate



The prevailing weather conditions during the fauna surveys conducted within the Subject Land are provided in **Table 3** (RPS 2011; Bureau of Meteorology 2016a-c). A number of limitations were noted in the Ecological Constraints and Assessment report (RPS 2011), in relation to the 2011 fauna surveys. These included: fauna surveys being undertaken in cooler months (i.e. May and June) when detectability of many fauna species, including the majority of amphibian species, is low due to reduced activity; and, heavy rain occurring on a number of days during the survey period.

Date	Temperature	Rain (24 hr to 9 am)	Sunrise	Sunset	Moonrise	Moonset
23 May 2011	12.8 - 24	3.4	6:55 AM	4:54 PM	10:36 PM	11:20 AM
24 May 2011	10.6 – 21	0	6:55 AM	4:55 PM	11:32 PM	11:52 AM
25 May 2011	10.3 – 15.7	42	6:55 AM	4:55 PM	-	12:22 PM
26 May 2011	10.0 – 17.5	13.4	6:56 AM	4:55 PM	12:27 AM	12:50 PM
27 May 2011	7.9 – 18.1	0.2	6:56 AM	4:56 PM	1:20 AM	1:18 PM
30 May 2011	12.6 – 19.5	1	6:56 AM	4:57 PM	4:04 AM	2:53 PM
31 May 2011	12.6 – 19.5	47.2	6:56 AM	4:57 PM	5:01 AM	3:31 PM
1 June 2011	13.7 – 21.4	12.6	6:56 AM	4:57 PM	5:58 AM	4:16 PM
2 June 2011	14.3 – 21.5	3.6	6:56 AM	4:57 PM	6:54 AM	5:06 PM
3 June 2011	10.9 – 19.7	4.8	6:56 AM	4:58 PM	7:48 AM	6:02 PM
28 August 2013	6.4 – 22.4	0	6:15 AM	5:33 PM	-	10:32 AM
29 August 2013	4.7 – 23.2	0.2	6:14 AM	5:33 PM	12:43 AM	11:17 AM
25 August 2014	8.0 – 19.2	17.2	6:19 AM	5:31 PM	5:43 AM	5:16 PM
26 August 2014	8.7 – 18.6	7	6:18 AM	5:31 PM	6:16 AM	6:09 PM
10 February 2015	18.1 – 28.8	0	6:24 AM	7:49 PM	11:09 PM	11:38 AM
12 February 2015	18.3 – 30.1	25	6:26 AM	7:47 PM	11:29 PM	1:28 PM
26 February 2015	19.3 – 26.2	14.2	6:38 AM	7:33 PM	2:03 PM	12:48 AM

## 3.2 SURVEY RESULTS

## 3.2.1 Flora

A total of 150 plant species, of which four were exotic, were identified during surveys undertaken in 2008, 2011 and 2013 – 2015 by RPS (2011) and Umwelt (2015). Three of these species are listed as Vulnerable under both the TSC Act and the EPBC Act; *Eucalyptus* 



camfieldii (Camfield's Stringybark), Eucalyptus parramattensis subsp. decadens and Grevillea parviflora subsp. parviflora (Small-flowered Grevillea).

## 3.2.2 Fauna

A total of 97 fauna species were identified within the Subject Land, including seven amphibian, 57 bird, 25 mammal and eight reptile species. Eight of these species are listed as threatened under the TSC Act and/ or the EPBC Act, and two are listed as migratory under the EPBC Act (**Table 4**).

Common Nome		Status		
	Scientific Name	TSC Act	EPBC Act	
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	-	
Eastern Freetail-bat	Mormopterus norfolkensis	V	-	
Eastern Osprey	Pandion cristatus	V	М	
Grey-headed Flying-fox	Pteropus poliocephalus	V	V	
Koala	Phascolarctos cinereus	V	V	
Little Bentwing-bat	Miniopterus australis	V	-	
Rufous Fantail	Rhipidura rufifrons	-	М	
Varied Sittella	Daphoenositta chrysoptera	V	-	
Wallum Froglet	Crinia tinnula	V	-	

Table 4: Threatened Fauna Species Identified within the Subject Land

Status: V = Vulnerable (TSC Act and EPBC Act), M = Migratory (EPBC Act)

### 3.2.2.1 Koala

A total of 10 Koala Spot Assessment Technique (SAT) surveys were undertaken in the Subject Land in September 2015 by Umwelt. Searches were undertaken on and around the base of 30 trees at each site. Searches included looking for signs of Koala activity including scats at the bases of trees or characteristic scratches on the trunk. The SAT surveys were completed across the Subject Land in five of the mapped vegetation communities which contained Koala feed trees (refer to Table 2.4). No signs of Koala activity were recorded at any of the 10 SAT survey locations and therefore, activity levels within the Subject Land at that time can be considered to be zero. The usage of the Subject Land by Koalas and the ability to detect use had been affected by the recent intense bushfire in October 2013. The trees occurring across the Subject Land were still recovering from this fire event at the time of the surveys.



SAT Survey Number	Vegetation Community	Koala Activity
SAT 1	Coastal Sand Apple – Blackbutt Forest	0%
SAT 2	Coastal Sand Apple - Blackbutt Forest	0%
SAT 3	Swamp Mahogany – Paperbark Swamp Forest	0%
SAT 4	Tomago Sand Swamp Woodland	0%
SAT 5	Coastal Sand Apple - Blackbutt Forest (Rehabilitation)	0%
SAT 6	Tomago Sand Swamp Heath	0%
SAT 7	Coastal Sand Apple - Blackbutt Forest (Rehabilitation)	0%
SAT 8	Swamp Mahogany – Paperbark Swamp Forest	0%
SAT 9	Swamp Mahogany – Paperbark Swamp Forest	0%
SAT 10	Coastal Sand Apple - Blackbutt Forest	0%

Table 5:	Results of Koala S	SAT Surveys
l able 5:	Results of Koala 3	SAI Survey

While the SAT surveys conducted by Umwelt in 2015 did not identify any Koala activity, the Subject Land would have contained habitat suitable for utilisation by the species. Matthews *et al.* (2007) identified that burnt trees could be utilised by Koalas from as little as three months after fire, as the epicormics growth provides sufficient nutrients. Un-burnt areas are important during wildlife events, to maintain the population and service as source of colonising individuals into area of burnt bush (Matthews *et al* 2007). It is likely that Koala re-colonisation of the habitat burnt in 2013 fire, including the Subject Land, is still occurring. This is supported by the lack of activity detected by Umwelt in 2015 (two years post fire), and the lack of Atlas records within burnt areas in close proximity to the Subject Land. Post 2013 fire event, there are seven records of the species within 5 km of the Subject Land (within the KMU). These occur along Medowie Road approximately 3 to 4 km to the east/ north-east (4 records from 2014) and approximately 4 km north along Richardson Road (two record from 2014 and one record from 2015). The four records along Medowie road all occur within areas that were not burnt during the fire and the three records along Richardson Road occur within 1 km of the mapped fire extent.

It is considered that the SAT results do not accurately portray the potential usage of the Subject Land by Koalas. Phillips and Callaghan (2011) acknowledge that this is a limitation of the SAT methodology and state that "Low activity levels recorded in what might otherwise be med-high carrying capacity *P. cinereus* habitat may be a result of contemporary population dynamics, landscape configuration and/ or historical disturbances including logging, mining, fire, agricultural activities and/ or urban development. Such considerations should not necessarily detract from the potential importance of such habitat for longer-term conservation, particularly if preferred koala food trees are present and populations of *P. cinereus* are known to occur in the general area".



Due to the presence of preferred feed trees (*Eucalyptus robusta, Eucalyptus parramattensis* subsp. *decadens* and *Eucalyptus signata*), the number of historic records in the locality (46 Atlas records within 1 km of the Subject Land; nine of which occur within the Subject Land), the connectivity to vegetation to the north and the importance of the Port Stephens Koala population the Subject Land it is considered to be an area of medium to high quality habitat for Koalas.

The Koala habitat mapping for the site has been updated, based on additional vegetation mapping surveys conducted by Kleinfelder, see **Section 4.3.1**.



# 4. ADDITIONAL ECOLOGICAL SURVEYS

This section outlines the additional field surveys and habitat assessment conducted by Kleinfelder in 2016.

## 4.1 **VEGETATION MAPPING**

## 4.1.1 Methodology

### 4.1.1.1 Review of Previous Studies

The two previous assessments conducted across the Subject Land and several regional vegetation studies were reviewed prior to conducting the vegetation assessment within the Subject Land. These studies were used to assist with the stratification of the site into vegetation zones, selection of plot/transect locations and determination of plant community types (PCTs).

These reports included:

- Ecological Constraints and Opportunities Assessment (RPS 2011);
- Ecological Assessment (Umwelt 2015a) Appendix 8 of the Environmental Impact Statement (Umwelt 2015b) prepared for the proposed sand quarry;
- Vegetation of the Tomago and Tomaree Sandbeds, Port Stephens NSW (Bell and Driscoll, 2006);
- Vegetation Survey Classification and Mapping Lower Hunter and Central Coast Region (LHCCREMS; NPWS 2000); and
- Hunter, Central and Lower North Coast Vegetation Classification and Mapping Project (Somerville, 2009).

### 4.1.1.2 Vegetation Survey and Mapping

Vegetation surveys and mapping was conducted by Kleinfelder, May – August 2016. The field surveys were conducted in accordance with the Biobanking Assessment Methodology (BBAM; OEH 2014) and *Threatened Biodiversity Survey and Assessment: Guidelines of Developments and Activities (working draft)* (DEC 2004). Details of the methodology used is outlined in the following sections.



### **Aerial Photo Interpretation**

Prior to field surveys, the spatial distribution of the vegetation and key features across the Subject Land were mapped remotely from aerial photography and satellite imagery through systematic visual inspection by an experienced botanist. This process involved digitising polygons around vegetation patches with homogenous combinations of the following parameters: dominant species, ground cover, woody cover, and growth stage at a scale of approximately 1:500 using a Geographic Information System (GIS) (ArcGIS). The latest Nearmap © imagery available for the site from October 2015 was used as the primary basis for all linework and attribution.

### **Field Surveys**

Vegetation surveys were conducted across the Subject Land on 6 and 9 – 13 May, 16 June, 1 July, 9 and 11 August 2016. The boundaries of each of the identified vegetation communities within the Subject Land were mapped using a combination of rapid data points (RDP) and walking transects, using the polygons produced through aerial photo interpretation (API) to assist in targeting survey effort. RDPs involved collecting waypoints over the Subject Land using a hand held Trimble<sup>™</sup> GPS unit and recording dominant species, structure and condition. Walking transects involved verifying polygons were homogenous in floristic composition and condition, as well as walking vegetation ecotones and using the recorded tracks to define vegetation community boundaries. The RDPs and survey tracks were then overlaid on an aerial photograph and used to delineate and/or clarify vegetation boundaries.

#### Site Stratification and Plot/ Transect Survey Effort

The Subject Land was stratified into vegetation zones based on the vegetation type and condition (e.g. age and structure of vegetation and weed cover). The development site and offset area were stratified separately. As per the BBAM 2014, a vegetation zone was defined as a relatively homogenous area that is the same vegetation type and has a similar broad condition state.

Following stratification of the sites into vegetation zones, plots/transects were undertaken, with a total of 45 plots/transects surveyed (11 within the development site and 34 within the offset area). The location of the plots/transects were selected through stratified random sampling to provide a representative sample of the variation in vegetation composition and condition within each vegetation zone. This survey effort sampled each of the vegetation zones adequately in accordance with the requirements of the BBAM 2014. The floristic plots (20 m x 20 m) were



surveyed for the presence of flora species. Each quadrat was carefully examined to identify all plant species present. Surveys were conducted until all flora species in each quadrat were recorded. Within each quadrat floristic data were collected, including stratum, growth form, species name, cover and abundance rating for each species. Along each 20 m x 50 m transect data on vegetation condition were collected in accordance with Section 5.3 of the BBAM 2014.

### Linework and Attribution

RDPs and plots were classified and tagged with a PCT by field surveyors. Polygons produced from the API work adopted the PCT of the sample point that they intersected. Field surveyors undertook a desktop inspection of linework, orthophotos and other GIS data (including 2 m contours, watercourses, and soil landscapes spatial datasets) to attribute any remaining polygons.

### Plant Community Type and TEC Determination

The identification of vegetation communities was based on dominant species present in the overstorey, midstorey, shrub and ground layers as recorded in the 20 m x 20 m floristic quadrats. The floristic and structural composition, as well as landscape position, soil type and other diagnostic features, of each vegetation community was compared to the vegetation descriptions in Vegetation of the Tomago and Tomaree Sandbeds (Bell and Driscoll 2006), Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS; NPWS, 2000) and Hunter, Central & Lower North Coast Vegetation Classification & Mapping Project (Somerville 2009) in order to arrive at an accepted community identity. Each vegetation community was also matched to an equivalent formation and class, as described by Keith (2004), as well as an equivalent Plant Community Type (PCT) (OEH 2016b) to enable the credit calculations as per the BBAM 2014 to be undertaken.

To determine the conservation status of each community within the Subject Land, the floristic and structural composition, as well as landscape position, soil type and other diagnostic features, of each vegetation community was also compared against Threatened Ecological Communities (TECs) listed under the NSW TSC Act and the Commonwealth EPBC Act.

### Floristic Identification and Nomenclature

Floristic identification and nomenclature was based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNet (<u>http://plantnet.rbgsyd.nsw.gov.au</u>). If a plant was unable to be identified using these references, a sample was sent to the National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW.



## 4.1.2 Results

Six native vegetation communities were identified within the Subject Land, these six native vegetation communities were stratified into 10 vegetation zones. Additionally, one area of exotic vegetation and small areas of cleared land (access tracks and previous sand extraction areas) also occur. The area of each vegetation community within the development site, offset area and excluded land are outlined in **Table 6**.

One of the native vegetation communities identified within the Subject Land, Swamp Mahogany – Paperbark Swamp Forest, is consistent with the *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* Endangered Ecological Community (EEC), listed under the TSC Act (NSW Scientific Committee 2004).

Vegetation Community	Development Area (ha)	Offset Area (ha)	Excluded Land (ha)	Total (ha)
Coastal Sand Apple – Blackbutt Forest	18.35	25.65	1.18	45.18
Coastal Sand Apple – Blackbutt Forest (Regenerating Vegetation)	2.84	1.73	0.27	4.84
Coastal Sand Apple – Blackbutt Forest (Rehabilitation)	19.01	3.60	-	22.61
Coastal Sand Wallum Woodland-Heath	0.04	29.91	-	29.96
Swamp Mahogany – Paperbark Swamp Forest	0.13	24.58	-	24.72
Swamp Mahogany – Paperbark Swamp Forest (Regenerating Vegetation)	-	15.55	-	15.55
Coastal Wet Sand Cyperoid Heath	-	15.10	-	15.10
Tomago Sand Swamp Heath	-	10.26	-	10.26
Tomago Sand Swamp Woodland	-	3.75	-	3.75
Exotic Vegetation	-	-	1.23	1.23
Excluded Land (Cleared Land)	1.88	0.99	0.05	2.82
Total Area	42.25	131.12	2.74	176.12
Total Native Vegetation	40.38	130.14	1.46	171.97

Table 6 <sup>.</sup>	Area of each Vegetation Community within the Subject Land
	Area of each vegetation community within the Subject Land

The location of each vegetation community within the Subject Land is shown on **Figure 1**. A species list of the flora species recorded within each quadrat is provided in **Appendix 1** and full descriptions of each community are provided in **Appendix 2**.





## 4.2 THREATENED FLORA SURVEYS

## 4.2.1 Eucalyptus camfieldii

### 4.2.1.1 Background

*Eucalyptus camfieldii* is a tree or mallee growing to 10 m high with orbiculate, cordate, glossy green and hispid juvenile leaves. Adult leaves are broad-lanceolate, 7 - 10 cm long, 2 - 3 cm wide, green and glossy. Buds are sessile, broadly ovoid and angular. The species occurs in coastal shrub heath on sandy soils on sandstone, often of restricted drainage (Hill 2002).

The core distribution of the species is the Hawkesbury Sandstone geology of the Sydney Basin, with all occurrences in small, localised populations in low forest or scrub (Hill 2003; Bell and Driscoll 2006). The identification of the species during the 1990's at Norah Head, Charmhaven, Forresters Beach, Dudley and Tomago, was an extension of the species range (Hill 2003). Hill (2003) discusses that the northern populations differ from the core *E. camfieldii* population, "in the reduction or absence of the cordate orbiculate juvenile leaves, the longer buds and the sometimes longer leaves". The populations inspected by Hill (2003) in the Wyong area were described as hybrids, with putative parent species of *E. camfieldii* and *E. capitellata* or *E. oblonga*. Ecological segregation was also observed by Hill (2003), one example is plants at Lake Haven exhibiting more *E. capitellata* characteristics in the drier eucalypt dominated sites, and plants in the wetter *Melaleuca* dominated sites showed more characteristics of *E. camfieldii*.

Hill (2003) also outlined that for identification purposes, "plants with a majority of morphological features of any one species can be identified as that species...as morphology reflects the predominance of the genes of that species".

The extent of the population on the Tomago Sandbeds is poorly understood. There are only four Atlas records of the species on the Tomago Sandbeds; two within the Subject Land and two at the south of the RAAF live firing range. It is likely that two of these records are duplicates (one at each location), and that the Atlas database only contains records of the species at two locations, as two of the records are sourced from Royal Botanic Gardens Herbarium Specimen Register (likely to be the samples sent to the herbarium for identification). Bell and Driscoll (2006) recorded a small number of individuals or groups at five locations on the Tomago


Sandbeds. Three of these locations occur within 3 km of the Subject Land (one likely to be the Atlas Records within the Subject Land).

### 4.2.1.2 Background within the Subject Land

During surveys in 2008 RPS identified one individual *Eucalyptus camfieldii* within the proposed disturbance area (specimen confirmed by the Royal Botanic Gardens Sydney (RBGS); Letter from RBGS supplied in Ecological Constraints and Opportunities Report (RPS 2011)). A population count of the species within the study area was not conducted as part of the RPS assessment. Umwelt conducted targeted surveys for the species and sent a number (not specified) of samples to the RBGS for identification. All samples were positively identified as *Eucalyptus capitellata* (Brown Stringybark) (letter from the RBGS was not provided in the Umwelt (2015) report).

During vegetation surveys in 2016 Kleinfelder identified potential *E. camfieldii* plants within the Subject Land (rehabilitation area (disturbance area) and the offset area). A total of eight specimens were sent to the RBGS for identification (letter from the RBGS is provided in (**Appendix 3**):

- Two specimens collected on 11 August from the Tomago Sand Swamp Heath (offset area) were both confirmed to be *E. camfieldii* (Enquiry No: 19772);
- Four specimens collected on 29 and 30 August; one sample of a Stringybark from within the rehabilitation within the disturbance area, and three from within the rehabilitation area adjoining to the Subject Land to the west, were also confirmed to be *E. camfieldii* (Enquiry No: 19782); and
- Two specimens from the disturbance area, collected 8 September were sent for identification. One was confirmed as *E. camfieldii* and the second was given an identification as probable *E. camfieldii* (Enquiry No: 19796).

### 4.2.1.3 Survey Methods

### Identification

As discussed above, the species is similar to *E. capitellata* and differentiation between these two species can be difficult. To assist with identification in the field, Kleinfelder discussed with the RBGS the key characteristics used to identify the specimens sent to the herbarium. The following characteristics were used:



- The primary identification tool was the leaf length to breadth ratio, being less than 3:1 in *E. camfieldii* and greater than 3:1 in *E. capitellata* (**Plate 1**);
- Leaves are thick and leathery;
- Blunt leaf apex with a mucro (*E. capitellata* typically has a more graduating leaf tip) (Plate 1); and
- Sessile buds that are angled (separates the species from *E. globoidea* which has pedicellate buds that are not angular) (**Plate 1**).



Plate 1: Examples of *Eucalyptus camfieldii* characteristics used for identification; leaf length to breadth ratio (top left and right), blunt leaf apex with mucro (top left and right), and sessile angular buds (bottom left).

Field surveys were conducted when the species was in-bud. As such, distinction between *E. camfieldii* and *E. globoidea* was based on bud characteristics (as these two species both have a leaf length to breadth ratio of less than 3:1). When distinguishing the species from *E. capitellata,* the leaf length to breath ratio was the primary determination tool used.



The specimen that was identified by the RBGS as 'probable *E. camfieldii*' was assumed to be the threatened species; only two individuals exhibiting the characteristics of this sample were identified within the subject site.

*Eucalyptus camfieldii* is a mallee tree and can sucker. As such where groups of stems occur, they were defined as one individual. Typically the separation distance between stems of separate individuals was defined as >1 m; however, where it was obvious that stems were connected (i.e. visible roots or lignotubers), stems >1 m apart were counted as an individual.

### Subject Land

Counts of the species within the Subject Land were conducted in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016). Surveys were conducted by walking systematic parallel transects 5 - 20 m apart through areas of suitable habitat (**Figure 2**). Where individuals were identified, their location was recorded with a hand-held GPS.

Habitat for the species was defined as the Coastal Sand Wallum Woodland-Heath, Tomago Sand Swamp Heath, low lying areas of Coastal Sand Apple Blackbutt Forest and the Coastal Sand Apple Blackbutt Forest (Rehabilitation).

### Off-Site

In addition to surveys within the subject site, surveys for the species were conducted in surrounding areas to determine the extent of the local population on 29, 30 August 7, 8, 9, 13, 15 September 2016 (**Figure 2**). Surveys were conducted within the Tilligerry SCA and on Hunter Water land to the north, north-west and north-east of the Subject Land. Areas mapped by Bell and Driscoll (2006) as Disturbed (Rehabilitation Mining Lands) and Peppermint-Apple-Bloodwood Forest, particularly where this community intergrades with Clay Wallum Scrub, were targeted. Additionally, the approximate location of where the species was identified within close proximity to the Subject Land by Bell and Driscoll (2006) were targeted. Surveys were conducted by walking systematic parallel transects 20 - 40 m apart. Where individuals were identified, their location was recorded with a hand-held GPS.





### 4.2.1.4 Results

A total of 1,868 *E. camfieldii* individuals were identified within the Subject Land; 227 within the development site and 1,641 within the offset area (**Plate 2** and **Figure 3**). The majority of the individuals occur within the Coastal Sand Wallum Woodland-Heath. The species also occurs within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation), Tomago Sand Swamp Heath and low lying areas of the Coastal Sand Apple – Blackbutt Forest which are co-dominated by *Eucalyptus piperita* (Sydney Peppermint), and also typically where *Melaleuca nodosa* (Prickly-leaved Paperbark) occurs.

The 229 individuals which occur within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) are likely to have been planted/seeded into the area post mining in the 1970's, and it is highly unlikely that the species would have been present prior to rehabilitation. The majority of the naturally occurring population within the Subject Land was identified at lower elevations, typically below 6 m elevation, within the Coastal Sand Wallum Woodland-Heath and Tomago Sand Swamp Heath. Only a few individuals were identified within the Coastal Sand Apple - Blackbutt Forest. These individuals occur at elevations below 9 m in areas which are co-dominated by *Eucalyptus piperita* (Sydney Peppermint) and with *Melaleuca nodosa* (Prickly-leaved Paperbark) in the understorey.

A total of 395 individuals were identified during surveys outside the Subject Land (**Figure 3**). The majority of these individuals, 334, were identified within Disturbed areas (Rehabilitation Mining Lands) to the north and west of the Subject Land. A further 61 individuals were identified within an area to the north of the Subject Land mapped as Peppermint – Apple – Bloodwood Forest by Bell and Driscoll (2006).

The total local population of *E. camfieldii* identified during the surveys was 2,263 individuals. All patches of *E. camfieldii* identified during the field surveys occur within 3 km of the individuals within the Subject Land and are within vegetation that is contiguous with the Subject Land. As such all individuals identified during field surveys will be assessed as occurring within the local population for the purposes of this impact assessment. It is likely that they are cross-pollinating with individuals within the Subject Land, as highly mobile species, such as birds, bats and insects, are pollinators for Eucalypts (House 1997). As such there is the potential for genetic material to be spread large distances (Potts 1997).

Not all areas of available habitat, or areas of rehabilitation, in the area to the north and west of the Subject Land were surveyed. As such the local population may be larger than determined.





Plate 2: *Eucalyptus camfieldii* within the Disturbance Area (rehabilitation) (left), and within the Offset Area (right).

Vegetation Community         Casital Sand Apple - Blackbutt Forest         Casital Sand App			
Legend Subject Land (176.1 ha) Biobank Site Boundary (131.1 ha) Development Area Boundary (42.3 ha) ☆ Excluded Areas (2.7 ha) Eucalyptus camfieldii Locations Within Offset Site (1,641 individuals) Within Development Site (227 individuals) Outside of Subject Land (395 individuals)	km         PROJECT REFERENCE:         20170448           0         0.05         0.1         0.2         0.3         0.4         0.5           N         DATE DRAWN:         14/10/2016         10:42         Version           DRAWN BY:         gjoyce           DATA SOURCE:         NSW Land and Property Information - 2011           Noww.kleinfelder.com         NSW Land and Property Information - 2011	Eucalyptus camfieldii Locations           Williamtown Sand Syndicate           Ecological Summary Report           Proposed Sand Quarry           Cabbace Tree Road, Williamtown	FIGURE:

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# 4.2.2 *Eucalyptus parramattensis* subsp. *decadens*

To inform the impact assessment, additional surveys for *E. parramattensis* subsp. *decadens* were conducted by Kleinfelder within the land adjoining the Subject Land. These surveys were conducted to estimate the size of a 'local population' of *E. parramattensis* subsp. *decadens* in which the individuals within the study area form a part of. A study conducted by Bell (2006) on the distribution and habitat of *E. parramattensis* subsp. *decadens* for the NSW Department of Environment and Conservation is the primary source of population information for this subspecies.

## 4.2.2.1 Regional Population Information

*Eucalyptus parramattensis* subsp. *decadens* occurs within two distinct meta-populations within the Hunter-Central Rivers CMA, one on the Tomago Sandbeds and the other in the Cessnock-Kurri region (Bell 2006). As of August 2015, a total of 3,047 records of the species occur within the NPWS Atlas Database; 1,224 occur within the Tomago Sandbeds population.

Bell (2006) estimated that the Tomago Sandbeds meta-population was between 2,500 and >8,000 individuals. This assessment was based on the number of NPWS Atlas records (820 records in the meta-population in 2006) and that each record may represent between 3 and 10 individuals. As such, using this methodology, an updated population assessment based on the number of records as of August 2016 would be between 3,500 and >12,000 individuals.

Bell (2006) defined nine sub-populations within the Tomago Sandbeds meta-population. Each population was based on a separation distance of greater than 1 km between successive records. As such the individuals within the Subject Land occur within the RAAF Williamtown West sub-population (shown on **Figure 4**). Using Bell's 2006 population estimate methodology, this sub-population would be between 1,900 and 6,500 individuals (based on 654 records within this sub-population all records that occur on developed or cleared land were excluded).

As this population estimate methodology used by Bell (2006) was based solely on the number of NPWS Atlas records, a more detailed estimate of the sub-population was conducted to inform the impact assessment. The methodology is outlined below.



## 4.2.2.2 Local Population

In determining the local population of the individuals within the study area, the *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC 2007), were taken into consideration. DECC (2007) defines 'the local population of a threatened plant species as comprising those individuals occurring in the study area or the cluster of individuals that extend into the habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area'. As such, the definition of the local population as the RAAF Williamtown West sub-population is considered to be appropriate for the impact assessment (**Figure 4**), as the Subject Land is contiguous with the sub-population are separated by less than 1 km (Bell 2006); and, the species is likely to be pollinated by foraging birds, bats and insects, as with most eucalypts, hence material has the potential to be spread kilometres (OEH 2011a).

### Methodology for Local Population Estimate

### **Density Estimates**

To estimate the population size of *E. parramattensis* subsp. *decadens* within the RAAF Williamtown West sub-population, density estimates of the species within key vegetation types was conducted.

Within the sub-population area, the number of NPWS Atlas records within each vegetation community mapped by Bell and Driscoll (2006) was assessed to determine the vegetation communities which contain the highest number of *E. parramattensis* subsp. *decadens* records. This assessment identified the Clay Wallum Scrub (Unit 3ai) and Earp's Gum Sedge Woodland (Unit 4d) which contained 152 and 118 records, respectively (**Table 7**). The results of this analysis are supported by the vegetation descriptions within the Bell and Driscoll (2006) report, which identifies *E. parramattensis* subsp. *decadens* as the dominant tree species within three vegetation communities; Clay Wallum Scrub (Unit 3ai), Earp's Gum – Peppermint Scrubby Forest (4cii, 4ciii, 3aii) and Earp's Gum Sedge Woodland (Unit 4d).



Table 7:Number of NPWS Atlas records per Bell and Driscoll (2006) VegetationCommunities within the RAAF Williamtown West sub-population and the area of<br/>each vegetation community

Vegetation Community (Bell and Driscoll 2006)	Number of NPWS Atlas Records	Area (ha) within Sub- population Extent
Callistemon-Hakea Shrub Swamp (2e)	3	10.16
Clay Wallum Scrub (3ai)	152	230.14
Disturbed - rehabilitated mining lands (R)	17	527.03
Earp's Gum Sedge Woodland (4d)	118	162.98
Fringing Baloskion Sedge Woodland (3e)	3	56.86
Lepidosperma Sedgeland (2i)	2	31.47
Paperbark-Apple-Mahogany Dry Swamp Forest (1i)	4	59.49
Peppermint-Apple-Bloodwood Forest (1aii)	3	82.22
Scribbly Gum-Apple-Bloodwood Forest (1b)	13	428.92
Swamp Mahogany Forest (1ii)	2	29.54
Tomago Blackbutt-Apple-Bloodwood Forest (1ai, 1aii, 1c)	3	108.68

As such, areas of Clay Wallum Scrub and Earp's Gum Sedge Woodland were targeted during surveys. Due to the low number of records within other vegetation community types and as Bell and Driscoll (2006) do not describe *E. parramattensis* subsp. *decadens* as occurring within them, density estimates were not conducted within these vegetation communities. The occurrence of the species within other vegetation communities is likely to be due to localised favourable conditions that cannot be accurately predicted, e.g. ecotones between preferred habitat and dry forest communities. There are also a number of records of the species within rehabilitation areas, and it is documented that the species was used in rehabilitation works following heavy mineral mining by RZM Pty Ltd on the sandbeds (i.e. the western portion of the population within the study area). However, areas of rehabilitation have not been used as part of the density estimates as the occurrence of the *E. parramattensis* subsp. *decadens* within these areas is potentially not predicable.

The density of *E. parramattensis* subsp. *decadens* was estimated by conducing counts of the species within 20 m x 20 m quadrats across areas of preferred habitat (Clay Wallum Scrub and Earp's Gum Sedge Woodland). Prior to conducting the field surveys, plot locations were selected to ensure an even distribution across the sub-population. Plot locations were selected to sample as many patches of preferred habitat as possible, and plots were located to sample areas that contain historical records and those without records (plot locations shown on **Figure 4**).



The location of each plot was loaded on to a hand held Trimble<sup>TM</sup> GPS unit to allow for navigation to the location in the field. During field surveys meandering transects were conducted through the areas of the targeted vegetation communities to assess the general density of *E. parramattensis* subsp. *decadens* within a patch. When the plot location was reached, if the density was not representative of that patch, the location was moved to ensure a representative sample was taken (a total of seven of the 19 plot locations were moved). Additionally, the boundary of the target vegetation communities with surrounding vegetation types was confirmed.

#### Area Searches

Within the land directly adjoining the study area to the west and north, where *E. parramattensis* subsp. *decadens* had been recorded within the study area, targeted surveys for the species were conducted by walking systematic parallel transects approximately 5 to 20 m apart. The location of each individual was recorded on a handheld GPS unit. Additionally, Kleinfelder were provided access to land owned by Port Stephens Shire Council approximately 750 m to the east of the Subject Land (Lot 1310 DP 1197158). Counts of individuals within this lot were also conducted. The location of area searches conducted is provided on **Figure 4**.

### **Results of Local Population Estimate**

#### **Density Estimates**

An average of 8.21 *E. parramattensis* subsp. *decadens* were recorded in the quadrats (**Table 8**).

Quadrat	Mapped Community Type (Bell and Driscoll 20016)	KLF Community Determination (at Plot Location)	Count
1	Clay Wallum Scrub	Clay Wallum Scrub	9
2	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	12
3	Clay Wallum Scrub	Clay Wallum Scrub	3
4	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	5
5	Clay Wallum Scrub	Earp's Gum Sedge Woodland	16
6	Clay Wallum Scrub	Earp's Gum Sedge Woodland	6
7	Clay Wallum Scrub	Clay Wallum Scrub	0
8	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	0
9	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	0
10	Clay Wallum Scrub	Clay Wallum Scrub	2
11	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	1

Table 8:	Number of Eucalyptus parramattensis subsp. decadens recorded within each
	quadrat sampled within the RAAF Williamtown West sub-population



Quadrat	drat Mapped Community Type KLF Community Determination (at (Bell and Driscoll 20016) Plot Location)		Count
12	Clay Wallum Scrub	Clay Wallum Scrub	9
13	Clay Wallum Scrub	Clay Wallum Scrub	9
14	Clay Wallum Scrub	Earp's Gum Sedge Woodland	6
15	Earp's Gum Sedge Woodland	Clay Wallum Scrub	8
16	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	29
17	Clay Wallum Scrub	Clay Wallum Scrub	16
18	Earp's Gum Sedge Woodland	Earp's Gum Sedge Woodland	12
19	Clay Wallum Scrub	Clay Wallum Scrub	13
Average Number per Quadrat			8.21
		Average Density per Quadrat	205.26

During the field surveys it was noted that the boundaries of the targeted vegetation communities and surrounding vegetation types (typically dry sclerophyll forest types or swamp sclerophyll forests), were largely correct. The differentiation between the target vegetation types and other vegetation types was easily distinguishable via API, and where boundaries were not visited they were checked using this method. No changes to the vegetation boundaries were made.

It was noted during the field survey that areas of Clay Wallum Scrub and Earp's Gum Sedge Woodland were at times incorrectly identified as each other (**Table 8**). This is likely due to the high similarities in floristics and landscape position between areas of these two vegetation types. Due to time restrictions, the polygons of the two target vegetation communities were not attributed during field surveys. Additionally, differentiation between the two communities via API was difficult. As such the total area of these two communities within the sub-population was used to estimate the local population. This methodology was deemed to be appropriate as the extent of the two communities was confirmed as correct (i.e. total area used for density estimate), and the two vegetation communities had similar ranges in *E. parramattensis* subsp. *decadens* densities.

#### Area Searches

A total of 360 individuals were identified during area searches conducted by Kleinfelder (131 individuals were recorded to the west of the Subject Land, 197 to the north of the Subject Land, and 30 individuals within Lot 1310 DP 1197158).



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### **Total Estimated Local Population**

Within the RAAF Williamtown West sub-population there is a total of 230.14 ha of Clay Wallum Scrub and 162.98 ha of Earp's Gum Sedge Woodland mapped by Bell and Driscoll (2006). As outlined above, the total area of the two target communities were used in the population density estimate due to difficultly in differentiating the two communities. As such, this equates to a total of 393.13 ha of potential habitat for *E. parramattensis* subsp. *decadens* within the sub-population area.

During the area searches, a patch of Clay Wallum Scrub to the north of the study area was surveyed, with no individuals identified. As such, the area of this polygon (13.17 ha; shown on **Figure 4**) was subtracted from the area of potential habitat used to calculate the density estimates, giving a total area of 379.96 ha of potential habitat within the sub-population.

The initial density estimate calculated a total of 77,992 individuals occurring within the 379.96 ha of potential habitat within the sub-population area; based on a density of 205.26 individuals per ha (as outlined in **Table 8**). The population density estimate calculation was reduced by a factor of 50% for the final local population estimate. A number of variables were accounted for in the population estimates through; pre-determined plot locations that were distributed throughout areas of potential habitat, assessments of the heterogeneity of *E. parramattensis* subsp. *decadens* within targeted vegetation community polygons, and validation of vegetation mapping (extent of the two communities). However, this factor was applied to account for the relatively small area of the population sampled during the density estimates; total of 19, 20 x 20 m plots equates to 0.76 ha (0.2% of the total area of potential habitat). The application of the 50% revision factor gives a density of 102.63 individuals per hectare (note: the density of individuals within the Tomago Sand Swamp Woodland within the Subject Land (equivalent to the Earp's Gum Sedge Woodland) is 122.13 plants/ ha).

The estimate of the RAAF Williamtown West Sub-population is 40,214 individuals; 38,996 individuals from the density estimate surveys, and 1,218 from area searches (864 within the Subject Land, 324 on land adjacent to the Subject Land and 30 individuals on Lot 1310 DP 1197158) (**Table 9**).

It should be noted that the total local population is potentially significantly larger, as areas of mine rehabilitation were not assessed during this population estimate. It was noted that the species occurs within mine rehabilitation areas to the north of the subject site, during surveys for *Eucalyptus camfieldii*.



Method	Average Density/ ha	Area (ha) of Potential Habitat	Population Estimate/ Count
Population Density (50% adjusted)	102.63	379.96	38,996
Count – Subject Land	-	-	864
Count – Land Adjacent to Subject Land	-	-	324
Count – Council Land	-	-	30
Total Local Population Estimate 40,214			

#### Table 9: Eucalyptus parramattensis subsp. decadens local population estimate

### *Eucalyptus parramattensis* subsp. *decadens* within the Subject Land

During surveys conducted by Umwelt in 2013 – 2015 and RPS in 2011, a total of 864 individuals were identified within the Subject Land. The revised extraction area will impact on a total of 230 of these individuals, with a total of 634 being retained within the on-site offset area (**Figure 4**).

# 4.3 FAUNA HABITAT ASSESSMENTS

# 4.3.1 Koala

### 4.3.1.1 Habitat Mapping within the Subject Land

### Methods

The Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) applies to all development applications on land within the Port Stephens LGA. The extent and quality of Koala habitat within the Subject Land was determined using the methodology described in *Appendix 6 - Guidelines for Koala Habitat Assessments* of the *Port Stephens Council Comprehensive Koala Plan of Management* (CKPoM) (PSC 2002). The Koala Habitat Assessment is undertaken in four major parts:

- Preliminary Assessment: examination of the Koala Habitat Planning Map of the Port Stephens LGA to determine mapped Koala Habitat and undertake an inspection of the site to determine whether it contains individuals of preferred Koala feed trees (Table 10) outside areas mapped as Preferred Koala Habitat.
- 2. **Vegetation Mapping**: mapping vegetation types across the study area using aerial photography and detailed ground-truthing. Floristic and structural characteristics of each vegetation community was determined using plot-based survey methods.



- 3. Koala Habitat Identification: If the LGA-wide Koala habitat map produced by PSC is inaccurate for the site, a revised map must be developed in accordance with the Koala habitat categories defined in the CKPoM. If it is identified that the site contains either preferred or supplementary Koala habitat, habitat buffers or Habitat linking areas then proceed to Step 4.
- 4. **Assessment of Proposal:** At this point, a map needs to be produced showing information gathered in Steps 1, 2 and 3 and showing the proposed development. The appropriateness of the proposal is assessed using performance criteria from Appendix 4 of the CKPoM.

Scientific Name	Common Name
Eucalyptus robusta	Swamp Mahogany
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus parramattensis	Earp's Gum

#### Table 10: List of Preferred Koala Feed Trees in the Port Stephens LGA.

### Results

Field assessments and vegetation mapping surveys identified that the PSC Koala habitat mapping for the Subject Land was inaccurate, with a larger amount of preferred and supplementary habitat identified during the field surveys.

The definitions of Preferred and Supplementary habitat in the CKPoM and Lunney *et al.* (1998) were applied to the revised vegetation mapping. The justification for this mapping is outlined in **Table 11**. A revised Koala habitat map is provided in **Figure 5**.

Vegetation Type	Classification	Justification
	Supplementary	This vegetation most closely aligned to the Tall Open Blackbutt Sydney Red Gum Forest in Table 1 of Lunney <i>et al.</i> (1998), which is a Category C Vegetation Association.
Coastal Sand Apple – Blackbutt Forest	Preferred	An area of this vegetation community (represented by Quadrat 17 on <b>Figure 1</b> ) is co-dominated by <i>Eucalyptus signata</i> , as such it is considered to most closely align to the Open Blackbutt and Sydney Red Gum Forest with Scribbly Gum in Table 1 of Lunney <i>et al.</i> (1998), which is a Category B Vegetation Association.
Coastal Sand Apple – Blackbutt Forest (Regenerating)	Supplementary	As above for Coastal Sand Apple – Blackbutt Forest classified as Supplementary
Coastal Sand Apple – Blackbutt Forest (Rehabilitation)	Preferred	The canopy of this vegetation community is co-dominated by both <i>Eucalyptus parramattensis</i> subsp. <i>decadens</i> and <i>Eucalyptus signata,</i> as such this area has been classified as preferred habitat.

 Table 11:
 Classification of Koala Habitat as per CKPoM



Vegetation Type	Classification	Justification
Coastal Sand Wallum Woodland – Heath	Preferred	This vegetation is most closely aligned to Sydney Red Gum, Red Bloodwood, Brown Stringybark, White Stringybark Forest with Scribbly Gum in Table 1 of Lunney <i>et al.</i> (1998), which is a Category A Vegetation Association.
Coastal Wet Sand Cyperoid Heath	Other	Classified as an Excluded Vegetation Association (Moist Heathland/ Sedgeland), as per Table 1 of Lunney <i>et al.</i> (1998).
Swamp Mahogany – Paperbark Swamp Forest		This vegetation is most closely aligned to Open Swamp
Swamp Mahogany – Paperbark Swamp Forest (Regenerating)	Preferred	Dominating in Table 1 of Lunney <i>et al.</i> (1998), which is a Category B Vegetation Association.
Tomago Sand Swamp Heath	Other	Classified as an Excluded Vegetation Association (Closed Heathland), as per Table 1 of Lunney <i>et al.</i> (1998).
Tomago Sand Swamp Woodland	Preferred	The canopy of this vegetation community is dominated by <i>Eucalyptus parramattensis</i> subsp. <i>decadens</i> and <i>Eucalyptus</i> <i>signata</i> also occurs, as such this area has been classified as preferred habitat.
Exotic Vegetation	Cleared Land	Non-native vegetation with limited canopy
Excluded (Cleared Land)	Cleared Land	Cleared of vegetation (e.g. tracks)

A total of 101.94 ha of preferred Koala habitat was identified within the Subject Land, of which 19.19 ha occurs within the Development Area, and 82.75 ha will be retained within the Offset Area and excluded land. An additional 8.48 ha of buffer area occurs within the Development Area, including 8.17 ha of buffer over supplementary habitat and 0.31 ha of buffer over cleared land. The area of each type of Koala habitat category mapped within the Subject Land is provided in **Table 12**.

Koala Habitat Type	Development Area (ha)	Offset Area (ha)	Excluded Land (ha)	Total (ha)
Preferred	19.19	82.75	-	101.94
50 m Buffer over Supplementary	8.17	15.95	0.12	24.23
50 m Buffer over Other	-	20.32	-	20.32
50 m Buffer over Cleared	0.31	0.87	1.03	2.21
Supplementary Habitat	2.93	0.01	1.33	4.27
Habitat Link over Supplementary	10.10	6.07	-	16.16
Habitat Link over Other	-	5.04	-	5.04
Habitat Link over Cleared	1.51	0.12	-	1.63
Cleared Vegetation	0.05	-	0.26	0.32
			Total	176.12

 Table 12:
 Area of Koala Habitat within the Subject Land



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## 4.3.1.2 Koala Habitat Assessment within the Tomago Sandbeds KMU

An analysis of the preferred and supplementary Koala habitat within the Tomago Sandbeds KMU was undertaken to inform the impact assessment, and also to determine if there was an appropriate amount of land within the KMU for offsetting purposes (discussed further in the Offset Strategy; Kleinfelder 2016).

The analysis involved examining available vegetation mapping for the Tomago Sandbeds KMU and assigning each vegetation community type as preferred, supplementary or other Koala habitat based on comparison of the floristic descriptions of the vegetation mapping studies with the descriptions of preferred and supplementary habitat by Lunney *et al.* (1998) and PSC (2002). The desktop analysis was primarily based on the *Vegetation of the Tomago and Anna Bay Sandbeds* (Bell and Driscoll 2006), which covers most of the Tomago Sandbeds KMU and is the most accurate and recent vegetation mapping available. For areas not covered by the Bell and Driscoll (2006) mapping within the Tomago Sandbeds KMU, the *Lower Hunter and Central Coast Regional Environment Management Strategy* (LHCCREMS; NPWS, 2000) vegetation mapping was used. Additionally, the vegetation mapping within the Subject Land was added to the totals.

The assessment identified an estimated 1,900 ha of preferred and 2,716 ha of supplementary habitat within the Tomago Sandbeds KMU (**Table 13**). A map of the habitat within the KMU is presented on **Figure 6**.

Koala habitat	Equivalent vegetation	Total area (ha) of Koala	
category	Bell and Driscoll (2006)	LHCCREMS (2000)	(including Subject Land)
Preferred	5, 7, 9, 17-19, 21, 24 & 43	36 & 37	1,900 ha
Supplementary	1-3, 11, 22 and 41	33	2,716 ha
Marginal, other and excluded	20, 23, 25-29, 31-38 & 42	9, 12, 15, 17, 30, 34, 36a, 40, 44, 46 and 47	N/A
		Total	4,616 ha

Table 13:Estimated preferred and supplementary Koala habitat and potential Koala<br/>habitat within the Tomago Sandbeds KMU







# 4.3.2 Wallum Froglet

Core habitat for the species was defined as low lying areas that contain permanent water or ephemeral pools with a dense ground stratum, that are suitable for breeding and foraging. This includes the remnant areas of the Swamp Mahogany – Paperbark Swamp Forest, the Coastal Wet Cyperoid Heath, and one area of the regenerating Swamp Mahogany – Paperbark Swamp Forest in the south-east of the Subject Land, which contains permanent water and standing vegetation. Supplementary habitat was defined as low lying areas (less than 5 m in elevation) that occur within 200 m of breeding habitat, that contain a dense ground stratum, including low shrubs, herbs, grasses or sedges, or areas that have substantial leaf litter and woody debris, which are suitable for foraging. Areas identified as either core of supplementary habitat within the Subject Land are mapped on **Figure 7**.

A total of 42.73 ha of core habitat and 43.39 ha of supplementary habitat was identified within the Subject Land. Of this, 0.13 ha of core habitat and 0.57 ha of supplementary habitat occurs within the extraction area.



Supplementary Habitat



Williamtown Sand Syndicate Ecological Summary Report Proposed Sand Quarry Cabbage Tree Road, Williamtown

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XX Excluded Areas (2.7 ha)

5m Contour Line



# 4.4 HOLLOW-BEARING TREE SURVEY

A survey of hollow-bearing trees within and directly adjacent to the original extraction area was conducted prior to the re-design of the extraction area. The information on the location of hollow-bearing trees was used to inform the re-design, in order to reduce the impacts of the proposal on hollow-dependent fauna.

A total of 242 hollow-bearing trees and dead stags with hollows were identified during the survey. Of the identified habitat trees, 77 are located within the extraction area; 56 hollow-bearing trees and 21 dead stags. The habitat trees contain a total of 42 small hollows, 28 medium hollows and 29 large hollows. It should be noted that the number and size of hollows was determined from a ground assessment. A summary of the total number of potential hollows identified during the survey is outlined in **Table 14**.

Turne	Hollow Size			
гуре	Small (<8 cm) Medium (8 – 20 cm)		Large (>20 cm)	
Impact Area				
Hollow-bearing Tree	28	21	22	
Dead Stag	14	7	7	
Total	42 28		29	
Offset Area				
Hollow-bearing Tree	47	85	43	
Dead Stag	11	22	18	
Total	58	107	61	

 Table 14:
 Number of potential hollows identified within and adjacent to the extraction area

As can be seen by the data in **Table 14**, the revised extraction area has been positioned to reduce impacts on habitat trees. The number of hollow-bearing trees likely to occur within the offset area is expected to be much greater as it was not extensively surveyed.



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# 5. ECOLOGICAL IMPACT ASSESSMENT

A list of the threatened species and ecological communities identified in the Ecological Assessment (Umwelt 2015) as being required to be considered as part of the assessment of significance is outlined in **Table 15**. This table details the conclusions of the original impact assessment and where, if required, these impacts have been re-addressed as part of this Summary Report.

An EPBC referral is being prepared for the proposed development. As such, all assessments relating to the federally listed species have been addressed in that document and have not be included in this summary report.



 Table 15:
 Summary of the conclusions of the impact assessment from the Ecological Assessment (Umwelt 2015) and this updated impact assessment

Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Threatened Flora Species		
<i>Commersonia prostrata</i> (Dwarf Kerrawang)	Species not identified during field surveys. The proposal will impact on 0.3 ha of potential habitat (Swamp Forest). The proposal is unlikely to significantly impact on the species.	The modified proposal will remove less potential habitat (0.13 ha; Swamp Mahogany Paperbark – Swamp Forest and Coastal Sand Wallum Woodland-Heath). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Eucalyptus parramattensis subsp. decadens	The proposal was assessed as having a significant impact due to the significant reduction in the local population and the removal of 38.14 ha of known habitat that is considered to be important to the long- term survival of the species.	Kleinfelder conducted an estimate of the local population ( <b>Section 4.2.2</b> ). The results of these surveys resulted in an estimated local population size of 40,214 individuals. As such the modified proposal will impact on 0.57% of the local population (230 individuals). The individuals to be removed from the extraction area were seeded/planted into this area following heavy mineral sand mining. Due to the elevation of this area, it was not assessed as suitable habitat for the species. Typical habitat for the species occurs at lower elevations on the sandbeds, in areas that are subject to periodic flooding. As such, the area of vegetation to be impacted was not assessed as being important to the long-term survival of the species. The original impact assessment was not appropriate. A modified assessment has been conducted ( <b>Appendix 4</b> ), and concluded that the proposal is unlikely to significantly impact on the species.
<i>Eucalyptus camfieldii</i> (Camfield's Stringybark)	Species found by RPS (2011) at one location within the extraction area, but not identified within the Subject Land by Umwelt (2015). The Ecological Assessment concluded that the proposal is unlikely to significantly impact on the species.	Additional surveys identified 1,868 individuals within the Subject Land, 227 of which occur within the Development Area. Further surveys were conducted in the locality to determine the extent of the local population. An additional 395 individuals were identified (Section 4.2.1). The proposal was assessed as impacting on 10% of the local population. Due to the identification of a significant number of individuals within the Subject Land, the assessment of significance for the species was updated (Appendix 4). The proposal will remove individuals that are not naturally occurring as they have been seeded/planted following rehabilitation. The majority of the area in which they occur was not assessed as potential habitat for the species. Suitable habitat for the species within the disturbance area occurs in low lying areas which adjoin the Coastal Sand Wallum Woodland-Heath. The assessment concluded that the proposal is unlikely to significantly impact on the species.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> (Small-flower Grevillea)	The species was identified within the north of the Subject Land. The proposal will not directly impact on the species, as such, it is unlikely that the proposal will significantly impact on the species.	The original assessment is appropriate (no significant impact) and no further assessment conducted.
Threatened Ecological Comm	unities	
Swamp Sclerophyll Forest on Coastal Floodplains	Unlikely to be significantly impacted due to small area (0.3 ha) of removal.	Modified proposal will impact on less of this EEC (0.13 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Freshwater Wetlands on Coastal Floodplains	This EEC was identified as occurring as part of a mosaic within areas of regenerating Swamp Sclerophyll Forest EEC. The original proposal was not going to impact directly on any areas of the EEC and the assessment concluded that the proposal is unlikely to significantly impact on the EEC.	The EEC was not identified during the vegetation mapping surveys conducted by Kleinfelder ( <b>Section 4.1</b> ). All areas of regenerating swamp vegetation within the Subject Land were mapped as regenerating Swamp Sclerophyll Forest EEC. As such, no further assessment was conducted.
Threatened Fauna Species Identified within the Subject Land		
Eastern Bentwing-bat ( <i>Miniopterus schreibersii</i> oceanensis)	The Subject Land represents suitable foraging habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Eastern Freetail-bat ( <i>Mormopterus norfolkensis</i> )	The Subject Land represents suitable foraging and roosting habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Eastern Opsrey ( <i>Pandion</i> cristatus)	The species was identified within the Subject Land. Suitable roosting and nesting habitat for the species is present within the Subject Land. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )	The species was identified within the Subject Land, which represents potential foraging habitat for the species (no camps identified). Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Koala (Phascolarctos cinereus)	The Ecological Assessment (Umwelt 2015) concluded that the proposal has the potential to significantly impact on the species as it would remove 48.1 ha of important habitat for the species in the locality. Additionally, the proposal has the potential to create barriers to movement for the species between areas of suitable habitat.	The current assessment updated the Koala habitat mapping of the Subject Land (Section 4.3.1) and re-assessed the impacts of the proposal on the species (Appendix 4). Surveys conducted in September 2015 did not identify any Koala activity in the Subject Land. However, due to the recent fire disturbance (October 2013), the precautionary principle was applied and the preferred habitat within the Subject Land is assumed to have the potential to support a medium (normal) usage category.
		Based on research conducted by Lunney <i>et al.</i> (2007), habitat availability is not the limiting factor for the Koala population in Port Stephens area and it is likely that there is a large amount of available habitat within the locality that is either un-occupied, or could potentially support a higher density of Koalas. As such, it is likely that any potentially displaced individuals from within the disturbance area would be able to self-relocate to areas of suitable habitat within and adjacent to the Subject Land. The proposal will remove a relatively small area of suitable habitat from the locality (approximately 1.01% of the preferred and 0.78% of the supplementary habitat within the
		Tomago Sandbeds KMU). The proposed extraction area was revised to ensure that no areas of habitat within the site will be isolated, and movement corridors within the Subject Land are maintained. The proposal will cause some fragmentation of areas of habitat in the south-west of the Subject Land. Based on this information it is unlikely that the proposal would impact on the life cycle of the local population, such that it would place it at the risk of extinction.
Little Bentwing-bat ( <i>Miniopterus australis</i> )	The Subject Land represents suitable foraging and roosting habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Varied Sittella (Daphoenositta chrysoptera)	The species was identified within the Subject Land. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Wallum Froglet ( <i>Crinia tinnula</i> )	The species was recorded within the Subject Land, approximately 0.3 ha of suitable habitat was assessed as being removed due to the proposal. The Ecological Assessment (Umwelt 2015) concluded that due to the potential for the proposal to fragment and isolate areas of suitable habitat and potentially create a barrier to movement between areas of suitable habitat within the Subject Land, there is the potential for the proposal to significantly impact on the species.	The assessment of suitable habitat for the species within the Subject Land was re- assessed as part of this current report ( <b>Section 4.3.2</b> ). The updated proposal will impact on approximately 0.70 ha of suitable habitat for the species (0.13 ha of core habitat and 0.57 ha of supplementary habitat). The current assessment concluded that the proposal is unlikely to significantly impact on the species ( <b>Appendix 4</b> ). While areas of habitat will be removed from the Subject Land, the level of removal is not considered to be large enough to significantly impact on the long-term survival of the species in the locality due to the large amount of habitat retained within the Offset Area. Additionally, based on Bell and Driscoll's (2006) vegetation mapping, there is a large amount of breeding habitat (Swamp Forest) in the locality. The proposal will not fragment or isolate any areas of potential habitat for the species. The proposal will create a temporary barrier to potential dispersal routes (through the proposed disturbance area).
Threatened Fauna Species Identified as Having Potential Habitat		
Brush-tailed Phascogale ( <i>Phascogale tapoatafa</i> )	The species was not recorded during field surveys but there are records of the species in the locality. The proposal was assessed as being unlikely to significantly impact on any potentially occurring local populations due to the relatively small area of habitat removal and given the large amount of suitable habitat in the locality.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Eastern Pygmy-possum ( <i>Cercartetus nanus</i> )	The species was not recorded during field surveys and the closest record occurs 10 km to the north. The removal of 48.1 ha of potential foraging habitat is unlikely to significantly impact on this highly mobile species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Glossy Black-Cockatoo (Calyptorhynchus lathami)	The Subject Land represents potential habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Gang-gang Cockatoo ( <i>Callocephalon finbriatum</i> )	The Subject Land represents potential habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Greater Broad-nosed Bat (Scoteanax rueppellii)	The Subject Land represents suitable foraging and roosting habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Little Lorikeet ( <i>Glossopsitta pusilla</i> )	The Subject Land represents potential habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Long-nosed Potoroo (Potorous tidactylus)	The proposal was assessed as being unlikely to significantly impact on any potentially occurring local populations due to the limited number of records of the species in the locality and the large amount of suitable habitat in the locality.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Masked Owl ( <i>Tyto novaehollandiae</i> )	The Subject Land represents potential habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Powerful Owl ( <i>Ninox strenua</i> )	The Subject Land represent potential habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	The species was not recorded during field surveys and the closest record occurs 15 km to the north- east. The removal of 48.1 ha of potential foraging habitat is unlikely to significantly impact on this highly mobile species.	Primary foraging habitat for the species occurs within the Swamp Mahogany – Paperbark Swamp Forest, due to the presence of <i>Eucalyptus robusta</i> . The dry forests within the extraction area is also suitable foraging habitat due to the presence of Stringybark species. The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Spotted-tailed Quoll ( <i>Dasyurus maculatus</i> )	The proposal was assessed as being unlikely to significantly impact on any potentially occurring local populations due to the limited number of recent records of the species in the locality and the large amount of suitable habitat in the locality.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Southern Myotis ( <i>Myotis macropus</i> )	The Subject Land represents suitable foraging and roosting habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



Species	Conclusion of Impact Assessment (Umwelt 2015)	Updated Impact Assessment
Squirrel Glider ( <i>Petaurus norfolcensis</i> )	The species was not recorded within the Subject Land, but has been recorded extensively in the Port Stephens area. The assessment concluded that the proposal is unlikely to have a significant impact on the species due to the relatively small area (48.1 ha) of habitat removal given the large amount of suitable habitat in the locality.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.
Swift Parrot ( <i>Lathamus discolor</i> )	The Subject Land represents potential foraging habitat for the species. Due to the high availability of suitable habitat in the locality and the highly mobile nature of the species, the removal of 48.1 ha of potential foraging habitat due to the proposal is unlikely to significantly impact on the species.	The modified proposal will remove less native vegetation than the original proposal (40.38 ha). As such, the original impact assessment is appropriate (no significant impact) and no further assessment conducted.



# 5.1 CKPOM PERFORMANCE CRITERIA ASSESSMENT

All development applications in the Port Stephens LGA are assessed against the provisions of the Performance Criteria contained within Appendix 4 "Performance Criteria for development applications" of the Port Stephens Council CKPoM (the Performance Criteria).The Performance Criteria state that proposed development activities must:

## a) Minimise the removal or degradation of native vegetation within Preferred Koala Habitat or Habitat Buffers.

The revised Koala habitat mapping (**Figure 5**) indicates the Subject Land contains a total of 101.94 ha of preferred Koala habitat and 46.76 ha of habitat buffers (i.e. 50 m from preferred habitat over supplementary, marginal and cleared habitat types which are afforded the same level of protection as preferred habitat). Of the preferred Koala habitat within the Subject Land, 19.19 ha (19%) is proposed to be removed along with 8.48 ha (18%) of habitat buffers. A total of 82.75 ha of preferred Koala habitat and 37.13 ha of habitat buffers within the Subject Land would be retained and protected within the offset area.

The proposed extraction area has been revised from the original proposal, and has subsequently reduced the area of impact on Koala habitat. It should also be noted that the preferred habitat within the impact area is rehabilitation, while the areas of preferred habitat within the offset area are naturally occurring vegetation communities. As such the proposal is consistent with this objective.

# b) Maximise the retention and minimise degradation of native vegetation within Supplementary Koala Habitat and Habitat Linking Areas.

The revised Koala habitat mapping (**Figure 5**) indicates the Subject Land contains 4.27 ha of supplementary Koala habitat (this does not including supplementary habitat mapped as buffers and links) and 22.83 ha of habitat linking areas. Of the supplementary habitat, 2.93 ha will be impacted (69%) and of the habitat linking areas, a total of 11.61 ha (51%) will be impacted. This does represent a large proportion of the supplementary habitat and habitat links in the Subject Land, however, the impacts of the proposed development have been revised, reducing the impacts on supplementary habitat and linking areas.



# c) Minimise the removal of any individuals of preferred Koala food trees, where they occur on a development site.

Within the extraction area, two of the preferred koala feed trees in the Port Stephens LGA were recorded. *Eucalyptus parramattensis* subsp. *decadens* occurs throughout the rehabilitation within the extraction area. Also *Eucalyptus robusta* was noted to occur in small lower lying areas of the rehabilitation. Additionally a very small area (0.13 ha) of Swamp Mahogany – Paperbark Swamp Forest will be impacted.

The two tree species also occur extensively within the offset area and will be retained as part of the proposal. It was assessed that 230 *E. parramattensis* subsp. *decadens* individuals will be removed, while 634 individuals will be retained. A total of 0.13 ha of Swamp Mahogany – Paperbark Swamp Forest will be removed, while 40.13 ha will be retained. As such the proposal is consistent with this objective.

d) Make provision, where appropriate, for restoration or rehabilitation of areas identified as Koala Habitat including Habitat Buffers and Habitat Linking Areas over Mainly Cleared Land. In instances where Council approves the removal of Koala habitat, and where circumstances permit, this is to include measures which result in 'net gain' of Koala habitat on the site and/or adjacent land

The proponent is committed to achieving a net conservation gain for the Koala. This would be achieved in two ways: 1) through the proposed Offset Strategy (Kleinfelder 2016), which is proposed to include rehabilitation and protection of Koala habitat (see **Section 7**); and, 2) rehabilitation of the extraction area, which will include Koala habitat.

Offsets can only be effective when they achieve 'conservation gain' and when this conservation gain is focussed on the impacted species (in this case the Koala) (SEWPaC 2012). Conservation gain is achieved in two different ways:

- By improving the condition of habitat for the impacted species. This is done by:
  - Restoring habitat that no longer provides benefit to the species;
  - Rehabilitating lower quality habitat so that it is of greater benefit to the species; and



- Removing or reducing key threatening processes from otherwise suitable, existing habitat, so that it becomes of greater benefit to the species, or
- Averting the loss of habitat for the species that is under threat.

The proposed offset will achieve both of these conservation goals; through the rehabilitation of areas of preferred habitat within the offset area of the Subject Land, and protecting areas of preferred habitat that are zoned as RU2.

The CKPoM requires these actions are to be undertaken on the site and/or adjacent land "where circumstances permit". The proposed offset strategy would secure and improve 105.49 ha of Koala habitat within the Subject Land through the establishment of a biobank site, which would be improved through management. Additionally, the offset strategy sets out that additional suitable offsets within the Tomago Sandbeds KMU, close to the Subject Land, are being investigated to fulfil the offsetting requirements for the species. This would secure an additional 40 - 60 ha of Koala habitat. It is proposed that this additional offset also be secured under a biobanking agreement.

Progressive rehabilitation of the extraction area will be conducted with locally occurring species. A focus on rehabilitation of Koala habitat will occur through the use of *Eucalyptus signata* (Scribbly Gum) in this area.

As such, the proposal is consistent with this objective.

# e) Make provision for long term management and protection of Koala habitat including both existing and restored habitat.

Detailed management plans will be developed for all offsets, as required for the establishment of a biobank. These plans will outline the long term management actions and measures to ensure that the Koala Habitat, both restored and existing, is protected into the future and that it will produce a net gain in conservation values for the Koala. As such, the proposal is consistent with this objective.

### f) Not compromise the potential for safe movement of Koalas across the site.

Specific mitigation measures for the protection of the Koala during the operational phase of the proposal have been developed (**Section 6**). One of these mitigation measures does include


a Koala exclusion fence along Cabbage Tree Road. This fence will be designed to prevent Koala movement from the site to the south onto Cabbage Tree Road and limit potential vehicle interactions in the area. Additionally, this fence line will be extended into the Subject Land, along the access road to the weighbridge. This initial section of internal road was assessed as having the greatest potential for impact due to low visibility around the corner entering the site. Any other internal fencing, and boundary fencing to the east and west will be open post and wire fences (not barbed wire) that will permit Koala movement. As such, the proposal is consistent with this objective.

### g) Be restricted to identified envelopes which contain all buildings and infrastructure and fire fuel reduction zone. Generally, there will be no clearing on the site outside these envelopes.

All activities will be restricted to the proposed development footprint.

# h) Include measures to effectively minimise the threat posed to Koalas by dogs, motor vehicles and swimming pools by adopting minimum standards.

Feral animal control will be conducted as part of the proposal, with feral dogs being one of the target species. This is designed to mitigate the impacts of dog attacks on Koalas in the locality.

The speed of traffic will be limited internally to 40 km/h or less, and signage will be posted along internal roads to minimise threats from vehicles within the site.

Within the proposed development area, no large pools of water will be created. Any table drains, which may collect and store water for a period, will naturally in their design have graduating edges.

The proposal is consistent with this objective.

#### Conclusion

The proposal is consistent with the CKPoM performance criteria. While there are impacts on both preferred and supplementary habitat within the site, the impacts to these areas have been reduced where possible since the original proposal. Due to the nature of the resource and the Koala habitat within the Subject Land, impacts to preferred and supplementary habitat cannot be fully avoided. The highest quality areas of Koala habitat (Swamp Mahogany – Paperbark



Swamp Forest, Earp's Gum Sedge Woodland and Coastal Sand Wallum Woodland-Heath) will be retained and protected, with a significant number of Koala feed trees in these areas.

The proposal will also result in the protection and enhancement of 105.49 ha of Koala habitat within the Subject Land, and an additional 40 - 60 ha of habitat within the Tomago Sandbeds KMU. The proposal will add protective measures along the frontage to Cabbage Tree Road, through the installation of a Koala exclusion fence in order to limit vehicle strikes in this area. Additionally, a feral animal control program will be implemented as part of the Project, with feral dogs being one of the target species.

As outlined in the CKPoM (PSC 2002), compliance with the requirements outlined in that document constitutes compliance with the requirements of SEPP 44 for relevant matters within the Port Stephens LGA. As outlined above, the proposal is compliant with the CKPoM, as such there is no requirement for a site specific Koala Plan of Management. Specific mitigation measures for the Koala have been outlined in **Section 6.1**.

### 5.2 CUMULATIVE IMPACTS

The cumulative impacts on the Koala was identified as not being sufficiently addressed in the Ecological Assessment (Umwelt 2015). As such, recently approved and constructed major projects within 20 km of the Subject Land were identified using the Major Projects website (<u>http://majorprojects.planning.nsw.gov.au/page/</u>) (**Table 16**). Cumulative impacts of the projects listed in **Table 16** have been assessed in relation to the local Koala population. The projects have been assessed in relation to the major identified impacts on Koalas, including habitat loss, vehicle strikes, dog attacks and fire (Lunney *et al.* 2007 and Phillips, Callaghan and Thompson 1996).

Project	Location	Description
Fullerton Cove Sand Extraction Project Approved (2016)	Located approximately 3 km to the south-east of the Subject Land	Small project (total site 25.3 ha), with minor impacts on vegetation (3.37 ha of regrowth vegetation). Project expected to operate for 1 to 7 years.
Gloucester Gas Project Concept plan approved (2011)	Within the area located approximately 6 km to the west (at closest point)	100 m wide easement that will occur primarily on the western side of the Hunter River. The easement will then cross the river and end at a receiving station at the Tomago Gas Storage Facility.

Table 16:	Major projects	within 20 km	of the Subject	Land
	major projecto		or the oubject	Lana



Project	Location	Description
Northbank Enterprise Hub Approved (2014) – construction not commenced.	Located approximately 4 km to the west/south-west of the Subject Land.	Impact to 70 ha of Freshwater Wetlands, 14.8 ha of Swamp Oak EEC and 2.2 ha of regenerating Swamp Oak EEC, and 1.5 ha of Swamp Sclerophyll Forest EEC. Long-term project impacts from increased traffic.
Redlake Enterprises Industrial Estate Approved and construction commenced (WesTrac constructed; industrial estate not developed).	Located approximately 3 km to the west/south-west of the Subject Land.	Impacts to 5.35 ha of Swamp Oak Forest EEC, 15.5 ha of Coastal Saltmarsh. Long-term project impacts from increased traffic.
Salt Ash Sand Project Approved (2010) and commenced.	Located approximately 10 km to the east/north-east of the Subject Land.	Project life 18 – 20 years. Impacts to 25.8 ha of Coastal Sand Apple – Blackbutt Forest.
Sandvik Machine Manufacturing and Maintenance Project Approved and constructed.	Located approximately 6 km west/ north-west of the Subject Land.	Impacts to 13.5 ha of vegetation.
Mackas Sand Project Approved (2009) and in operational phase.	Located approximately 8 km to the west of the Subject Land.	Long-term project that will operate over a period of up to 20 years. One extraction area will require vegetation removal of 72 ha.
Newcastle Gas Storage Facility Approved and constructed.	Located approximately 6 km west of the Subject Land.	Impact on 23.7 ha of vegetation.
Fern Bay Residential Subdivision Approved and construction completed.	Located approximately 5 km to the south of the Subject Land.	947 lot subdivision which required the removal of approximately 90 ha of vegetation.

Two projects within 20 km of the Subject Land have recently been approved or commenced within the Tomago Sandbeds KMU; the Newcastle Gas Storage Facility and Sandvik Machine Manufacturing and Maintenance Project. These two projects were assessed as impacting on Koala habitat. The Gas Storage facility impacted on 2 ha of preferred habitat and 19 ha of supplementary habitat, and Sandvik impacted on 13.5 ha of supplementary habitat.

Both the Gas Storage Facility and Sandvik are constructed and in the operational phase. The gas storage facility was not assessed as significantly increasing traffic during its operational phase. Due to the number of employees potentially working at the Sandvik project, there would be a potential impact on local traffic. As this project occurs near the northern boundary of the KMU, potential impacts to the Koala population would most likely be along the Pacific Highway.

Mackas Sand Project, Fern Bay Residential Subdivision and the Salt Ash Sand Project were also assessed as impacting on Koala habitat. However, these three projects occur outside the



Tomago Sandbeds KMU. While these projects occur outside the KMU, they have the potential to increase traffic along the periphery of the KMU if additional vehicles are travelling along Nelson Bay Road and Cabbage Tree Road.

The Redlake Industrial Estate and Northbank Enterprise Hub sites adjoin the Tomago Sandbeds KMU (occur just to the south). However, impacts to Koala habitat due to these developments will be minimal with limited habitat identified. These developments, when completed, will increase the traffic along Tomago Road which could impact on the local population at this road occurs at the southern boundary of the KMU.

The only project which has the potential to increase impacts from dog attacks is the Fern Bay Residential Subdivision. All of the developments have a low potential to increase the risk of bushfires in the locality.

With respect to the Cabbage Tree Road Sand Quarry and its contribution to these impacts, it is deemed to be minimal given the size and duration of the project (8 to 15 years). The level of Koala habitat clearing within the Tomago Sandbeds KMU is not considered significant, with only three other approved major projects clearing Koala habitat within 20 km of the Subject Land, and only the current project and one other impacting on preferred Koala habitat. Given the large area of preferred (1,900 ha) and supplementary (2,694 ha) Koala habitat mapped in the Tomago Sandbeds KMU these cumulative impacts are unlikely to significantly impact on the species in the locality.

The Cabbage Tree Road Sand Quarry was not assessed as contributing significantly to traffic in the area. Mitigation measures will be implemented to reduce the potential for Koala deaths from vehicle strikes. Additionally, the proposal will implement a feral animal control program, with feral dogs being one of the target species. As such, this mitigation measure will benefit the species in the locality. It is unlikely that the proposal will increase the frequency of bushfires in the locality.



### 6. ECOLOGICAL IMPACT MITIGATION

An environmental management plan has been prepared for the project. This plan details the specific mitigation measures that will be implemented throughout the operational phase of the quarry. Mitigation measures that relate to the Koala, including specific measures for the species are outlined in the following section.

### 6.1 KOALA SPECIFIC MITIGATION MEASURES

#### Vehicle Mortality

A specific Koala exclusion fence will be installed along the frontage to Cabbage Tree Road to limit the potential of vehicle strikes. This fence will be installed in accordance with the design specification outlined in the *Koala-sensitive Design Guideline* (DEHP 2012); either a floppy top fence, or a fence with a smooth metal or perspex top will be installed. One-way fauna valves will be installed along the fence, for circumstances where Koalas (or other fauna) are trapped on the road side of the fence. This fence line will be extended into the Subject Land, along the access road to the weighbridge. This initial section of internal road was assessed as having the greatest potential for impact due to low visibility around the corner entering the site. For this section of road, speed limits will be 40 km/hr. For all other sections of road that will not be fenced, speed limits will be 20 km/hr. The visibility of Koalas along internal roads will be increased through the management of roadside vegetation and trimming of over-hanging vegetation.

#### Vegetation Clearing

The following standard mitigation measures will be implemented to limit impacts on locally occurring fauna, including the Koala:

- Pre-clearing surveys within the area proposed for clearing each day:
  - o Nocturnal surveys will be conducted the night before clearing, and diurnal surveys will be conducted the morning of clearing, prior to commencement; and
  - o The procedure for when a Koala is identified within the clearing area is outlined below.
- All clearing will be supervised by a suitable qualified ecologist; and
- Clearing will not create vegetation islands: clearing will occur from disturbed areas towards vegetated areas.



The following procedure will be used if a Koala is identified as occupying a tree within the proposed clearing area. The aim of this capture and relocation procedure is to ensure that no Koalas are harmed during the vegetation clearing activities within the extraction area:

- The individual will be captured prior to the commencement of clearing;
- The individual will be given a veterinary check for any disease or illness and a monitoring device will be attached (remote tracker);
- Any Koalas captured will be relocated into an area of retained vegetation adjacent to where it was originally located;
- All individuals will be monitored for a three-month period post relocation; and
- Where any Koalas are identified and captured for re-location, the following will be reported on:
  - o Location identified within the disturbance area, and location of relocation;
  - o Movement of the Koala will be mapped for the three-month period;
  - Any instances where the Koala enters areas proposed for future clearing will be identified, and the need for further monitoring/action determined. If there is the potential for the individual to occur within areas of future vegetation clearing, a plan to ensure the individual is not impacted will be developed; and
  - The health of the individual will be checked at the end of the three-month period and any impacts (i.e. dog attacks, vehicle strikes, bushfire impacts, or disease) will be identified.

This relocation method for Koalas is deemed to be an appropriate mitigation measure for any identified Koalas within the impact area. The assessment of significance applied to the species (**Appendix 4**) outlined that if the removal of vegetation from the extraction area impacts on the home range of an individual, it is unlikely to significantly impact on the local population due to the large area of available habitat within the Tomago Sandbends KMU. Lunney *et al.* (2007) modelled the carrying capacity of the Port Stephens area to be a maximum of 2,500 individuals. However, the population within the same area was estimated to be only 350 – 800 individuals (Lunney *et al.* 2007). Based on this assessment, there is a large amount of available habitat within the locality that is either un-occupied, or could potentially support a higher density of Koalas. As such, it is likely that any potentially displaced individuals from within the disturbance area would be able to self-relocate to areas of suitable habitat within and adjacent to the Subject Land. The potential for impacts on Koala welfare, from anthropogenic sources would not be increased using the self-relocation methodology. The vegetation within the disturbance area is connected to the north and individuals would not need to intersect any hostile barriers (i.e. roads) to access this habitat.



Long distance translocations are usually only required when all available habitat on a site is being cleared, and there is no suitable habitat adjacent to the site. In these situations it is unethical to allow displaced Koalas to move through areas where there is the potential for injury or death (i.e. residential properties and/ or roads). As such, translocation of any Koalas occurring within the extraction area, to areas of suitable habitat away from the site, is considered unlikely to be warranted as the preference is to allow Koalas to self-relocate to adjacent existing habitat. If at any point during the operational phase of the project, translocation is deemed to be necessary, a translocation plan will be prepared in consultation with the relevant authorities (i.e. OEH and Port Stephens Council).

#### **Monitoring of Mitigation Measures**

Infra-red cameras will be used to monitor the Koala exclusion fence and the one-way fauna valves during the breeding season (September to February) when Koalas are most active, for two years post construction. This will help inform future design of similar structures and demonstrate if the structures are effective, both for Koalas and other locally occurring fauna species.



## 7. BIODIVERSITY OFFSET STRATEGY

A biodiversity offset strategy for the Cabbage Tree Road Sand Quarry was prepared by Kleinfelder (2016). To determine the offset requirements of the proposal, the assessment was conducted in accordance with the Biobanking Assessment Methodology (BBAM) 2014 and the *NSW OEH Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and Stage Significant Infrastructure (SSI) Projects* (OEH 2011b). It is proposed that the land not subject to development be secured as a biobank site to ensure its in-perpetuity protection. The proposed biobank is 131.12 ha and occupies the majority of the remaining areas of the Subject Land.

The assessment determined that the impact at the development site requires a total of 2,207 ecosystems credits for impact on HU860 and 17,479 *Eucalyptus camfieldii*, 3,220 *Eucalyptus parramattensis* subsp. *decadens*, 525 Eastern Osprey, 1,050 Koala and nine Wallum Froglet species credits.

The assessment determined that the biobank site would generate a total of 1,189 ecosystem credits comprised of HU860, HU851, HU917, HU865, HU938, and HU948, and 11,651 *Eucalyptus camfieldii*, 4,501 *Eucalyptus parramattensis* subsp. *decadens*, 724 *Grevillea parviflora* subsp. *parviflora*, 717 Eastern Osprey, 744 Koala and 606 Wallum Froglet species credits (**Table 17**).

It is proposed to retire all ecosystem credits created at the biobank site (total 1,189 ecosystem credits), as per variation criterion (f) for mitigated net loss (tier 3) under the Interim Policy, to partially fulfil the ecosystem credit requirements at the development site (this would fulfil 54% of the ecosystem credit requirements). This variation criterion allows for the conversion of ecosystem credits to a regional conservation priority as identified in a regional conservation plan or similar. The proposed biobank is of high conservation value due to its location; adjacent to Tilligerry SCA, proposed Hunter Water biobank sites and mapped fauna habitat and corridors, and quality of the vegetation; moderate to good condition vegetation that is predominantly old-growth, and the presence of threatened species and ecological communities within the site.

Williamtown Sand Syndicate are committed to retiring between 80% - 85% of the required ecosystem credits for the development, utilising the ecosystem credits generated at the onsite biobank and additional credits available at a potential off-site biobank located to the east



of Williamtown Airport. The retirement of this proportion of ecosystem credits is adequate for the proposed development, given that the impact area predominantly contains rehabilitated or regenerating vegetation (54% of the impact area), and the majority of the vegetation within the on-site and potential off-site biobanks is old-growth forest. Additionally, both the on-site and potential off-site biobanks contain a threatened ecological community (Swamp Sclerophyll Forest) and multiple threatened species (or historical records).

The biobank site fulfils the species credit requirements for impacts on *Eucalyptus parramattensis* subsp. *decadens*, Eastern Osprey and Wallum Froglet. The biobank site does not generate enough species credits for *Eucalyptus camfieldii*, with a shortfall of 5,828 species credits, and the Koala, with a shortfall of 306 species credits (**Table 17**).

The biobank fulfils 67% of the species credits required for *Eucalyptus camfieldii* at the development site. As such it is proposed to apply Variation Criteria (B) – Convert one type of species credit to another type of species credit with the same or more endangered conservation status, under Tier 3: Negotiation of a "Mitigated Net Loss Outcome" of the OEH Interim Policy (OEH 2011b). There are residual species credits generated at the biobank site for *E. parramattensis* subsp. *decadens* (1,281) and *G. parviflora* subsp. *parviflora* (724). As such, the total number of species credits available at the biobank to offset impacts on *E. camfieldii* at the development site is 13,656 (78% of the required 17,479 credits) (**Table 17**).

The fulfilment of 78% of the required *E. camfieldii* species credits is considered adequate. As the majority of the *E. camfieldii* within the development site is part of a planted (rehabilitated) population, it is highly unlikely that the species would have been present in this area prior to rehabilitation. Additionally, the species will be replanted within the rehabilitation area, as it will represent potential habitat for the species due to the lower elevation of the final landform. Furthermore, there are additional species credits generated at the biobank for both the Eastern Osprey and Wallum Froglet. While these fauna species credits may not directly transfer to offset impacts against *E. camfieldii*, WSS propose to retire these credits as part of the offset package for the development.

Williamtown Sand Syndicate are committed to retiring the remaining 306 Koala species credits at an off-site offset within the Tomago Sandbeds KMU. Williamtown Sand Syndicate are currently investigating potential freehold land to the east of Williamtown Airport to establish a biobank. Based on a desktop assessment, the land contains preferred and supplementary Koala habitat and could potentially fulfil the remaining Koala credit requirements, within the Tomago Sandbeds KMU.



# Table 17:Summary of the credits generated at the development site and credits that will<br/>be retired at the biobank site to fulfil, or partially fulfil the credits requirements

Credit Type	Credits Requirements (Impact Site)	Credits at the To be Retired (% of cred	Biobank: lit requirement meet)
		HU860	273
		HU851	311
		HU917	80
HU860 Ecosystem Credits	2 207	HU965	22
	_,_01	HU938	388
		HU948	115
		Total	1,189 (54% of credits required)
		Eucalyptus camfieldii	11,651
		Eucalyptus parramattensis subsp. decadens	1,281
Eucalyptus camfieldii	17,479	Grevillea parviflora subsp. parviflora	724
		Total	13,656 (78% of credits required)
Eucalyptus parramattensis subsp. decadens	3,220	3,22 (100% of credi	0 ts required)
Eastern Osprey	525	717 (137% of credi	ts required)
Koala	1,050	744 (71% of credit	s required)
Wallum Froglet	9	606 (6,733% of cred	its required))



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## APPENDIX 1. FLORA SPECIES LIST



#### **Development Site**

Over dest Normalises						00		00		04		OF		00		0	7		10		<b>\</b> 0		10	044	
Quadrat Number				11				43							20		000		1000		19		000		_
Vegetation Code			HU	860	HU D	1860 J860	HU D	0860		1080	,		-1 84		00	HU	008	HU	008	HU	008	HU	360	HU86U	<u>,</u>
Condition/ Zone			Re	nap	Re	enab	Re	enap	R	kenar		od-Goo		oa-G	000	Mod-	Good	NIOG	-G000	Re	gen	Rec	jen	Regen	1
Easting			387	752	38	7934	38	37690	30	8775		387794	;	3878	65	388	083	388	3519	387	/583	387	524	387669	9
Northing			636	9721	636	9600	636	69573	3 63	36933	1 6	36906	5 6	3685	989	6369	3350	636	9331	636	9129	6368	867	636879	33
Family	Scientific Name	Common Name	FPC	Ab	FPC	; Ab	FPC	; Ab	D FP	C A	b FI	C A	) Fł	50	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC A	<u>رله</u>
Anthericaceae	Tricoryne simplex				_	_	_		_				_							1	10			1	10
Apiaceae	Platysace ericoides	-	1	2	0	_	_					1 2	20	1	10	1	25	1	10	5	100	1	15	1	5
Apocynaceae	Marsdenia suaveolens	Scented Marsdenia											_	1	3			1	2			$\square$			
Asteraceae	*Senecio madagascariensis	Fireweed											_									1	3		
Asteraceae	Actinotus helianthi	Flannel Flower	80	100	0 50	100	0 30	0 40	0 2	20 5	00	1	5			30	270	30	300	1	5	5	70	1	5
Bignoniaceae	Pandorea pandorana subsp. pandorana	Wonga Wonga Vine	1	1	0							1 2	20	1	20	1	2								
Casuarinaceae	Allocasuarina littoralis	Black she-oak												1	2							L			
Casuarinaceae	Allocasuarina torulosa	Forest Oak										1 1	0									L			
Cyperaceae	Ptilothrix deusta															1	8					L			
Cyperaceae	Schoenus ericetorum	Heath Bog-rush	1	2	0 1	10	0													1	100	1			
Dennstaedtiaceae	Pteridium esculentum	Common Bracken	20	10	0							20 100	0	2	50	1	10	25	100	1	2	3	30	3	40
Dilleniaceae	Hibbertia fasciculata															1	3					1	5		
Dilleniaceae	Hibbertia linearis		1	2	0 1	1 1	0 1	1 4	0	1	20	1 2	20	1	20	1	4	1	20	3	50	1	15	1	5
Ericaceae - Epacridoideae	Astroloma pinifolium	Pine Heath	1		5		1	1 5	i0	1	20					1	10			1	20	1	45	1	30
Ericaceae - Epacridoideae	Brachvloma daphnoides	Daphne Heath								2	60									1	10				
Ericaceae - Epacridoideae	Leucopogon appressus				1	1	1													1	10				
Ericaceae - Epacridoideae	Leucopagon ericoides	Pink Beard-heath			1	50	0 2	2 5	10	1	1	1 {	0							3	500		, — †		
Ericaceae - Epacridoideae	Leucopogon esquamatus	i inic Board Hoali					<u> </u>			·	- I							1	10	Ŭ	000		<del> </del>		
Ericaceae - Epacridoideae	Leucopogon iuninerinus	Prickly Beard-beath	1									-						2	15			<b>├</b> ──┤			
Ericaceae - Epacridoideae	Leucopogon Janeolatus var Janceolatus	Thong Board House	1									-						1	10			<b>├</b> ──┤			
Ericaceae Epacridoideae							1	1	2			-	_	_					10			<b>⊢</b> →		<del>_</del>	
Ericaceae - Epacidoideae	Manataga allintiga	Tree Breem heath	1	5	0			2 5	2	2 1	00	1 4	0	1	50	1	6E			1	20	1	160		60
Ericaceae - Epacridoideae	Monotoca emplica	Thee Broom-neath		5	0	2 2	0 1	2 D	2	3 1	5	1 3	0	-	50		65			1	20		160	4	00
			4	4	2	2 2		1	2	1	5		_	_		4	25			- 1	20	⊢́	25		
Elicaceae - Epacituoldeae	Woolisia pullyelis				0 1	1 100	0 2	2 40	0	2	50		_	_		1	30					⊢−−−	I	<b>┌──┼─</b>	
Euphorbiaceae	Ampered xiphociada val. xiphociada		4	4	~		_	_	_	_	_	_	_	_		1	15					┝──┤	<u> </u>		
Euphorbiaceae	Porantnera microphylia		1	10						_			-		-						= 0	<u>⊢                                     </u>	<u> </u>	<u> </u>	
Euphorbiaceae	Ricinocarpos pinifolius	Wedding Bush	1		5 1	1 2	0 1	1 1	0	_	-	1	5	1	5	1	10	1	5	3	50	1	20	1	20
Fabaceae - Faboideae	Aotus ericoides		3	2	0 2	2 2	0 1	1	2	1	2					1	5	1	3			┥──┤	J]		
Fabaceae - Faboideae	Bossiaea heterophylla	Variable Bossiaea	1	2	0 10	) 50	0 10	0 10	00 1	10 2	00	1 5	0			4	120	1	10			┥──┤		1	
Fabaceae - Faboideae	Bossiaea obcordata	Spiny Bossiaea							1	15 2	60									3	40		لـــــــا		
Fabaceae - Faboideae	Bossiaea rhombifolia																					1	10	1	10
Fabaceae - Faboideae	Dillwynia floribunda											1	1							1	30				
Fabaceae - Faboideae	Dillwynia glaberrima																					1	10		
Fabaceae - Faboideae	Dillwynia retorta		5	10	0 3	3 5	0 30	0 10	00 1	10 2	00					10	100	1	15						
Fabaceae - Faboideae	Gompholobium glabratum	Dainty Wedge Pea										1	5									L			
Fabaceae - Faboideae	Gompholobium latifolium	Golden Glory Pea			1	1	1			1	30	1	5			1	3					1			
Fabaceae - Faboideae	Hardenbergia violacea	Purple Coral Pea								1	10	1 1	0	3	500							1	4	1	4
Fabaceae - Mimosoideae	Acacia brownii	Prickly Moses			1	1	1					1 1	0										,		
Fabaceae - Mimosoideae	Acacia longifolia subsp. longifolia	Sydney Golden Wattle								1	10	2 1	0	1	20	1	5			1	4	3	30	5	80
Fabaceae - Mimosoideae	Acacia suaveolens	Sweet Wattle	1		1 1	1 :	3 2	2	5	3	40					1	10					1	5	1	1
Fabaceae - Mimosoideae	Acacia terminalis var. Long inflorescences (P.G.Kodela 307)	Sunshine Wattle					5	5 1	0	4	40	20 5	0	1	10										
Fabaceae - Mimosoideae	Acacia ulicifolia	Prickly Moses	2	1	0		5	5 1	0 2	25 2	00			3	50	3	60	1	5	2	20	1	25	3	40
Haemodoraceae	Haemodorum planifolium																			1	30				
Haloragaceae	Gonocarpus teucrioides	Raspwort										1 '	0	1	20									1	2
Lauraceae	Cassytha glabella		1		1					1	3					1	15								
Lomandraceae	Lomandra cylindrica	Needle Mat- rush	1		1					-	-														
Lomandraceae	Lomandra dauca	Pale Mat-rush			1	1 5	0 2	2 10	0			1 10	0	1	50	2	40	1	10	1	20		, — †	1	5
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush	1		-			1	1	1	5	1	5	1	50	- 1	1			1	2	1	5		
Muntanana	# Europuntus comfieldii	Comfields Chien to ad			-		4		·	· -	0		<u> </u>	· ·	00					<u> </u>	-	<u>⊢                                    </u>		<del>_</del>	
wynaceae		Carmed's Stringybark	+	<del> </del>	1	-	-	_	-		_	_	+	_					<u> </u>			$\vdash$			
Myrtaceae	" Eucalyptus parramattensis subsp. decadens	-			3	3	3 5	5	4				_									$\square$			
Myrtaceae	Angophora costata	Smooth-barked Apple	5		3 5		2 1	1	1	1	2	40 2	0	40	9				I	1	2	20	9	1	2
Myrtaceae	Callistemon rigidus	Stiff Bottlebrush	1	I	_		1	1	1										L			<b>ل</b> ــــــا		$ \longrightarrow $	
Myrtaceae	Corymbia gummifera	Red Bloodwood	10	· ·	4 3	3	2 2	2	1	3	4	20	8	10	3	40	18	5	3			$\square$			
Myrtaceae	Eucalyptus pilularis	Blackbutt	1	I			_		1	10	9											$\square$			
Myrtaceae	Eucalyptus piperita	Sydney Peppermint	1				5	5	3									40	14						
Myrtaceae	Eucalyptus signata	Scribbly Gum	30		2 10	)	2 5	5	2	5	3											LЦ			
Myrtaceae	Leptospermum laevigatum	Coast Teatree																		15	280	10	120	2	30
Myrtaceae	Leptospermum polygalifolium subsp. cismontanum	Tantoon	1	1	0																	1 7	,		_

#### KLEINFELDER Bright People. Right Solutions.

#### **Development Site**

Quadrat Number			G	21	C	22	C	13	G	24	Q	5	G	26	0	27	0	28		29	G	10	Q	11
Vegetation Code			HU	860	HU	860	HU	860	HU	860	HU	360	HU	860	HU	1860	HU	860	HU	1860	HU	860	HU	860
Condition/ Zone			Re	hab	Re	hab	Re	hab	Re	hab	Mod-	Good	Mod	Good	Mod	-Good	Mod	Good	Re	gen	Re	gen	Re	gen
Easting			387	752	387	'934	387	'690	387	757	387	794	387	7865	388	3083	388	3519	38	7583	387	524	387	7669
Northing			6369	9721	6369	9600	6369	9573	6369	9331	6369	063	636	8989	636	9350	636	9331	636	9129	636	8867	636	8793
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab								
Myrtaceae	Leptospermum trinervium	Flaky-barked Tea-tree	20	20	30	50	3	5			1	5			2	35	1	10			1	10		
Myrtaceae	Melaleuca sieberi																				1	1		
Myrtaceae	Melaleuca thymifolia	Thyme Honey- myrtle																			1	1		
Orchidaceae	Acianthus fornicatus	Pixie Caps	1	100							1	100	1	500			1	20						
Orchidaceae	Pterostylis longifolia	Tall Greenhood	1	100					1	10														
Phormiaceae	Dianella caerulea	Blue Flax-lily	1	20	1	10	2	100			4	100	3	500	1	4	1	10	5	50	3	30	3	30
Phyllanthaceae	Breynia oblongifolia	Coffee Bush																			1	25	2	30
Poaceae	*Eragrostis curvula	African Love Grass																	50	200	15	80	65	300
Poaceae	*Melinis repens	Red Natal Grass																	20	500	30	200	20	100
Poaceae	Cynodon dactylon	Couch																					1	3
Poaceae	Eragrostis brownii	Brown's Lovegrass					1	1	1	10									1	10	1	15	1	20
Poaceae	Imperata cylindrica	Blady Grass																			1	5		
Poaceae	Themeda triandra	Kangaroo Grass																					1	10
Polygalaceae	Comesperma ericinum	Pyramid Flower			1	10	2	10																
Proteaceae	Banksia aemula	Wallum Banksia			1	1																		
Proteaceae	Banksia integrifolia	Coast Banksia					1	4	1	5													1	3
Proteaceae	Banksia serrata	Old Man Banksia	5	5			3	2			2	40	1	20	10	30	20	80			2	15	5	120
Proteaceae	Conospermum taxifolium	Variable Smoke-bush					5	50									1	10	5	60			1	3
Proteaceae	Isopogon anemonifolius	Broad- leaf Drumsticks					1	2																
Proteaceae	Persoonia lanceolata	Lance Leaf Geebung	1	10			10	100	1	20			1	2	1	20	1	20	1	100	2	80	5	120
Proteaceae	Persoonia levis	Broad-leaved Geebung			2	50					1	10							2	5	1	20		
Pteridaceae	Cheilanthes sieberi																				1	5	1	10
Rubiaceae	Pomax umbellata		1	50			1	20	1	20	2	500	5	1000					1	10	2	30	1	10
Rutaceae	Eriostemon australasius	Pink Wax Flower	2	10	2	10	1	1							5	50	5	45						
Thymelaeaceae	Pimelea linifolia subsp. linifolia	Slender Rice-flower	1	15							1	100	3	100	1	25					1	25	1	1
Verbenaceae	*Lantana camara	Lantana																	1	1	2	3	2	. 2
Xanthorrhoeaceae	Xanthorrhoea latifolia												1	1										
Zamiaceae	Macrozamia communis	Burrawang									4	10	30	100					1	2	. 1	4	1	2
		Total Species Richness	3	31	2	26	3	4	2	9	3	0	2	25	1 2	29	2	23		32	1	.6	3	34

\* Denotes Introducted Species

# Denotes Threatened Species (Listed under TSC Act and/ or EPBC)



Quadrat Number			Q	12	01	3	01	14	0	15	0	16	0	17	0	18	0	19	02	D	02	1	02	2	02	23	0	24	0	25	02	6
Vegetation Code			HU	917	HUS	917	HUS	917	HU	860	ни	860	HU	1860	HU	860	HU	860	HU8	60	HU8	360	HU	360	HU	860	HU	351	HU	851	HU8	351
Condition/ Zone			Mod-	Good	Mod-	Good	Mod-	Good	Mod-	Good	Mod	-Good	Mod	-Good	Mod	-Good	Mod-	Good	Reh	ab	Reh	ab	Reh	ab	Reg	zen	Mod-	Good	Mod-	Good	Mod-C	Good
Easting			387	747	388	164	388	931	387	759	387	7583	388	3853	389	9029	389	209	3876	03	3875	569	387	596	387	650	388	019	388	302	3884	406
Northing			6369	9950	6369	730	6369	9769	6369	9788	636	9215	636	9410	636	9288	6369	9358	63690	538	6369	434	6369	249	6369	9163	6369	804	6369	727	6369	600
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	S	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Anthericaceae	Tricoryne simplex																						1	10	1	1						
Apiaceae	Centella asiatica	Indian Pennywort																														
Apiaceae	Platysace ericoides		2	100	1	10	1	1	1	10					1	4			1	5	1	50	2	20	5	1000	1	100	1	10	2	45
Apiaceae	Trachymene incisa		1	10			2	100																							_	
Apocynaceae	Gomphocarpus fruticosus	Narrow- leaved Cottonbush																														
Apocynaceae	Marsdenia suaveolens	Scented Marsdenia													1	10																
Apocynaceae	Parsonsia straminea	Common Silkpod									2	1																				
Asteraceae	*Bidens pilosa	Cobblers Pegs																														
Asteraceae	*Conyza bonariensis	Flaxleaf Fleabane																														
Asteraceae	*Hypochaeris radicata	Catsear																														
Asteraceae	*Senecio madagascariensis	Fireweed																					1	1								_
Asteraceae	Actinotus helianthi	Flannel Flower									1	10							10	500	15	500	10	200	1	50					1	15
Asteraceae	Ozothamnus diosmifolius	Rice Flower																														_
Bignoniaceae	Pandorea pandorana subsp. pandorana	Wonga Wonga Vine							2	10	1	10			2	50	1	1					1	10	1	2	1	5				_
Blandfordiaceae	Blandfordia nobilis	Christmas Bells					1	1																								
Blechnaceae	Blechnum cartilagineum	Gristle Fern																														
Blechnaceae	Blechnum indicum	Swamp Water Fern															5	25														_
Casuarinaceae	Allocasuarina torulosa	Forest Oak									1	1																				_
Casuarinaceae	Casuarina glauca	Swamp Oak																	1	10												
Commelinaceae	Commelina cyanea														1	2																
Cyperaceae	*Isolepis prolifera																															
Cyperaceae	Baumea articulata	Jointed Twig-rush																														_
Cyperaceae	Baumea rubiginosa																															
Cyperaceae	Baumea sp.																															
Cyperaceae	Baumea teretifolia																															
Cyperaceae	Caustis pentandra																										1	1				
Cyperaceae	Caustis recurvata				1	20	1	10																					1	1	1	20
Cyperaceae	Gahnia clarkei	Tall Saw-sedge															20	45														
Cyperaceae	Gahnia sieberiana	Red-fruit Saw-sedge																														
Cyperaceae	Lepidosperma laterale																										2	50				_
Cyperaceae	Ptilothrix deusta		1	20					1	100							1	4													1	10
Cyperaceae	Schoenus brevifolius	Zig- zag Bog- rush	1	50																					1	100					1	2
Cyperaceae	Schoenus ericetorum	Heath Bog-rush	1	100	1	10			2	100									1	10	1	20					2	500	2	50	1	5
Dennstaedtiaceae	Histiopteris incisa	Bat's Wing Fern																														
Dennstaedtiaceae	Pteridium esculentum	Common Bracken							50	500	100	1000	40	100	5	100	20	100	1	5					10	100						
Dicksoniaceae	Calochlaena dubia	Rainbow Fern																														
Dilleniaceae	Hibbertia acicularis				1	10																							1	1		
Dilleniaceae	Hibbertia fasciculata		1	50	1	50	1	5																					1	50	1	4
Dilleniaceae	Hibbertia linearis								1	10	1	10	1	5	1	5			1	10	1	10	2	20	1	50	1	1				
Droseraceae	Drosera auriculata																															
Droseraceae	Drosera binata	Forked Sundew															1	5														
Droseraceae	Drosera peltata																															
Elaeocarpaceae	Tetratheca thymifolia	Thyme Pink-bells															1	3									1	1				
Ericaceae - Epacridoideae	Astroloma pinifolium	Pine Heath	1	1	1	10													1	20	1	20	1	30	1	20	1	1	1	1	1	15
Ericaceae - Epacridoideae	Brachyloma daphnoides	Daphne Heath			1	2													1	5	1	3			1	1						
Ericaceae - Epacridoideae	Epacris obtusifolia	Blunt- leaf Heath																														
Ericaceae - Epacridoideae	Epacris pulchella	Wallum Heath																														
Ericaceae - Epacridoideae	Leucopogon appressus																														1	25
Ericaceae - Epacridoideae	Leucopogon ericoides	Pink Beard-heath	1	50	2	100	1	100	2	100									2	50	10	250	1	5	2	100	1	50	2	1000	1	20
Ericaceae - Epacridoideae	Leucopogon esquamatus						1	1	4	10																						
Ericaceae - Epacridoideae	Leucopogon juniperinus	Prickly Beard-heath																													1	30
Ericaceae - Epacridoideae	Leucopogon lanceolatus var. lanceolatus										1	2	1	1	1	10	1	30				_	_									
Ericaceae - Epacridoideae	Leucopogon leptospermoides																															
Ericaceae - Epacridoideae	Leucopogon virgatus				1	5													2	10			1	10		_	_		1	1		
Ericaceae - Epacridoideae	Monotoca elliptica	Tree Broom-heath					1	50	1	100	1	20			1	40	1	25					2	30	1	100	1	1	3	50		
Ericaceae - Epacridoideae	Monotoca scoparia		1	20	1	10	2	50											30	50					_		1	20			2	40



Quadrat Number			01	12	01	.3	01	4	0	15	0	16	0	17	0	18	0	19	02	0	02	21	0	22	0	23	0	24	C	25	07	26
Vegetation Code			HUS	917	HUS	917	HUS	917	HU	860	HU	860	HU	860	ни	860	HU	860	HUE	360	HUB	360	HU	860	HU	860	ни	851	н	851	HU	851
Condition/ Zone			Mod-	Good	Mod-0	Good	Mod-	Good	Mod-	Good	Mod-	Good	Mod	-Good	Mod	-Good	Mod-	Good	Reh	ab	Reh	ab	Rel	nab	Rea	zen	Mod	-Good	Mod	-Good	Mod-	Good
Easting			3877	747	3883	164	3889	931	387	759	387	583	388	3853	389	9029	389	209	3876	503	3875	569	387	696	387	650	388	3019	38	3302	388	406
Northing			6369	950	6369	730	6369	769	6369	788	6369	9215	636	9410	636	9288	636	9358	6369	638	6369	434	6369	249	6369	9163	636	9804	636	9727	6369	9600
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	s	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Ericaceae - Epacridoideae	Styphelia viridis	Green Eive-corners																			1	50			-							
Ericaceae - Epacridoideae	Woollsia pungens																				1	30										
Euphorbiaceae	Amperea xiphoclada var. xiphoclada		1	10	3	500	1	10	4	100									1	5							1	10	1	50	1	20
Euphorbiaceae	Homalanthus populifolius	Bleeding Heart						-																								
Euphorbiaceae	Ricinocarpos pinifolius	Wedding Bush			1	20	1	5	2	10									1	10	1	2	2	30	1	2	1	10	5	10	1	20
Fabaceae - Faboideae	Almaleea paludosa																															
Fabaceae - Faboideae	Aotus ericoides				2	50			2	40							2	30	1	5	1	3	1	10			1	5				
Fabaceae - Faboideae	Bossiaea ensata	Sword Bossiaea			1	20															1	10										
Fabaceae - Faboideae	Bossiaea heterophylla	Variable Bossiaea	2	50	1	50	5	100	5	100			1	10					1	20	3	100	2	30	1	10	5	50	10	50	5	80
Fabaceae - Faboideae	Bossiaea obcordata	Spiny Bossiaea																					5	60								
Fabaceae - Faboideae	Bossiaea rhombifolia	··· / ··· · ··									1	10									2	30										
Fabaceae - Faboideae	Daviesia ulicifolia	Gorse Bitter Pea																							3	20						
Fabaceae - Faboideae	Dillwynia floribunda																						1	1								
Fabaceae - Faboideae	Dillwynia retorta				1	50			5	100	1	1							10	500	10	100	5	50	1	10	2	100	1	10	15	60
Fabaceae - Faboideae	Glycine microphylla	Small- leaf Glycine															1	1														
Fabaceae - Faboideae	Glycine tabacina														1	1																
Fabaceae - Faboideae	Gompholobium latifolium	Golden Glory Pea																					1	10								
Fabaceae - Faboideae	Gompholobium virgatum	Leafy Wedge Pea			1	2																										
Fabaceae - Faboideae	Hardenberaia violacea	Purple Coral Pea									1	1	2	20	1	4					1	10	1	3			1	1				
Fabaceae - Faboideae	Indiaofera australis	Australian Indigo													1	3																
Fabaceae - Faboideae	Kennedia rubicunda	Dusky Coral Pea													1	15	1	20														
Fabaceae - Faboideae	Mirbelia rubiifolia	Heathy Mirbelia																														
Fabaceae - Faboideae	Pultenaea retusa	Notched Bush- pea															1	25														
Fabaceae - Faboideae	Viminaria iuncea	Golden Spray																														
Fabaceae - Mimosoideae	*Acacia saliana	Golden Wreath Wattle																														
Fabaceae - Mimosoideae	Acacia brownii	Prickly Moses	1	5			2	10	2	10																						
Fabaceae - Mimosoideae	Acacia elonaata	Swamp Wattle																														
Fabaceae - Mimosoideae	Acacia floribunda	White Sally Wattle													60	300																
Fabaceae - Mimosoideae	Acacia Ionaifolia subsp. Ionaifolia	Sydney Golden Wattle									1	3	10	50	1	20	3	50			1	5	1	20	2	50						
Fabaceae - Mimosoideae	Acacia stricta	Straight Wattle																														
Fabaceae - Mimosoideae	Acacia suaveolens	Sweet Wattle					1	1	20	20					1	10			1	5	20	250	2	10			1	5			1	5
Fabaceae - Mimosoideae	Acacia terminalis var. Lona inflorescences (P.G.Kodela 307)	Sunshine Wattle									20	40									5	50	5	15	1	20						
Fabaceae - Mimosoideae	Acacia ulicifolia	Prickly Moses									1	2	1	20	1	5	1	2	1	10	25	250	10	70	1	5					1	10
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern																														
Goodeniaceae	Dampiera stricta						1	100																					2	50	3	80
Goodeniaceae	Goodenia bellidifolia																															
Haemodoraceae	Haemodorum planifolium				1	5																					4	500	1	10	2	45
Haloragaceae	Gonocarpus micranthus subsp. micranthus																1	10														
Haloragaceae	Gonocarpus teucrioides	Raspwort									1	20	1	5	1	8	1	10					1	3	1	1						
Hydrocharitaceae	Ottelia ovalifolia	Swamp Lily																														
Iridaceae	Patersonia sericea	Silky Purple-flag									1	5																				
Juncaceae	Juncus continuus																															
Juncaceae	Juncus usitatus																															
Lauraceae	Cassytha glabella																														1	10
Lauraceae	Cassytha pubescens																		1	1												
Loganiaceae	Mitrasacme polymorpha																						1	5								
Lomandraceae	Lomandra confertifolia	Mat- rush							1	1																						
Lomandraceae	Lomandra filiformis subsp. filiformis	Wattle Mat-rush									1	5	1		1	1											1	1				
Lomandraceae	Lomandra glauca	Pale Mat-rush			1	5	1	10	2	100	1	10		1	1	10					1	20			2	100	4	500	1	50	1	20
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush					1	10			2	10	1	10	5	60			1	1	1	5					1	10				
Lomandraceae	Lomandra micrantha	Small- flower Mat- rush						-					1	Ē	1	4											<u> </u>					
Malvaceae	*Sida rhombifolia	Paddy's Lucerne											1		1	1											1	1				
Menyanthaceae	Liparophyllum exaltatum												1		1	1											1	1				
Myrtaceae	<sup>#</sup> Eucalyptus camfieldii	Camfield's Stringybark											1		1	1			5	1							1	1			5	11
Myrtaceae	Angonhora costata	Smooth-barked Apple							2	1	40	15	40	Δ	30	30	45	40	1	1	5	3	10	Δ	1	1						
Myrtaceae	Callistemon citrinus	Crimson Bottlebrush							-	-					50			20	-	-	5	5	10	4	-	- 1						
,																	<u> </u>															



Quadrat Number			Q	12	Q	13	C	214	0	15	Q	16	Q	17	Q	18	Q19	0	220	0	21	Q	22	Q	23	Q	24	C	25	Q26
Vegetation Code			HU	917	HU	917	HU	J917	н	860	HU	860	HU	860	HU	860	HU860	н	J860	HU	860	HU	860	HU	860	HU	851	HU	1851	HU851
Condition/ Zone			Mod-	Good	Mod	Good	Mod	-Good	Mod	-Good	Mod	-Good	Mod-	-Good	Mod-	Good I	/lod-Go	od Re	ehab	Re	hab	Re	hab	Re	gen	Mod	-Good	Mod	-Good	Mod-Goor
Easting			387	747	388	3164	38	8931	38	759	387	7583	388	3853	389	029	389209	38	7603	38	7569	387	696	387	650	388	3019	38	3302	388406
Northing			6369	9950	636	9730	636	9769	636	9788	636	9215	6369	9410	6369	288	636935	8 636	59638	636	9434	636	9249	636'	9163	636	9804	636	9727	6369600
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC A	b FPC	Ab	FPC	Ab	FPC	Ab	s	Ab	FPC	Ab	FPC	Ab	FPC Ab
Myrtaceae	Callistemon pachyphyllus	Wallum Bottlebrush																1	L 1	1										
Myrtaceae	Callistemon sp.																													
Myrtaceae	Corymbia gummifera	Red Bloodwood	1	1					50	13	5	1			10	3	5	2 1	L 1	10	3	10	3	,		2	1			
Myrtaceae	Eucalyptus globoidea	White Stringybark																												
Myrtaceae	<sup>#</sup> Eucalvotus parramattensis subsp. decadens																	1	L 2	2 1	1									
Myrtaceae	Eucalvotus pilularis	Blackbutt							4	1								2	2 1	25	4	40	6	5				1		
Myrtaceae	Eucalyptus piperita	Sydney Peppermint	1	1					-											20		5						20	4	
Myrtaceae	Eucalyptus robusta	Swamp Mahogany															5	1												
Myrtaceae	Eucalyptus sianata	Scribbly Gum							2	1			20	3			-	- 5	5 2	10	2	2 5	1	1		30	4			10 7
Myrtaceae	Eurvomvrtus ramosissima	Bosy Baeckea	1	100	3	250	2	50	)													-	_	1		2	50	10	100	
Myrtaceae	Leptospermum arachnoides						-																	1						
Myrtaceae	Leptospermum juniperinum	Prickly Tea- tree																										1		
Myrtaceae	Leptospermum laeviaatum	Coast Teatree																		1	20	)		20	100			1		
Myrtaceae	Leptospermum polyaglifolium subsp. cismontanum	Tantoon	5	20	5	20	20	50	)											-		1	1		100			5	10	
Myrtaceae	l entospermum trinervium	Elaky-barked Tea-tree	30	50	30	50	10	100	) 5	20								1	1 5	,		-		÷		40	100	30	100	20 80
Myrtaceae	Melaleuca decora	Fland barned fed free	1	5	50	50		100	/ 3										-					<u> </u>		10	100		100	20 00
Myrtaceae	Melaleuca ericifolia	Swamp Paperbark	-	5																				+				<u> </u>		
Myrtaceae	Melaleuca linariifalia	Elax-leaved Paperbark																						<u> </u>				<u> </u>		
Myrtaceae	Melaleuca nodosa	Prickly- leaved Paperbark	30	30	15	20	50	100	1		2	2												+		40	50	60	100	20 11(
Myrtaceae	Melaleuca avinguenervia	Broad-leaved Paperbark	50	50	15	20	50	100	, 		-	-					2	2				-		<u> </u>		40	50		100	20 110
Myrtaceae	Melaleuca sieheri	bload-leaved raperbalk					5	20									2	2		-				+				<u> </u>		$\vdash$
Myrtaceae	Melaleuca thumifolia	Thyme Honey- myrtle					10	50	,											-				+				<u> </u>		$\vdash$
Myrtaceae	Micromyrtus ciliata	Heath- myrtle	1	50	1	50	10	1	1															+		1	10	1	10	2 //
Orchidaceae	Acianthus fornicatus	Rivie Cans	1	50	1	50	1	100	1	1000	1	20	1	20	5	400	1	15		-				+		1	500		10	43
Orchidaceae	Chiloglattic sp	rivie caps	T	5			-	100	, <u>1</u>	1000	1	20	T	20	5	400	1			-				+		1	500	<u> </u>		$\vdash$
Orchidaceae	Pterostylis Ionaifolia	Tall Greenbood					1	100			1	20								-				+				1	10	$\vdash$
Orchidaceae	Pterostylis iongijoliu	Midget Greenbood					1	100	,										-	-				+		1	10		10	$\vdash$
Dicilidaceae	Pierostyns matica	Rhug Elax like			2	E0	1	1	1	10	10	E00			E	60	2	10		-		c	120	2	E00	1	10	1	10	$\vdash$
Phormiaceae	Dianella longifolia	Blue Flax-Illy			5	50	1	. 1	1	10	10	300			5	00	2	+0		-		5	120		300				10	$\vdash$
Pholiniaceae	Billardiara scandans	Hain/ Apple Pern/					1	2	, 1	10	-				1	2		_	-	-		1	1							$\vdash$
Dicrodondracoao	Disidiard Scandens						1	. 2	-						1	2		_	-	-		1	-							$\vdash$
Pinacoao	*Binuc alliattii	Slach Bing					1	1	-										-	-				+				<u> </u>		$\vdash$
Pinaceae	*Dinus radiata	Padiata Dino							-											-				+				<u> </u>		$\vdash$
Pillaceae	Philos radiata	Radiata Pine							-										-	-				+				<u> </u>		$\vdash$
Pittosporaceae	*Andronogon virginicus	Which Grace							-								1	2	-	-				+				<u> </u>		$\vdash$
Poaceae	Anaropogon virginicus	Nerrow Josfed Cornet Cross							-								1	2	-	-		-						<u> </u>		$\vdash$
Poaceae	AXONOPUS JISSIJONUS	Danie Veldtgrees							-										-	-		-						<u> </u>		$\vdash$
Poaceae	*Emmanua eleccia	Pariic velugrass																_	-					1	10			<u> </u>		$\vdash$
Poaceae	*Eragrostis culturensis	African Lava Crass							-	-	2	10							-	-		1	2	1 20	1000			<u> </u>		$\vdash$
Poaceae	*Melinis renens	Red Natal Grass			<u> </u>			+	+	<del> </del>	- 2	10						-	+	+	<u> </u>	1	- 4	50	100			┼──		$\vdash$
Roacoao	*Dacadum dilatatum	Decolum						-	1									+	1	1		+			100			┼──		$\vdash$
Roacoao	*Doppisatum clandactinum	r aspaium Vikuwu Groce						-	1									+	1	1		+		+'				┼──		$\vdash$
Roacoao	rennisetani tanaestinani *Sotoria papuifora	NIKUYU OTd55				<u> </u>		+	1		<u> </u>		$\vdash$	$\left  \right $				_	+	1		+		–				├		$\vdash$
Poaceae	*Seturia parvijiora	Dela Diasan Caras							-										-	-		-						<u> </u>		$\vdash$
Poaceae	*Setaria pumila	Pale Pigeon Grass																_	-									<u> </u>		$\vdash$
Poaceae	*Setaria sphacelata	South African Pigeon Grass									-							_				_						—		$\vdash$
Poaceae	Anisopogon avenaceus	Oat Speargrass							_									_	-	_		-		<b> </b> '				─		$\vdash$
Розсеае	Austrosupa pubescens	Cauch								<u> </u>	<u> </u>								+		<u> </u>	+		<u>+</u> '				├		$\vdash$
Poaceae	Cynoaon aactylôn	Louch			<u> </u>			<u> </u>	-	<u> </u>				-				_		-	<u> </u>			—				—		$\vdash$
Poaceae	Echinopogon caespitosus	Bushy Hedgenog Grass			<u> </u>			<u> </u>	-	<u> </u>				-				_		-	<u> </u>			—				—		$\vdash$
Poaceae	Entolasia marginata	Bordered Panic	_	1000	I		-		1	<u> </u>	-	20					2	20		1	I			<u> </u>		-	40	—		$\vdash$
Poaceae	Entolasia stricta	wiry Panic	5	1000	<u> </u>					<u> </u>	1	20				20	2	su			I			<u> </u>		1	10	┣—		$\vdash$
Poaceae	Eragrostis brownii	Brown's Lovegrass	<u> </u>		I	ļ	<u> </u>	<u> </u>	1	<u> </u>	<u> </u>	L	$\vdash$	$\vdash$	1	20		_	1	1	I		ļ	<u>+</u> '			L	──	┣	$\vdash$
Poaceae	Hemartnria uncinata var. uncinata	Mat Grass	<u> </u>		I	ļ	<u> </u>	<u> </u>	1	<u> </u>	<u> </u>		$\vdash$					_	1	1	I		ļ	<u>+</u> '			L	──	┣	$\vdash$
Poaceae	Imperata cylindrica	Blady Grass			<u> </u>	L	<u> </u>		<u> </u>	<u> </u>	10	100	1	50	1	10				<u> </u>	<u> </u>		L	1	50		L	┢───	<u> </u>	$\vdash$
Poaceae	Microlaena stipoides var. stipoides	Weeping Grass			<u> </u>			<u> </u>	1	<u> </u>	<b> </b>							_		1	I			–				—		$\vdash$
Poaceae	Panıcum simile	Two-colour Panic			1			1	1	1	1		1				1	1	1	1	1	1							1	



Quadrat Number			Q12	2	Q13		Q14		Q15		Q16		Q17		Q18		Q19	0	20	C	21	0	22	0	23	C	24	Q	25	Q2	6
Vegetation Code			HU9	17	HU917	7	HU917	Н	IU860	н	U860	D H	10860	о н	IU860	Н	U860	H	J860	HU	1860	HU	1860	HU	860	HU	851	HU	851	HU8	351
Condition/ Zone			Mod-G	iood N	Vlod-Go	od M	od-Goo	od Mo	d-Goo	od Mo	d-Go	od Mo	d-Go	od Mo	d-Goo	od Mo	d-Goo	d Re	hab	Re	hab	Re	hab	Re	gen	Mod	-Good	Mod-	Good	Mod-C	Good
Easting			3877	47	388164	4 3	388931	3	87759	38	8758	3 3	8885	3 3	89029	3	39209	38	7603	38	7569	387	7696	387	7650	388	3019	388	302	3884	406
Northing			63699	950	636973	0 6	5369769	9 63	869788	3 63	6921	15 63	36941	.0 63	69288	3 63	69358	636	9638	636	9434	636	9249	636	9163	636	9804	6365	<del>)</del> 727	63696	600
Family	Scientific Name	Common Name	FPC	Ab	FPC A	b Fl	PC Al	) FP	C Ał	D FPO	C A	b FP	C A	b FP	C Al	D FPO	C Ab	FPC	Ab	FPC	Ab	FPC	Ab	S	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Poaceae	Paspalidium distans		1	1													2 30	)													
Poaceae	Paspalidium sp.																2 30	)													
Poaceae	Themeda triandra	Kangaroo Grass													1	2															
Polygalaceae	Comesperma ericinum	Pyramid Flower																													
Polygonaceae	Persicaria decipiens	Slender Knotweed																													
Proteaceae	Banksia aemula	Wallum Banksia	40	20	30	50	50 10	00																		30	30	60	100	15	80
Proteaceae	Banksia oblongifolia		1	20			20 5	50										1	1							1	20			1	5
Proteaceae	Banksia serrata	Old Man Banksia						2	20 2	20 2	0	10	5	5	6 4	10	1 20	) 2	8	1	1	. 1	. 2	. 20	15						
Proteaceae	Conospermum taxifolium	Variable Smoke-bush													1 1	.0	1 5	5				1	. 10	1	. 1						
Proteaceae	Hakea sericea	Needlebush					1	5																					, T		
Proteaceae	Hakea teretifolia	Needlebush																													
Proteaceae	Isopogon anemonifolius	Broad- leaf Drumsticks	1	20	5	20	5 2	20														1	. 2			1	20	2	5	3	30
Proteaceae	Lambertia formosa	Mountain Devils	10	10																						20	50			10	45
Proteaceae	Persoonia lanceolata	Lance Leaf Geebung	1	10	1	10	1	5	1 10	00	1	2						1	20	1	10	) 5	80	1	10			1	5	1	20
Proteaceae	Persoonia levis	Broad-leaved Geebung	1	1							1	4	1	2								1	. 1	. 1	. 50	1	10			1	20
Proteaceae	Petrophile pulchella	Drumsticks																				1								1	15
Pteridaceae	Cheilanthes sieberi																							1	. 2						
Restionaceae	Baloskion pallens											4	10 10	00																	
Restionaceae	Baloskion sp.																														
Restionaceae	Baloskion tetraphyllum subsp. meiostachyum	Plume Rush														6	0 220	)													
Restionaceae	Empodisma minus	Spreading Rope- rush																													
Restionaceae	Eurychorda complanata		1	30			1 5	50																							
Restionaceae	Hypolaena fastigiata		1	100	1	10	1 1	10																		1	100	1	50		
Restionaceae	Leptocarpus tenax		1	50			10 50	00																		1	100			2	80
Restionaceae	Lepyrodia muelleri																														
Restionaceae	Lepyrodia scariosa						10 50	00																						2	70
Rubiaceae	*Richardia brasiliensis	White Eye																													
Rubiaceae	Pomax umbellata									2	0 5	00	1	50	3 6	50	1 20	)		2	50	1	. 15	1	. 50				, T		
Rutaceae	Eriostemon australasius	Pink Wax Flower			3	20			2 1	.0																1	20	2	5	1	15
Rutaceae	Zieria laxiflora	Wallum Zieria																										1	1		
Selaginellaceae	Selaginella uliginosa	Swamp Selaginella			1	20							1	10			1 5	5													
Solanaceae	*Solanum pseudocapsicum	Jerusalem Cherry																													
Stylidiaceae	Stylidium graminifolium	Grass Trigger Plant																													
Thymelaeaceae	Pimelea linifolia subsp. linifolia	Slender Rice-flower	1	100	1	20			1 10	00	1	10			1 1	0										1	50	2	50	3	50
Verbenaceae	*Lantana camara	Lantana																													
Verbenaceae	*Verbena bonariensis	Purpletop																													
Violaceae	Viola hederacea	Ivy-leaved Violet																				1									
Xanthorrhoeaceae	Xanthorrhoea glauca							3	10	0	1	2										T	T	Ī	T	1	2	,			
Xanthorrhoeaceae	Xanthorrhoea minor														1	4		1		1	1	1	1	1	1						
Xyridaceae	Xyris gracilis																		1	1	1	1	1	1	1						
Zamiaceae	Macrozamia communis	Burrawang	1 1		1						1	3			1	5		1		1	1	1	1	.1	1	1	<b>├</b>	<del> </del>			
		Total Species Bichness	33		32		38		31		35		18		34		34	1	31	1	32	:	39	:	13	( (	40	3	1	32	8

\* Denotes Introducted Species

# Denotes Threatened Species (Listed under TSC Act and/ or EPBC)



Quadrat Number			Q2	27	Q2	B	Q	29	Q	30	Q	31	Q	32	Q	33	Q	34	Q	35	Q	36	Q	37	Q	38	Q	39
Vegetation Code			HU	851	HU8	51	HU	865	HU	865	HU	J865	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938	HUS	938
Condition/ Zone			Mod-	Good	Mod-G	iood	Mod-	Good	Mod	-Good	Mod	-Good	Mod	Good	Mod-	Good	Mod-	Good	Mod-	Good	Rea	zen	Rea	zen	Rea	en	Reg	zen
Easting			388	601	3890	68	388	538	388	3641	388	8767	388	8005	388	048	388	881	389	033	388	353	388	759	389	008	389	080
Northing			6369	9505	63697	729	6369	9837	636	9726	636	9745	636	9088	6368	3778	636	9053	6369	9501	6369	9172	6369	9254	6369	094	6369	112
Family	Scientific Name	Common Name	FPC	Ab	FPC.	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Anthericaceae	Tricorvne simplex																											
Anjaceae	Centella asiatica	Indian Pennywort																										,
Apiaceae	Platysace ericoides		1	20	3	50	10	500																				
Apiaceae	Trachymene incisa		-	20	2	100	20	100	1	20	1	50																
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cottonbush			-	100	-	100	-	20	-																	
Apocynaceae	Marsdenia suaveolens	Scented Marsdenia																										
Apocynaceae	Parsonsia straminea	Common Silknod											1	5	1	20												
Asteraceae	*Bidens nilosa	Cohblers Pegs											-	5	-	20												
Asteraceae	*Convra honariensis	Flavleaf Fleahane																					1	10				
Asteraceae	*Hypochaeris radicata	Catsear																					1	10				
Asteraceae	*Senecio madagascariensis	Eiroweed																					1	4			1	1
Astoraçõão	Actinetus helianthi	Flappal Flower	1	10			1	10				-											1	4			1	<u>+</u>
Astoraçõão	Actinotus nellantin	Pico Flower	1	10			1	10															1	E	2	10		
Bignopiaceae	Dzotinumius ulosinijolius	Manga Manga Vina	1	г	1	г																	1	3	2	10		
Blandfordiacoao	Plandfordia pobilic	Christmas Polls	1	э	1	э										$\vdash$												
Diariurururaceae	Blacknum cartilacin cum	Cristle Form			<u> </u>				<u> </u>					00					<u> </u>		<u> </u>							
Blechnoceae	Blechnum curulagineum												4	80	40	220	40											
Biechnaceae	Biechnum indicum	Swamp Water Fern													40	320	10	50										
Casuarinaceae	Allocasuarina torulosa	Forest Oak																										600
Casuarinaceae	Casuarina glauca	Swamp Оак																									35	120
Commelinaceae	Commelina cyanea																											
Cyperaceae	*Isolepis prolifera																											,l
Cyperaceae	Baumea articulata	Jointed Twig-rush															1	10	20	1000								
Cyperaceae	Baumea rubiginosa																		5	200								
Cyperaceae	Baumea sp.														1	3												,l
Cyperaceae	Baumea teretifolia																											
Cyperaceae	Caustis pentandra																											
Cyperaceae	Caustis recurvata				1	2																						
Cyperaceae	Gahnia clarkei	Tall Saw-sedge							1	5			2	15	2	20									1	1		
Cyperaceae	Gahnia sieberiana	Red-fruit Saw-sedge											3	40			80	240			1	10						
Cyperaceae	Lepidosperma laterale																											
Cyperaceae	Ptilothrix deusta						2	100			2	100																
Cyperaceae	Schoenus brevifolius	Zig- zag Bog- rush					1	5	70	1000	2	500							50	1000								
Cyperaceae	Schoenus ericetorum	Heath Bog-rush			2	40																						
Dennstaedtiaceae	Histiopteris incisa	Bat's Wing Fern											4	110														1
Dennstaedtiaceae	Pteridium esculentum	Common Bracken	20	250									4	140			1	15			50	200			15	120		
Dicksoniaceae	Calochlaena dubia	Rainbow Fern											4	120														
Dilleniaceae	Hibbertia acicularis																											,
Dilleniaceae	Hibbertia fasciculata				1	5																						
Dilleniaceae	Hibbertia linearis		2	20																								
Droseraceae	Drosera auriculata										1	500																
Droseraceae	Drosera binata	Forked Sundew																										
Droseraceae	Drosera peltata								1	50																		, I
Flaeocarpaceae	Tetratheca thymifolia	Thyme Pink-hells			1	10																						, I
Fricaceae - Enacridoideae	Astroloma ninifolium	Pine Heath			-	10															1	6						
Ericaceae - Epacridoideae	Brachyloma daphnoides	Danhne Heath																			-	0						
Fricaceae - Epacridoideae	Enacris obtusifolia	Blunt- leaf Heath																										
Ericaceae - Epacridoideae	Epacris outosjona	Wallum Heath									1	10																
Ericaceae - Epacridoideae		Walldin neath									1	10																
Ericaceae - Epacridoidoao	Leucopogon appressus	Pink Reard-heath			1	50			-			+																·
Ericaceae - Epacridoideae		FIIIK Dedfu-fiedtii			1	50	1	1																				
		Drickly Roard beath	$\vdash$		1	T	1	-			40	F00				$\vdash$												
	Laucopogon juniperinus	r nekly bedru-nedtil	$\vdash$								40	500				$\vdash$												
Encaceae - Epacridoldeae		1	-	20												$\vdash$												
Ericaceae - Epacridoideae	Leucopoyon ieptospermoiaes	1	5	20																								
Ericaceae - Epacridoideae	Leucopogon virgatus	Tura Dura una la sult						-								$ \rightarrow $												
Ericaceae - Epacridoideae		Tree Broom-heath	1	10			1	5				<u> </u>		20							1	15						
Ericaceae - Epacridoideae	Monotoca scoparia						1	5																				



Quadrat Number			Q2	7	Q2	.8	Q	29	Q	30	(	Q31	0	32	0	33	Q	34	Q	35	Q	36	Q	37	Q	38	Q	39
Vegetation Code			HUS	51	HU8	351	HU	865	HU	865	н	U865	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938
Condition/ Zone			Mod-	l bood	Mod-0	Good	Mod	-Good	Mod	-Good	Mod	d-Good	Mod	-Good	Mod	-Good	Mod	-Good	Mod	Good	Re	gen	Re	gen	Re	gen	Reg	gen
Easting			3886	601	3890	068	388	3538	388	8641	38	8767	38	3005	388	3048	388	8881	389	033	388	3353	388	3759	389	008	389	080
Northing			6369	505	6369	729	636	9837	636	9726	63	69745	636	9088	636	8778	636	9053	636	9501	636	9172	636	9254	636	9094	6369	9112
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Ericaceae - Epacridoideae	Styphelia viridis	Green Five-corners																										
Ericaceae - Epacridoideae	Woollsia pungens																											
Euphorbiaceae	Amperea xiphoclada var. xiphoclada		3	50	3	50																						
Euphorbiaceae	Homalanthus populifolius	Bleeding Heart																									1	1
Euphorbiaceae	Ricinocarpos pinifolius	Wedding Bush			2	10																						
Fabaceae - Faboideae	Almaleea paludosa								1	20																		
Fabaceae - Faboideae	Aotus ericoides		1	5	4	20																						
Fabaceae - Faboideae	Bossiaea ensata	Sword Bossiaea																										
Fabaceae - Faboideae	Bossiaea heterophylla	Variable Bossiaea	1	5	5	100	5	50																				
Fabaceae - Faboideae	Bossiaea obcordata	Spiny Bossiaea																										
Fabaceae - Faboideae	Bossiaea rhombifolia						1	1																				
Fabaceae - Faboideae	Daviesia ulicifolia	Gorse Bitter Pea																										
Fabaceae - Faboideae	Dillwynia floribunda				1	1																						
Fabaceae - Faboideae	Dillwynia retorta		2	10																								
Fabaceae - Faboideae	Glycine microphylla	Small- leaf Glycine																										
Fabaceae - Faboideae	Glycine tabacina																											
Fabaceae - Faboideae	Gompholobium latifolium	Golden Glory Pea																										
Fabaceae - Faboideae	Gompholobium virgatum	Leafy Wedge Pea																										
Fabaceae - Faboideae	Hardenbergia violacea	Purple Coral Pea																										
Fabaceae - Faboideae	Indigofera australis	Australian Indigo																										
Fabaceae - Faboideae	Kennedia rubicunda	Dusky Coral Pea											15	100	1	15									1	3		
Fabaceae - Faboideae	Mirbelia rubiifolia	Heathy Mirbelia					1	1	10	250	4(	0 500	)															
Fabaceae - Faboideae	Pultenaea retusa	Notched Bush- pea					1	3	2	50															1	1		
Fabaceae - Faboideae	Viminaria juncea	Golden Spray											1	6									3	30	1	2		
Fabaceae - Mimosoideae	*Acacia saligna	Golden Wreath Wattle																									1	6
Fabaceae - Mimosoideae	Acacia brownii	Prickly Moses			2	5	1	1																				$\square$
Fabaceae - Mimosoideae	Acacia elongata	Swamp Wattle							1	20			1	3							1	7	4	25	30	120		
Fabaceae - Mimosoideae	Acacia floribunda	White Sally Wattle																										
Fabaceae - Mimosoideae	Acacia longifolia subsp. longifolia	Sydney Golden Wattle	1	2	2	10			1	5	1	2 10	) 45	280	1	7	1	1			10	40	5	40	40	200	5	30
Fabaceae - Mimosoideae	Acacia stricta	Straight Wattle																	1	2								
Fabaceae - Mimosoideae	Acacia suaveolens	Sweet Wattle					1	1													1	1						
Fabaceae - Mimosoideae	Acacia terminalis var. Long inflorescences (P.G.Kodela 307)	Sunshine Wattle																										
Fabaceae - Mimosoideae	Acacia ulicifolia	Prickly Moses	1	5																								
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern																										
Goodeniaceae	Dampiera stricta						2	100																	1	1		
Goodeniaceae	Goodenia bellidifolia								1	20																		
Haemodoraceae	Haemodorum planifolium						2	100				2 100	)															
Haloragaceae	Gonocarpus micranthus subsp. micranthus								1	50		_							1	10	1	3	1	3				L
Haloragaceae	Gonocarpus teucrioides	Raspwort										_																L
Hydrocharitaceae	Ottelia ovalifolia	Swamp Lily										_							1	50								
Iridaceae	Patersonia sericea	Silky Purple-flag										_																L
Juncaceae	Juncus continuus												_															ļ
Juncaceae	Juncus usitatus												_				1	20										ļ
Lauraceae	Cassytha glabella				1	10						1 10	)						1	10								ļ
Lauraceae	Cassytha pubescens		1	5					1	10		_																
Loganiaceae	Mitrasacme polymorpha											_																L
Lomandraceae	Lomandra confertifolia	Mat- rush											_															ļ
Lomandraceae	Lomandra filiformis subsp. filiformis	Wattle Mat-rush			1	1						-	-															—
Lomandraceae	Lomandra glauca	Pale Mat-rush	1	10												ļ						ļ		ļ				└──
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush	1	10	1	10	L				I	_					L			L			L	L				└──
Lomandraceae	Lomandra micrantha	Small- flower Mat- rush										_											L					└──
Malvaceae	*Sida rhombifolia	Paddy's Lucerne					L		L	L		_					L	L	L	L			L					
Menyanthaceae	Liparophyllum exaltatum						L		L	L		_					L	L	L	L			L					
Myrtaceae	<sup>#</sup> Eucalyptus camfieldii	Camfield's Stringybark																										1
Myrtaceae	Angophora costata	Smooth-barked Apple	10	4	2	1																						
Myrtaceae	Callistemon citrinus	Crimson Bottlebrush							1	2											1	1						



Quadrat Number			Q2	.7	Q2	8	Q	29	0	30	0	231	0	32	Q	33	Q	34	Q	35	Q	36	Q	37	Q	38	Q	39
Vegetation Code			HU	351	HU	851	HU	865	HU	1865	н	J865	HU	J938	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938	HU	938
Condition/ Zone			Mod-	Good	Mod-	Good	Mod	-Good	Mod	-Good	Mod	-Good	Mod	-Good	Mod	Good	Mod	-Good	Mod-	Good	Re	gen	Re	gen	Re	gen	Re	gen
Easting			388	501	3890	)68	388	3538	388	3641	38	8767	388	8005	388	8048	388	8881	389	033	388	3353	388	759	389	008	389	080
Northing			6369	505	6369	729	636	9837	636	9726	636	9745	636	9088	636	8778	636	9053	6369	9501	636	9172	636	9254	636	9094	636	9112
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Myrtaceae	Callistemon pachyphyllus	Wallum Bottlebrush					1	3	1	3																		
Myrtaceae	Callistemon sp.																						1	25				
Myrtaceae	Corymbia gummifera	Red Bloodwood																										
Myrtaceae	Eucalyptus globoidea	White Stringybark			40	40																						
Myrtaceae	"Eucalyptus parramattensis subsp. decadens						30	22	15	8	5	5	5															
Myrtaceae	Fucalvatus pilularis	Blackbutt																										
Myrtaceae	Fucalvatus piperita	Sydney Peppermint					2	1	1		10	15	5															
Myrtaceae	Fucalyptus robusta	Swamp Mahogany											50	27	35	16	5	3	2	2	15	4	3	3	10	70	1	15
Myrtaceae	Eucalyptus sianata	Scribbly Gum	50	20					20	6	2	2	2					-					-					
Myrtaceae	Furvomyrtus ramosissima	Bosy Baeckea		-	2	20															1	4						
Myrtaceae	Leptospermum arachnoides				_				3	50	2	100	)								_						ł	
Myrtaceae	Lentospermum juninerinum	Prickly Tea- tree																	1	2			2	30	1	3		
Myrtaceae	Leptospermum laeviaatum	Coast Teatree																			1	25	1	2				
Myrtaceae	Leptospermum polyaglifolium subsp. cismontanum	Tantoon	5	20	10	100	5	20	1	3	10	50	)								-	20	-	_			ł	
Myrtaceae	Leptospermum trinervium	Flaky-barked Tea-tree	5	10	15	50	5	10		5	15	50	, )														ł	<u> </u>
Myrtaceae	Melaleuca decora	Field barred fed free	5	10	10	50	5	10			10		, 													'		
Myrtaceae	Melaleuca ericifalia	Swamp Paperbark																								<sup> </sup>	1	1
Myrtaceae	Melaleuca lingriifolia	Elay-leaved Paperbark																							1	5	^	<u> </u>
Myrtaceae	Melaleuca nodosa	Prickly- leaved Paperbark	10	20	40	100	5	5																	1		1	1
Myrtaceae	Melaleuca auinguenenvia	Broad-leaved Paperbark	10	20	40	100	5	5	2	1	1	2	2 2	3	25	14	15	20	20	20			2	4	1	15	2	10
Myrtaceae	Melaleuca sieberi	bload-leaved raperbalk					1	5	2	1		. 2	2		25	14	15	20	20	50			2	4	1	15		10
Myrtaceae	Melaleuca thumifolia	Thyme Honey- myrtle					5	100	2	20	5	50		-					1	1						<u> </u>		
Murtaceae	Micromyrtus ciliata	Hooth myrtlo			1	c	1	100	2	20		50	,	-					1	1						<u> </u>		
Orchidaceae	Acianthus fornicatus	Pixie Cans			1	1000	1	2						-												<u> </u>		
Orchidaceae	Chilogottis sp	rivie caps			1	1000								-												<u> </u>		
Orchidaceae	Pterostylis Iongifolia	Tall Greenbood												-												<u> </u>		
Orchidaceae	Pterostylis iongijolid	Midget Greenbood																								'		I
Dhormiaceae	Pierostyns muticu	Rhuo Elax lily			1	20			1	E			1	20							1	20	2	40		<u> </u>		
Phormiaceae	Dianella longifolia	Blue Flax-Illy			1	20	1	1	1	5			1	50	1	4					1	20	2	40		<u> </u>		
Phonilaceae	Billardiara scandans	Hain/ Apple Perry			1	2	1	2							1	4										'		<u> </u>
Picrodopdracoao	Brind dield sculdens	Папу Арріе Венту			1	2	1	2																	1	2		<u> </u>
Pinaceae	*Dipus alliattii	Slach Bina									1	1	1												1	<u> </u>		I
Pinaceae	*Dinus radiata	Padiata Dino										. 1	<u> </u>	-												<u> </u>	2	6
Pillaceae	Pintos radiata	Radiata Pille																								'		0
Pittosporaceae	*Andronagon virginicus	Whichy Grass							1	20			1	4									25	190	c	25		60
Poaceae	*Avananus fissifalius	Nerrow Josfed Carpet Cross							1	20	-		1	4									23	100	1	23		10
Poaceae	*Chrhatta arasta	Dania Valdtaraas																					1	15	1			20
Poaceae	*Ennuru erecu	Pariic Veluigrass					-							-										-		'	<u>+</u>	20
Poaceae	*Eragrostis culturensis	African Love Crass																					20	100	10	50	20	140
Poaceae	*Malinic ranges	Anican Love Grass																					20	100	10	50	50	140
Poaceae	*Baspalum dilatatum	Decolum										+	-										5	40		<u> </u>		00
Poaceae	*Paspulan anatalan	Paspalum Kilunu Cross					-							-										-		'	/	I
Poaceae	*Ceterie e prifere	Kikuyu Grass							-		-	-		-												'		
Poaceae	*Setaria purvila	Dela Diana a Casa																								'		i
Poaceae	*Setaria pumila	Pale Pigeon Grass					-						1	-									25	450	45	100		10
Poaceae	*Setaria sphacelata	South African Pigeon Grass											1	5									25	150	15	100	10	40
Poaceae	Anisopogon avenaceus	Oat Speargrass						10					_													<b>├</b> ───'		I
Poaceae	Austrostipa pubescens	Cauch					1	10	-						-	45										40		20
Poaceae	Cynodon dactylôn	Loucn					1	10	1						1	15									1	10	3	20
Poaceae	Echinopogon caespitosus	Bushy Hedgenog Grass					-																			<u> </u>	]	<u> </u>
Poaceae	Entolasia marginata	Bordered Panic					2	50	-	50			-		1	10					-	-			-			<b> </b>
Poaceae	Entolasia strictă	wiry Panic							2	50					1	10					1	5	-		2	30	ليسم	
Роасеае	Eragrostis Drownii	Brown's Lovegrass					1	10	-			1	4	<u> </u>							1	25	3	30	5	50	1	20
Роасеае	Hemartnria uncinata var. uncinata	Iviat Grass							3	100			-			┥ ┥										<u> </u>		<b> </b>
Роасеае	Imperata cylinarica	Blady Grass					5	500					-													<u> </u>		<b> </b>
Poaceae	Microlaena stipoides var. stipoides	Weeping Grass							<u> </u>		<u> </u>			<u> </u>												<u> </u>		<b> </b>
Poaceae	Panicum simile	Two-colour Panic						L	1		1	1		1												<u>ــــــــــــــــــــــــــــــــــــ</u>		<u>ــــــــــــــــــــــــــــــــــــ</u>



											_																_	
Quadrat Number			Q	27	Q2	8	Q	29	Q	30	(	Q31	0	32	Q	33	Q	34	Q	35	Q	36	0	37	0	38	<u> </u>	139
Vegetation Code			HU	851	HU8	51	HU	865	HU	865	н	U865	HU	938	HU	938	HU	938	HU	938	HU	938	HU	1938	н	J938	HU	J938
Condition/ Zone			Mod	Good	Mod-G	Good	Mod	Good	Mod	Good	Mod	d-Good	Mod	-Good	Mod	Good	Mod-	Good	Mod-	Good	Re	gen	Re	gen	Re	gen	Re	egen
Easting			388	8601	3890	68	388	3538	388	8641	38	8767	38	3005	388	3048	388	881	389	033	388	3353	388	3759	38	9008	389	9080
Northing			636	9505	6369	729	636	9837	636	9726	636	69745	636	9088	636	8778	6369	9053	6369	9501	636	9172	636	9254	636	9094	636	j9112
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Poaceae	Paspalidium distans														1	25									1	15	5	T
Poaceae	Paspalidium sp.																											T
Poaceae	Themeda triandra	Kangaroo Grass																										
Polygalaceae	Comesperma ericinum	Pyramid Flower									1	1 50	)															
Polygonaceae	Persicaria decipiens	Slender Knotweed																										
Proteaceae	Banksia aemula	Wallum Banksia	10	20																								
Proteaceae	Banksia oblongifolia						2	30	2	3	Ę.	5 250	)												2		1	T
Proteaceae	Banksia serrata	Old Man Banksia			20	20	2	10															1	1				
Proteaceae	Conospermum taxifolium	Variable Smoke-bush									1	1 50	)															
Proteaceae	Hakea sericea	Needlebush							1	10	10	500	)															
Proteaceae	Hakea teretifolia	Needlebush							1	20									1	2								T
Proteaceae	Isopogon anemonifolius	Broad- leaf Drumsticks	5	10	4	5	1	1																				T
Proteaceae	Lambertia formosa	Mountain Devils			1	1																						
Proteaceae	Persoonia lanceolata	Lance Leaf Geebung							1	3	1	1 50	) 1	15							1	20	1	40	)			
Proteaceae	Persoonia levis	Broad-leaved Geebung	1	10	2	10	2	50	1	2	2	2 2	2								2	30			1	60	J	
Proteaceae	Petrophile pulchella	Drumsticks					1	10	1	10	1	1 100	)															
Pteridaceae	Cheilanthes sieberi																											T
Restionaceae	Baloskion pallens																											T
Restionaceae	Baloskion sp.				1	10	1	50																				T
Restionaceae	Baloskion tetraphyllum subsp. meiostachyum	Plume Rush											3	60	50	300	20	80										
Restionaceae	Empodisma minus	Spreading Rope- rush																										
Restionaceae	Eurychorda complanata						2	100			2	2 1000	)															
Restionaceae	Hypolaena fastigiata				2	10																						
Restionaceae	Leptocarpus tenax						20	1000	50	1000	1	1 100	)															
Restionaceae	Lepyrodia muelleri																											
Restionaceae	Lepyrodia scariosa						3	50	5	100	4	4 1000	)															
Rubiaceae	*Richardia brasiliensis	White Eye																									2	20
Rubiaceae	Pomax umbellata		1	10	1	10															1	5			1	. 4	4	
Rutaceae	Eriostemon australasius	Pink Wax Flower	5	20																								
Rutaceae	Zieria laxiflora	Wallum Zieria			1	3																						
Selaginellaceae	Selaginella uliginosa	Swamp Selaginella							1	20																		
Solanaceae	*Solanum pseudocapsicum	Jerusalem Cherry																										
Stylidiaceae	Stylidium graminifolium	Grass Trigger Plant									1	1 100	)															
Thymelaeaceae	Pimelea linifolia subsp. linifolia	Slender Rice-flower	1	5	1	10																						
Verbenaceae	*Lantana camara	Lantana																									1	2
Verbenaceae	*Verbena bonariensis	Purpletop																										
Violaceae	Viola hederacea	Ivy-leaved Violet																										
Xanthorrhoeaceae	Xanthorrhoea glauca		1	5																								
Xanthorrhoeaceae	Xanthorrhoea minor						1	1																				
Xyridaceae	Xyris gracilis																											
Zamiaceae	Macrozamia communis	Burrawang																										
		Total Species Richness	2	.8	38		4	2	Э	3		31		19	1	4	9	9	1	2	1	8	1	21		25	:	20

\* Denotes Introducted Species

# Denotes Threatened Species (Listed under TSC Act and/ or EPBC)



Quadrat Number	Irat Number		0	40		41		42	0	12	0	A A	0	<b>1</b> E
Vegetation Code				40		1020		42	LUI LUI	43 0/18		44 0/10		45 0/10
Condition/Zone			Re	gen	Re	gen	Re	gen	Mod-	Good	Mod	Good	Mod	Good
Fasting			380	9219	380	9180	380	9105	388	248	388	523	388	566
Northing			636	9229	636	9104	636	8731	6369	9086	636	9144	636	9226
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Anthericaceae	Tricoryne simplex													
Apiaceae	Centella asiatica	Indian Pennywort	1	25										
Apiaceae	Platysace ericoides	· ·												
Apiaceae	Trachymene incisa													
Apocynaceae	Gomphocarpus fruticosus	Narrow- leaved Cottonbush	1	5										
Apocynaceae	Marsdenia suaveolens	Scented Marsdenia												
Apocynaceae	Parsonsia straminea	Common Silkpod	1	20										
Asteraceae	*Bidens pilosa	Cobblers Pegs	1	30										
Asteraceae	*Conyza bonariensis	Flaxleaf Fleabane	1	10	1	10								
Asteraceae	*Hypochaeris radicata	Catsear	1	25										
Asteraceae	*Senecio madagascariensis	Fireweed	1	30										
Asteraceae	Actinotus helianthi	Flannel Flower												
Asteraceae	Ozothamnus diosmifolius	Rice Flower												
Bignoniaceae	Pandorea pandorana subsp. pandorana	Wonga Wonga Vine	1	5	1	1								
Blandfordiaceae	Blandfordia nobilis	Christmas Bells												
Blechnaceae	Blechnum cartilagineum	Gristle Fern												
Blechnaceae	Blechnum indicum	Swamp Water Fern	5	40							5	50	10	250
Casuarinaceae	Allocasuarina torulosa	Forest Oak												
Casuarinaceae	Casuarina glauca	Swamp Oak	1	30	1	1								
Commelinaceae	Commelina cyanea													
Cyperaceae	*Isolepis prolifera						5	160						
Cyperaceae	Baumea articulata	Jointed Twig-rush							5	50	1	20	80	1000
Cyperaceae	Baumea rubiginosa								15	100				
Cyperaceae	Baumea sp.													
Cyperaceae	Baumea teretifolia										5	50		
Cyperaceae	Caustis pentandra													
Cyperaceae	Caustis recurvata													
Cyperaceae	Gahnia clarkei	Tall Saw-sedge	45	60					50	100	90	250	25	100
Cyperaceae	Gahnia sieberiana	Red-fruit Saw-sedge												
Cyperaceae	Lepidosperma laterale													
Cyperaceae	Ptilothrix deusta													
Cyperaceae	Schoenus brevifolius	Zig- zag Bog- rush							2	20			2	20
Cyperaceae	Schoenus ericetorum	Heath Bog-rush												
Dennstaedtiaceae	Histiopteris incisa	Bat's Wing Fern	1	1	45	100								20
Dennstaedtiaceae	Pteriaium esculentum	Common Bracken	3	60	15	130							2	20
Dicksoniaceae	Calochiaena aubia	Rainbow Fern	2	80										
Dilleniaceae	Hibbertia acicularis		-											
Dilloniaceae	Hibbertia Jusciculata													
Drocoracoao	Prosora quriculata													
Drosoraçõo	Drosera binata	Forked Sundaw							1	20			1	10
Drosoraçõo	Drosera politata	Forked Sundew							1	20			1	10
Elagosarração	Tatrathasa thumifalia	Thyma Bink bolls	-											
Ericaceae - Epacridoideae	Astroloma ninifolium	Dine Heath	1											
Ericaceae - Epacridoideae	Brachyloma danhnoides	Daphne Heath												
Fricaceae - Epacridoideae	Enacris obtusifolia	Blunt- leaf Heath							1	20				
Ericaceae - Epacridoideae	Epacris outcolla	Wallum Heath							-					
Fricaceae - Epacridoideae	Leucopogon appressus		1											
Ericaceae - Epacridoideae	Leucopoaon ericoides	Pink Beard-heath	1											
Ericaceae - Epacridoideae	Leucopogon esquamatus		1											
Ericaceae - Epacridoideae	Leucopoaon iuniperinus	Prickly Beard-heath	1											<u> </u>
Ericaceae - Epacridoideae	Leucopoaon lanceolatus var. lanceolatus	,	1											
Ericaceae - Epacridoideae	Leucopoaon leptospermoides	1	1											
Ericaceae - Epacridoideae	Leucopogon virgatus	1	1											
Ericaceae - Epacridoideae	Monotoca elliptica	Tree Broom-heath	1											
Ericaceae - Epacridoideae	Monotoca scoparia		1											



Quedret Number				40	<b>_</b>	41	_	40		40	_	44		45
Quadrat Number				40		41	Q	42	<u> </u>	45	UI	44 0/9	<u> </u>	+5 0.4 9
Condition / Zono			RO RO	938		930	Po Po	1938 707	Mod	Good	Mod	Good	Mod	Good
Easting			200	3210	200	190	200	2105	200	240	200	2522	200	GUUU
Edsting			505	0220	626	0104	505	0721	500	0006	500	0144	500	200
Family	Scientific Name	Common Namo	EDC	5225 Ab	EDC	5104 Ab	EDC	0/31 Ab	EDC	5080 Ah	EDC	9144	EDC	)220
Fairing Ericaceae Enacrideideae	Stendine viridie	Groop Five corpore	FFC	AU	FFC	AU	FFC	AU	FFC	AU	FFC	AU	FFC	AU
Ericaceae - Epacridoideae	Woollsig pungens	Green rive-corners	-											
Euphorbiaceae	Ampereg vinhoclada var vinhoclada													<u> </u>
Euphorbiaceae	Homalanthus populifalius	Bleeding Heart												<u> </u>
Euphorbiaceae	Ricinocarpos pinifolius	Wedding Bush												
Eabaceae - Eaboideae	Almaleea naludosa	Tredding Bush												
Fabaceae - Faboideae	Aotus ericoides													
Fabaceae - Faboideae	Bossiaea ensata	Sword Bossiaea												
Fabaceae - Faboideae	Bossiaea heterophylla	Variable Bossiaea												
Fabaceae - Faboideae	Bossiaea obcordata	Spiny Bossiaea												
Fabaceae - Faboideae	Bossiaea rhombifolia													
Fabaceae - Faboideae	Daviesia ulicifolia	Gorse Bitter Pea												
Fabaceae - Faboideae	Dillwynia floribunda													
Fabaceae - Faboideae	Dillwynia retorta			l	l			1						(
Fabaceae - Faboideae	Glycine microphylla	Small- leaf Glycine												(
Fabaceae - Faboideae	Glycine tabacina													(
Fabaceae - Faboideae	Gompholobium latifolium	Golden Glory Pea												
Fabaceae - Faboideae	Gompholobium virgatum	Leafy Wedge Pea												
Fabaceae - Faboideae	Hardenbergia violacea	Purple Coral Pea												
Fabaceae - Faboideae	Indigofera australis	Australian Indigo												
Fabaceae - Faboideae	Kennedia rubicunda	Dusky Coral Pea	1	30										
Fabaceae - Faboideae	Mirbelia rubiifolia	Heathy Mirbelia												ł
Fabaceae - Faboideae	Pultenaea retusa	Notched Bush- pea	1	2										ł
Fabaceae - Faboideae	Viminaria juncea	Golden Spray			1	1			1	10			10	50
Fabaceae - Mimosoideae	*Acacia saligna	Golden Wreath Wattle												ł
Fabaceae - Mimosoideae	Acacia brownii	Prickly Moses												
Fabaceae - Mimosoideae	Acacia elongata	Swamp Wattle			3	10			1	20			1	10
Fabaceae - Mimosoideae	Acacia floribunda	White Sally Wattle												ł
Fabaceae - Mimosoideae	Acacia longifolia subsp. longifolia	Sydney Golden Wattle	2	5	65	200							1	5
Fabaceae - Mimosoideae	Acacia stricta	Straight Wattle												
Fabaceae - Mimosoideae	Acacia suaveolens	Sweet Wattle												l
Fabaceae - Mimosoideae	Acacia terminalis var. Long inflorescences (P.G.Kodela 307)	Sunshine Wattle												<u> </u>
Fabaceae - Mimosoideae	Acacia ulicifolia	Prickly Moses												l
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern									5	50	1	10
Goodeniaceae	Dampiera stricta													L
Goodeniaceae	Goodenia bellidifolia													L
Haemodoraceae	Haemodorum planifolium													<b> </b>
Haloragaceae	Gonocarpus micranthus subsp. micranthus				1	2								<b> </b>
Haloragaceae	Gonocarpus teucrioides	Raspwort												L
Hydrocharitaceae	Ottelia ovalifolia	Swamp Lily												L
Iridaceae	Patersonia sericea	Silky Purple-flag					_							<u> </u>
Juncaceae	Juncus continuus		1	10			5	30					1	5
Juncaceae	Juncus usitatus		1	5					10					<u> </u>
Lauraceae	Cassytha glabella								10	50				<b> </b>
Lauraceae	Cassytha pubescens		-											<u> </u>
Loganiaceae	Iomandra confortifolia	Mat ruch												
Lomandraceae	Lomandra filiformic subsp. filiformic	Wattle Mat rush	1											
Lomandraceae	Lomandra algusa	Palo Mat ruch	1											
Lomandraceac	Lomandra longifolia		1	10										
Lomandraceac	Lomandra micrantha	Small_flower Mat_rush	1	10										
Malvaceae	*Sida rhomhifolia	Paddy's Lucerco	1	10										
Menyanthacean	Lingrophyllum evaltatum		+ 1	10			15	240	4	10				
Nertyantilacede	# Susselvatus ann 6 dalii	Constitution Chair and a					15	240	1	10				
Nyrtaceae	Eucuryptus camplelali	Camileio s Stringybark		42										
Nurtaceae	Anyophora costata	Sillooth-barked Apple	30	12					65	100	-	<u> </u>	-	10
wyrtaceae	constemon citinus	CHINSON BOTTIEDRUSH	1	1	1			1	65	100	2	5	2	1 10



Quadrat Number	adrat Number		0	/10	0	/11	0	12	0	/12	0	11	0	45
Vegetation Code				40	L L L	1038		1028	н	45	<u>ц</u>	44		9/8
Condition/Zone			Re	gen	Re	gen	Re	gen	Mod	-Good	Mod	-Good	Mod	-Good
Fasting			380	9219	380	9180	380	9105	388	3248	388	3523	388	3566
Northing			636	9229	636	9104	636	8731	636	9086	636	9144	636	9226
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Myrtaceae	Callistemon pachyphyllus	Wallum Bottlebrush												
Myrtaceae	Callistemon sp.													
Myrtaceae	Corymbia gummifera	Red Bloodwood												
Myrtaceae	Eucalyptus globoidea	White Stringybark												
Myrtaceae	<sup>#</sup> Eucalyptus parramattensis subsp. decadens													
Myrtaceae	Eucalyptus pilularis	Blackbutt												
Myrtaceae	Eucalyptus piperita	Sydney Peppermint												
Myrtaceae	Eucalyptus robusta	Swamp Mahogany	4	2	5	2			1	3				
Myrtaceae	Eucalyptus signata	Scribbly Gum												
Myrtaceae	Euryomyrtus ramosissima	Rosy Baeckea												
Myrtaceae	Leptospermum arachnoides								1	5				
Myrtaceae	Leptospermum juniperinum	Prickly Tea- tree			1	2			1	3	30	50	40	250
Myrtaceae	Leptospermum laevigatum	Coast Teatree			1	3								
Myrtaceae	Leptospermum polygalifolium subsp. cismontanum	Tantoon												
Myrtaceae	Leptospermum trinervium	Flaky-barked Tea-tree												
Myrtaceae	Melaleuca decora													
Myrtaceae	Melaleuca ericifolia	Swamp Paperbark												
Myrtaceae	Melaleuca linariifolia	Flax-leaved Paperbark												
Myrtaceae	Melaleuca nodosa	Prickly- leaved Paperbark												
Myrtaceae	Melaleuca quinquenervia	Broad-leaved Paperbark	25	11			5	20			3	10	2	10
Myrtaceae	Melaleuca sieberi													
Myrtaceae	Melaleuca thymifolia	Thyme Honey- myrtle												
Myrtaceae	Micromyrtus ciliata	Heath- myrtle												
Orchidaceae	Acianthus fornicatus	Pixie Caps												
Orchidaceae	Chiloglottis sp.													
Orchidaceae	Pterostylis longifolia	Tall Greenhood												
Orchidaceae	Pterostylis mutica	Midget Greenhood												
Phormiaceae	Dianella caerulea	Blue Flax-lily	2	20										
Phormiaceae	Dianella longifolia													
Phyllanthaceae	Billardiera scandens	Hairy Apple Berry												
Picrodendraceae	Pseudanthus orientalis													
Pinaceae	*Pinus elliottii	Slash Pine												
Pinaceae	*Pinus radiata	Radiata Pine					1	1						
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum	1	1										
Poaceae	*Andropogon virginicus	Whisky Grass	1	10										
Poaceae	*Axonopus fissifolius	Narrow-leafed Carpet Grass	1	25										
Poaceae	*Ehrharta erecta	Panic Veldtgrass												
Poaceae	*Eragrostis cilianensis	Stinkgrass	_											
Poaceae	*Eragrostis curvula	African Love Grass	1	10	25	160								
Poaceae	*Melinis repens	Red Natal Grass	1	5	10	50								
Poaceae	*Paspalum dilatatum	Paspalum	1	1			1	1						
Poaceae	*Pennisetum clandestinum	Kikuyu Grass	1	2										
Poaceae	*Setaria parviflora		1	20										
Poaceae	*Setaria pumila	Pale Pigeon Grass	1	25										
Poaceae	*Setaria sphacelata	South African Pigeon Grass	1	15										
Poaceae	Anisopogon avenaceus	Oat Speargrass	-						1	5				
Poaceae	Austrostipa pubescens						<u> </u>							
Poaceae	Cynodon dactylon	Couch	1	10			95	500						
Poaceae	Echinopogon caespitosus	Bushy Hedgehog Grass	1	30										<u> </u>
Poaceae	Entolasia marginata	Bordered Panic	2	30										
Poaceae	Entolasia stricta	Wiry Panic	1	10					1	20	1	50	5	500
Poaceae	Eragrostis brownii	Brown's Lovegrass	1	30	1	20								
Poaceae	Hemarthria uncinata var. uncinata	Mat Grass									1	20	5	500
Poaceae	Imperata cylindrica	Blady Grass	1	5										
Poaceae	Microlaena stipoides var. stipoides	Weeping Grass	1	60										$\vdash$
Poaceae	Panicum simile	Two-colour Panic	1	1	1	1	1	1	1	1		1		1



Quadrat Number	iadrat Number		Q	40	Q	41	Q	42	Q	43	Q	44	Q	45
Vegetation Code			HU	938	HU	938	HU	938	HU	948	HU	948	HU	948
Condition/ Zone			Re	gen	Re	gen	Re	gen	Mod	-Good	Mod-	Good	Mod-	Good
Easting			389	9219	389	9180	389	9105	388	3248	388	523	388	566
Northing			636	9229	636	9104	636	8731	636	9086	636	9144	636	9226
Family	Scientific Name	Common Name	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab	FPC	Ab
Poaceae	Paspalidium distans													
Poaceae	Paspalidium sp.		1	10										
Poaceae	Themeda triandra	Kangaroo Grass	1	20										
Polygalaceae	Comesperma ericinum	Pyramid Flower												
Polygonaceae	Persicaria decipiens	Slender Knotweed					1	1						
Proteaceae	Banksia aemula	Wallum Banksia												
Proteaceae	Banksia oblongifolia													
Proteaceae	Banksia serrata	Old Man Banksia			1	1								
Proteaceae	Conospermum taxifolium	Variable Smoke-bush												
Proteaceae	Hakea sericea	Needlebush												
Proteaceae	Hakea teretifolia	Needlebush											1	5
Proteaceae	Isopogon anemonifolius	Broad- leaf Drumsticks												
Proteaceae	Lambertia formosa	Mountain Devils												
Proteaceae	Persoonia lanceolata	Lance Leaf Geebung			2	40								
Proteaceae	Persoonia levis	Broad-leaved Geebung												
Proteaceae	Petrophile pulchella	Drumsticks												
Pteridaceae	Cheilanthes sieberi													
Restionaceae	Baloskion pallens													
Restionaceae	Baloskion sp.													
Restionaceae	Baloskion tetraphyllum subsp. meiostachyum	Plume Rush	5	20										
Restionaceae	Empodisma minus	Spreading Rope- rush							20	250				
Restionaceae	Eurychorda complanata													
Restionaceae	Hypolaena fastigiata													
Restionaceae	Leptocarpus tenax								1	5				
Restionaceae	Lepyrodia muelleri								3	50				
Restionaceae	Lepyrodia scariosa								1	10				
Rubiaceae	*Richardia brasiliensis	White Eye												
Rubiaceae	Pomax umbellata		1	2										
Rutaceae	Eriostemon australasius	Pink Wax Flower												
Rutaceae	Zieria laxiflora	Wallum Zieria												
Selaginellaceae	Selaginella uliginosa	Swamp Selaginella												
Solanaceae	*Solanum pseudocapsicum	Jerusalem Cherry	1	1	1	2								
Stylidiaceae	Stylidium graminifolium	Grass Trigger Plant												
Thymelaeaceae	Pimelea linifolia subsp. linifolia	Slender Rice-flower												
Verbenaceae	*Lantana camara	Lantana	1	3										
Verbenaceae	*Verbena bonariensis	Purpletop	1	1										
Violaceae	Viola hederacea	Ivy-leaved Violet	1	15										
Xanthorrhoeaceae	Xanthorrhoea glauca													
Xanthorrhoeaceae	Xanthorrhoea minor													
Xyridaceae	Xyris gracilis								1	20				
Zamiaceae	Macrozamia communis	Burrawang												
		Total Species Richness	5	50	1	.7		8	2	21	1	.0	1	.7

\* Denotes Introducted Species

# Denotes Threatened Species (Listed under TSC Act and/ or EPBC)



# APPENDIX 2.

## VEGETATION DESCRIPTIONS





**Coastal Sand Apple – Blackbutt Forest** 



Coastal Sand Apple – Blackbutt Forest



Coastal Sand Apple – Blackbutt Forest (Rehabilitation)





#### Coastal Sand Apple – Blackbutt Forest (Regeneration)

#### **Vegetation Formation:**

Dry Sclerophyll Forests (shrubby subformation).

#### **Vegetation Class:**

Coastal Dune Dry Sclerophyll Forests.

#### Equivalent Map Units:

LHCCREMS (NPWS 2000): MU33 Coastal Sand Apple – Blackbutt Forest.

**Bell and Driscoll (2006):** 1ai Tomago Blackbutt-Apple-Bloodwood-Forest, with elements of 1b Scribbly Gum-Apple-Bloodwood Forest in the east of its occurrence, and 1aii Peppermint-Apple-Bloodwood Forest in the central and north-west of its occurrence within the Subject Land.

#### Equivalent Plant Community Type:

HU860 was determined as the closest equivalent PCT for this community within the Subject Land. Comparison of floristic data indicates a very high similarity between this PCT and the community onsite, with the majority of species listed in the description for the community in the VIS recorded, including; *A. costata, C. gummifera, Eucalyptus pilularis* (although it is noted that this species is only present within rehabilitation areas), *B. serrata, M. elliptica, M. communis* and *A. ulicifolia, P. esculentum* and *D. caerulea*.

The description for HU860 on the VIS database is also consistent with the location (Central and Lower North Coast) and landscape position of the vegetation within the development area (coastal flats and low rises and is confined to Quaternary dune sands at elevations up to 100 m). Refer to the Biodiversity Offset Strategy (Kleinfelder 2016) for further details.



#### Structure:

Open forest with an overstorey to 20 m high. Midstorey up to 15 m, over a dense shrub and ground layer.

#### General Description:

This canopy of this community is dominated by *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood). In lower lying areas of its occurrence (north-west and the central dune), the canopy is co-dominated by *Eucalyptus piperita* (Sydney Peppermint). *Eucalyptus signata* (Scribbly Gum) also occurs within the canopy of this community, with a scattered occurrence along the central dune, and also co-dominates in the east where the community intergrades with an area of Swamp Forest.

The midstorey is characterised by *Banksia serrata* (Old-man Banksia), along with occurrences of *Banksia aemula* (Wallum Banksia) where the community intergrades with the Coastal Sand Wallum Woodland-Heath. Other mid-storey species included *Acacia longifolia* subsp. *longifolia* (Sydney Golden Wattle) and *Monotoca elliptica* (Tree Broom-heath).

Common shrubs include *Dillwynia retorta, Acacia ulicifolia* (Prickly Moses), *Acacia terminalis* (Sunshine Wattle) and *Macrozamia communis* (Burrawang).

The ground layer is typically dominated by *Pteridium esculentum* (Common Bracken), along with *Pomax umbellata, Imperata cylindrica* (Blady Grass) *Dianella caerulea* (Blue Flax-lily), *Hibbertia linearis, Lomandra glauca* (Pale Mat-rush) and *Lomandra longifolia* (Spiny-headed Mat-rush) and *Baloskion pallens*.

Climbers and twining species include *Pandorea pandorana* (Wonga Wonga Vine) and *Hardenbergia violacea* (Purple Coral Pea).

This community is generally free of exotic species.

#### Floristic/Structural Variations:

There are two mapped variations of this community within the Subject Land: an area of rehabilitation in the east of the site and regenerating areas in areas of previous disturbance.

The rehabilitation area has previously been subject to mining, and contains a greater diversity of canopy trees, with species such as *Eucalyptus signata* (Scribbly Gum), *Eucalyptus parramattensis* subsp. *decadens* and *Eucalyptus camfieldii* (Camfield's Stringybark) co-dominating.

The regeneration areas of the community are structurally different due to historical clearing. These areas generally only contain a scattered canopy layer and have a higher dominance of weeds in the understorey with *Eragrostis curvula* (African Lovegrass) and *Lantana camara* (Lantana) occurring.

#### **Conservation Status:**

Not listed.

#### Distribution:

This community predominantly occurs in the west of the Subject Land at higher elevations on the dunes. This community also extends into the central and eastern portions of the Subject Land, along a central dune.



#### **Coastal Sand Wallum Woodland-Heath**



#### **Coastal Sand Wallum Woodland-Heath**

#### Vegetation Formation:

Dry Sclerophyll Forests (shrubby subformation).

#### **Vegetation Class:**

Coastal Dune Dry Sclerophyll Forests.

#### Equivalent Map Units:

LHCCREMS (NPWS 2000): MU34 Coastal Sand wallum Woodland-Heath.

Bell and Driscoll (2006): 3c Scribbly Gum-Bloodwood Wallum Woodland.

#### Equivalent Plant Community Type:

HU851 was determined as the closest equivalent PCT for this community on the biobank site. Comparison of floristic data indicates a very high similarity between this PCT and the community onsite, with the majority of species listed in the description for the community in the VIS recorded, including; *E. signata, B. aemula, L. trinervium, L. polygalifolium, M. nodosa, I. anemonifolius B. heterophylla, Xanthorrhoea glauca, P. ericoides, E. australis* and *Leucopogon leptospermoides*.

#### Structure:

Woodland to open forest with an overstorey to 15 m high. A dense midstorey up to 8 m, over a dense shrub and ground layer.



#### General Description:

This canopy of this community is dominated by *Eucalyptus signata* (Scribbly Gum). *Eucalyptus piperita* (Sydney Peppermint), along with the smaller tree *Eucalyptus camfieldii* (Camfield's Stringybark) co-dominate in the west of the community's distribution. *Eucalyptus globoidea* (Shite Stringybark) dominates a patch of the community in the north-east corner. *Corymbia gummifera* (Red Bloodwood) and *Angophora costata* (Smooth-barked Apple) also occur at lower densities.

The midstorey is characterised by a dense layer of *Melaleuca nodosa* (Prickly-leaved Paperbark), *Leptospermum trinervium* (Flaky-barked Tea-tree) and *Banksia aemula* (Wallum Banksia).

Common shrubs include *Dillwynia retorta, Lambertia formosa* (Mountain Devils), *Isopogon anemonifolius* (Broad-leaf Drumsticks), *Leucopogon ericoides* (Pink Bear-heath), *Ricinocarpos pinifolius* (Wedding Bush), *Bossiaea heterophylla* (Variable Bossiaea), *Eriostemon australis* (Pink Wax Flower) and *Pimelea linifolia* subsp. *linifolia* (Slender Rice-flower).

The ground layer is typically dominated by *Lomandra glauca* (Pale Mat-rush), *Amperea xiphoclada* var. *xiphoclada, Euryomyrtus ramosissima* (Rosy Baeckea), *Haemodorum planifolium, Schoenus ericetorum* (Heath Bog-rush), *Astroloma pinifolium* (Pine Heath), *Hibbertia fasciculata* and *Platysace ericoides*.

This community is generally free of exotic species.

This vegetation community is in some aspects floristically similar to the Coastal Sand Apple – Blackbutt Forest through the presence of *E. piperita*, *E. signata* and *C. gummifera* in the canopy and a number of understorey species of both communities. Floristic and landscape features were used to distinguish these two communities. The key floristic features used to distinguish these two communities was the lack of *A. costata* in the Coastal Sand Wallum Woodland-Heath, and the relatively dominance of *B. serrata* and *B. aemula* in the midstorey, with *B. aemula* replacing *B. serrata* in the Coastal Sand Wallum Woodland-Heath. Additionally, *M. nodosa* was generally lacking from the Coastal Sand Apple – Blackbutt Forest, but dominated the midstorey of the Coastal Sand Wallum Woodland-Heath.

The Coastal Sand Apple – Blackbutt Forest typically occurs in areas of higher elevation within the Subject Land, with a larger depth to groundwater. While the Coastal Sand Wallum Woodland-Heath occurred in lower lying areas closer to the water table.

#### Floristic/ Structural Variations:

No variations of this community were mapped within the Subject Land.

#### Conservation Status:

Not listed.

#### Distribution:

This community occurs in the north of the Subject Land, typically on lower lying areas. This community is replaced by the Coastal Sand Apple – Blackbutt Forest at higher elevations and intergrades with the Tomago Sand Swamp Heath, Tomago Sand Swamp Woodland and Swamp Mahogany – Paperbark Swamp Forest in lower/wetter areas of the Subject Land.





#### Swamp Mahogany – Paperbark Swamp Forest

Swamp Mahogany – Paperbark Swamp Forest



Swamp Mahogany – Paperbark Swamp Forest (Regeneration – Medium)


## Vegetation Formation:

Forested Wetlands.

## Vegetation Class:

Coastal Swamp Forests.

## **Equivalent Map Units:**

LHCCREMS (NPWS 2000): MU37 Swamp Mahogany-Paperbark Swamp Forest.

Bell and Driscoll (2006): 2aii Paperbark Swamp Forest.

## **Equivalent Plant Community Type:**

HU938 was determined as the closest equivalent PCT for this community on the site. Comparison of floristic data indicates a very high similarity between this PCT and the community onsite, with the majority of diagnostic species listed in the VIS for HU938 recorded, including; *E. robusta, M. quinquenervia, Casuarina glauca, A. longifolia, G. clarkei, B. indicum, Baumea articulata* and *D. caerulea*.

The description for HU938 is also consistent with the location (NSW North Coast) and landscape position of this community on the site (i.e. alluvial sands and muds on floodplains and barrier sands at elevations from 1 to 350 m).

### Structure:

Forest with an overstorey to 20 m high and a dense ground layer dominated by graminoides and ferns.

#### General Description:

The canopy is dominated by *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca quinquenervia* (Broad-leaved Paperbark).

The midstorey and shrub layers are dominated by *Acacia longifolia* subsp. *longifolia* (Sydney Golden Wattle) and *Leptospermum juniperinum* (Prickly Tea-tree).

The understorey is dominated by *Blechnum indicum* (Swamp Water Fern), *Blechnum cartilagineum* (Gristle Fern), *Baumea articulata* (Jointed Twig-rush), *Baumea rubiginosa, Schoenus brevifolius* (Zigzag Bog-rush), *Baloskion tetraphyllum* subsp. *meiostachyum, Gahnia sieberiana* (Red-fruit Sawsedge) and *Gahnia clarkei* (Tall Saw Sedge).

## Floristic/ Structural Variations:

Areas of this community which have undergone historical disturbance were mapped as a variation. These areas were historically used as sand tailings dams and therefore have a slightly higher elevation than the surrounding areas of Swamp Mahogany – Paperbark Swamp Forest. As such, these areas contain a higher dominance of drier species, *A. longifolia* subsp. *longifolia* and *Pteridium esculentum* (Common Bracken). Also these areas have a higher density of weeds, including *Eragrostis curvula* (African Lovegrass).

#### **Conservation Status:**

Not listed.

## Distribution:

This community occurs in the lower lying areas of the Subject Land. Patches of this community occur in the south-west, central portion and east of the Subject Land.



## **Coastal Wet Sand Cyperoid Heath**



## **Coastal Wet Cyperoid Heath**

## **Vegetation Formation:**

Freshwater Wetlands

## Vegetation Class:

Coastal Heath Swamps

## Equivalent Map Units:

LHCCREMS (NPWS 2000): MU44 Coastal Wet Cyperoid Heath.

Bell and Driscoll (2006): 3f Leptospermum – Callistemon Shrub Swamp.

## **Equivalent Plant Community Type:**

HU948 was determined as the closest equivalent PCT for this community on the site. Comparison of floristic data indicates a high similarity between this PCT and the community onsite, with the majority of diagnostic species listed in the VIS for HU948 recorded, including; *M. quinquenervia, H. teretifolia, L. tenax, S. brevifolius, E. stricta* and *B. teretifolia.* 

## Structure:

Dense wet heath dominated by graminoides with a scattered canopy and dense midstorey.



## General Description:

A scattered canopy of *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca quinquenervia* (Broadleaved Paperbark) occurs, generally at the periphery of the community where it intergrades with the Swamp Mahogany – Paperbark Swamp Forest.

The midstorey and shrub layers are dominated by *Callistemon citrinus* (Crimson Bottebrush) and *Leptospermum juniperinum* (Prickly Tea-tree).

The understorey is dominated by *Gahnia clarkei* (Tall Saw Sedge), *Baumea articulata* (Jointed Twigrush), *Baumea rubiginosa, Blechnum indicum* (Swamp Water Fern), *Schoenus brevifolius* (Zig-zag Bog-rush), *Empodisma minus* (Spreading Rope- rush), *Gleichenia dicarpa* (Pouched Coral Fern) and *Cassytha glabella*. Scattered grasses also occur including *Hemarthria uncinata* var. *uncinata* (Mat Grass) and *Entolasia stricta* (Wiry Panic).

## Floristic/ Structural Variations:

None identified.

## **Conservation Status:**

Not listed.

## **Distribution:**

Two areas of this community occur in the southern-central and eastern portions of the Subject Land. The community occurs on the periphery of the Swamp Mahogany – Paperbark Swamp Forest.



## Tomago Sand Swamp Heath



## Tomago Sand Swamp Heath

## **Vegetation Formation:**

Heathlands.

## Vegetation Class:

Coastal Headland Heaths.

## Equivalent Map Units:

LHCCREMS (NPWS 2000): MU36a Tomago Sand Swamp Heath.

Bell and Driscoll (2006): 3ai Clay Wallum Scrub.

## Equivalent Plant Community Type:

HU917 was determined as the closest equivalent PCT for this community on the site. Comparison of floristic data indicates a very high similarity between this PCT and the community onsite, with the majority of species listed in the description for the community in the VIS recorded, including; *Banksia aemula, Melaleuca nodosa, Leptospermum trinervium, Leptospermum polygalifolium, Monotoca scoparia, Ricinocarpos pinifolius, Caustis recurvata, Hypolaena fastigiata and Lomandra glauca.* 

## Structure:

Dense scrub with only scattered canopy trees. Dense midstorey species dominate over a dense shrub layer with a scattered groundcover.

## General Description:

A scattered occurrence of *Eucalyptus piperita* (Sydney Peppermint), *Eucalyptus camfieldii* (Camfield's Stringybark) and *Corymbia gummifera* (Red Bloodwood) occur.

The dense midstorey is characterised by *Banksia aemula* (Wallum Banksia), *Melaleuca nodosa* (Prickly-leaved Paperbark) and *Leptospermum trinervium* (Flaky-barked Tea-tree), with *Persoonia lanceolata* (Broad-leaved Geebung) also occurring.



Common shrubs include *Leptospermum polygalifolium* subsp. *cismontanum, Leucopogon ericoides* (Pink Beard-heath), *Monotoca scoparia, Micromyrtus ciliata* (Heath-myrtle), *Bossiaea heterophylla* (Variable Bossiaea), *Banksia oblongifolia, Isopogon anemonifolius* (Broad-leaf Drumsticks) and *Ricinocarpos pinifolius* (Wedding Bush).

The ground layer is typically dominated by *Euryomyrtus ramosissima* (Rosy Baeckea), *Amperea xiphoclada* var. *xiphoclada*, *Hypolaena fastigiata*, *Schoenus ericetorum* (Heath Bog-rush), *Astroloma pinifolium* (Pine Heath), *Hibbertia fasciculata*, *Platysace ericoides* and *Lomandra glauca* (Pale Matrush).

This community is generally free of exotic species.

This community is floristically very similar to the Coastal Sand Wallum Woodland-Heath. These two communities were distinguished through the low canopy cover (less than 5%) within the Tomago Sand Swamp Heath.

## Floristic/ Structural Variations:

None identified.

### **Conservation Status:**

Not listed.

### **Distribution:**

This community occurs in the north of the Subject Land, on lower lying areas adjacent to the Coastal Sand Wallum Woodland-Heath.



## **Tomago Sand Swamp Woodland**



## Tomago Sand Swamp Woodland

## **Vegetation Formation:**

Forested Wetlands.

## Vegetation Class:

Coastal Floodplain Wetlands.

## Equivalent Map Units:

LHCCREMS (NPWS 2000): MU36 Tomago Sand Swamp Woodland

Bell and Driscoll (2006): 4d Earp's Gum Sedge Woodland

## Equivalent Plant Community Type:

HU865 was determined as the closest equivalent PCT for this community on the site. Comparison of floristic data indicates a high similarity between this PCT and the community onsite, with the majority of diagnostic species listed in the VIS for HU865 recorded, including; *E. parramattensis* subsp. *decadens, M. thymifolia, M. sieberi, B. oblongifolia, L. polygalifolium, C. pachyphyllus, Hakea teretifolia, L. tenax, S. brevifolius, L. scariosa* and *Entolasia stricta*.

## Structure:

Open woodland to forest with an overstorey to 10 m high over a scattered midstorey with a moderately dense shrub layer and a sedge species in the understorey.

## **General Description:**

The canopy of this community is dominated by *Eucalyptus parramattensis* subsp. *decadens*, with *Eucalyptus signata* (Scribbly Gum) and *Eucalyptus piperita* (Sydney Peppermint) also occurring.

The shrub layer is dominated by *Leptospermum polygalifolium* subsp. *cismontanum* (Tantoon), *Melaleuca thymifolia* (Thyme Honey-myrtle), *Banksia oblongifolia, Leucopogon juniperinus* (Prickly



Beard-heath), *Leptospermum arachnoides, Mirbelia rubiifolia* (Heathy Mirbelia), *Hakea sericea* (Needlebush) and *Pultenaea retusa* (Notched Bush-pea).

The ground cover is dominated by *Schoenus brevifolius* (Zig-zag Bog-rush), *Ptilothrix deusta*, *Leptocarpus tenax*, *Lepyrodia scariosa*, *Dampiera stricta*, *Haemodorum planifolium* and *Trachymene incisa*. Scattered grasses include *Hemarthria uncinata* var. *uncinata* (Mat Grass), *Entolasia marginata* (Bordered Panic), *Entolasia stricta* (Wiry Panic) and *Eragrostis brownii* (Brown's Lovegrass).

The community is largely free from weeds. However, some *Andropogon virginicus* (Whisky Grass) is present along an access track which occurs along part of the southern boundary of the community.

## Floristic/ Structural Variations:

None identified.

#### Conservation Status:

Not listed.

### Distribution:

A patch of this community occurs in the north of the Subject Land in an area likely to be subject to periodic inundation. This community intergrades with the Coastal Sand Wallum Woodland-Heath in higher areas and the Swamp Mahogany - Paperbark Swamp Forest in lower lying wetter areas.



# APPENDIX 3. LETTERS FROM THE ROYAL BOTANIC GARDENS SYDNEY



National Herbarium of New South Wales

Ms Samara SCHULZ Kleinfelder 95 Mitchell Road Cardiff, NSW 2285 Enquiry No: 19772 Botanical.Is@rbgsyd.nsw.gov.au Fax No: (02) 9251 1952 Ph No: (02) 9231 8111 Date: 29 August 2016

Dear Samara,

## Re: plant identification - eucalypt specimens collected from Williamtown

Both of your specimens have been determined as *Eucalyptus camfieldii* – det. by Dr Peter G. Wilson & Mr A.E. Orme, 26<sup>th</sup> August 2016.

We are going to keep your specimens for the herbarium collection. Thank you for providing the locality details.

An invoice for \$44.00 (incl. GST) will be forwarded to you separately by our finance section to cover cost of identification.

Thank you for your enquiry.

Yours sincerely,

Andrew Orme Identification Technical Officer Botanical Information Service



Go to our online Botanical Information Services at <u>plantnet.rbgsyd.nsw.gov.au</u> to find out more about plants of New South Wales



The Botanical Information Email address is Botanical.Is@rbgsyd.nsw.gov.au Mrs Macquaries Road Sydney NSW 2000 Australia • Telephone (02) 9231 8111 • Fax (02) 9251 1952



National Herbarium of New South Wales

Ms Samara SCHULZ Kleinfelder 95 Mitchell Road Cardiff, NSW 2285 Enquiry No: 19782 Botanical.Is@rbgsyd.nsw.gov.au Fax No: (02) 9251 1952 Ph No: (02) 9231 8111 Date: 2<sup>nd</sup> September 2016

Dear Samara,

## <u>Re: plant ID – eucalypt specimens collected from Williamtown (mine rehab site)</u>

All **four (4)** of your specimens have been determined as *Eucalyptus camfieldii* – det. by Dr Peter G. Wilson & Mr A.E. Orme, 2<sup>nd</sup> September 2016.

An invoice for \$88.00 (incl. GST) will be forwarded to you separately by our finance section to cover cost of identification.

Thank you for your enquiry.

Yours sincerely,

Andrew Orme Identification Technical Officer Botanical Information Service



Go to our online Botanical Information Services at <u>plantnet.rbgsyd.nsw.gov.au</u> to find out more about plants of New South Wales



The Botanical Information Email address is Botanical.Is@rbgsyd.nsw.gov.au Mrs Macquaries Road Sydney NSW 2000 Australia • Telephone (02) 9231 8111 • Fax (02) 9251 1952



National Herbarium of New South Wales

Ms Samara SCHULZ Kleinfelder 27 Alfred Street Waratah, NSW 2298

Enquiry No: 19796 Botanical.Is@rbgsyd.nsw.gov.au Fax No: (02) 9251 1952 Ph No: (02) 9231 8111 Date: 14 September 2016

Dear Samara,

# Re: 2 x eucalypt specimens from Williamtown - rehabilitation site

- Sample 1. *Eucalyptus camfieldii* det. A.E. Orme, 13<sup>th</sup> Sept 2016
- Sample 2. *Eucalyptus* probably *camfieldii* det. A.E. Orme, 13<sup>th</sup> Sept 2016. This specimen displayed intermediate growth only, it was inadequate for positive identification.

An invoice for \$66.00 (incl. GST) will be forwarded to you separately by our finance section to cover cost of identification.

Thank you for your enquiry.

Yours sincerely,

Andrew Orme Identification Technical Officer Botanical Information Service



Go to our online Botanical Information Services at <u>plantnet.rbgsyd.nsw.gov.au</u> to find out more about plants of New South Wales



The Botanical Information Email address is Botanical.Is@rbgsyd.nsw.gov.au Mrs Macquaries Road Sydney NSW 2000 Australia • Telephone (02) 9231 8111 • Fax (02) 9251 1952



# APPENDIX 4. ASSESSMENTS OF SIGNIFICANCE



The seven factors considered in the assessment of significance, s5A of the EP&A Act, are shown in the table below.

## Factors addressed in the assessment of significance

	Factor	Species	Population	Ecological Community
(a)	in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	Х		
(b)	in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.		Х	
(c)	<ul> <li>in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</li> <li>(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or</li> <li>(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction</li> </ul>			х
(d)	<ul> <li>in relation to the habitat of a threatened species, population or ecological community:</li> <li>(iii) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and</li> <li>(iv) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and</li> <li>(v) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality</li> </ul>	х	х	х
(e)	whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly.	NA	NA	NA
(f)	whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan	х	х	х
(g)	whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process	х	х	х



# Eucalyptus camfieldii

	<i>Eucalyptus camfieldii</i> is a tree or mallee to 10 m high with orbiculate, cordate, glossy green and hispid juvenile leaves. Adult leaves are broad-lanceolate, $7 - 10$ cm long, $2 - 3$ cm wide, green and glossy. Buds are sessile, broadly ovoid and angular. The species occurs in coastal shrub heath on sandy soils on sandstone, often of restricted drainage (Hill 2002).
	The identification of the species on the Tomago Sandbeds (and other locations on the Central Coast) in the 1990's was an extension of the species range, which had previously been restricted to the Hawkesbury Sandstone geology of the Sydney Basin (Hill 2003; Bell and Driscoll 2006). The extent of the population on the Tomago Sandbeds in not well known, with only four Atlas records (two of which are within the Subject Land). Additionally, Bell and Driscoll (2006) noted that the individual occurred at five locations on the Tomago Sandbeds.
	A total of 1,868 <i>E. camfieldii</i> individuals were recorded on the Subject Land. Of these individuals, 229 occur within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) and 1,639 occur naturally, predominantly within the Coastal Sand Wallum Woodland-Heath. The individuals within the Subject Land that occur within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) are not considered to be naturally occurring. It is highly unlikely that the species would have been present in this area prior to heavy mineral sand mining in the 1970's. The majority of the naturally occurring population within the Subject Land was identified at lower elevations, typically below 6 m elevation, within the Coastal Sand Wallum Woodland-Heath and Tomago Sand Swamp Heath. Only a few individuals were identified within the Coastal Sand Apple Blackbutt Forest; these individuals occur at elevations below 9 m in areas which are co-dominated by <i>Eucalyptus piperita</i> (Sydney Peppermint) and with <i>Melaleuca nodosa</i> (Prickly-leaved Paperbark) in the understorey. As such, it is likely that all individuals have been planted or seeded into this area during rehabilitation works.
(a) Effect on life cycle	For this impact assessment a survey of the extent of the local population was undertaken. The total local population of <i>E. camfieldii</i> identified during these surveys was 2,263 individuals; 1,868 within the Subject Land, 334 within Mine Rehabilitation areas to the west and north, and 61 within an area of Peppermint – Apple – Bloodwood Forest (mapped by Bell and Driscoll (2006)), to the north of the Subject Land. However, it is likely that the local population is larger than that identified during the field surveys, as not all areas of rehabilitation or Peppermint – Apple – Bloodwood Forest within the locality were surveyed.
	All patches of <i>E. camfieldii</i> identified during the field surveys occur within 3 km of the individuals within the Subject Land and are within vegetation that is contiguous with the Subject Land. All of these individuals were assessed as being part of the local population as it is likely that they are cross-pollinating with individuals within the Subject Land, as highly mobile species, such as birds, bats and insects, are pollinators for Eucalypts (House 1997). As such, there is the potential for genetic material to be spread a long distance (Pots and Wiltshire 1997).
	The proposal would result in the removal of 227 <i>E. camfieldii</i> individuals within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) on the Subject Land. This represents a total of 12% of the population within the Subject Land. In relation to the total estimated local population, the impacts equate to a total removal of 10% of the local population.
	The proposal will remove individuals that are not naturally occurring as they have been seeded/ planted following rehabilitation. The majority of the area in which they occur was not assessed as potential habitat for the species. Suitable habitat for the species within the disturbance area occurs in low lying areas which adjoin the Coastal Sand Wallum Woodland-Heath. The species was identified in these ecotonal areas where <i>E. piperita</i> and <i>M. nodosa</i> occur.
	There is the potential for indirect impacts on 197 individuals occurring within 50 m of the extraction area. These individuals occur adjacent to the disturbance area and as such, there is the potential for indirect impacts through habitat modification. However, these impacts are unlikely to significantly impact on the reproductive potential or health of the retained individuals, as the disturbance will not be permanent, with progressive rehabilitation occurring within the disturbance area.
	The proposal was assessed as not significantly modifying the hydrology of the area (surface or groundwater). As such, indirect impacts to the retained population due to changes in hydrology are unlikely to occur.
	The proposal will remove approximately 10% of the local population (227 individuals), the majority of which (201 individuals) have been seeded/planted into the rehabilitation area and are not naturally occurring. The potential for indirect impacts (edge effects from the extraction area) on



	the adjacent population within the Subject Land will be temporary and unlikely to impact on the reproductive potential of the species. As such, the proposal is unlikely to adversely affect the species, such that the local population will be placed at the risk of extinction.
(d) (i) Habitat Removal	The low lying ecotonal areas which adjoin the Coastal Sand Wallum Woodland-Heath where <i>E. piperita</i> and <i>M. nodosa</i> occur, represent suitable habitat for the species. As the species can occur within these ecotonal areas, the exact area of suitable habitat is hard to define. As such for this impact assessment, all areas in the north of the extraction area that occur below 9 m (highest elevation at which the species was identified) and which adjoin the Coastal Sand Wallum Woodland-Heath were assessed as suitable habitat. Based on this definition, a total of 11.17 ha of suitable habitat for the species will be impacted (0.04 ha of Coastal Sand Wallum Woodland-Heath, 6.42 ha remnant Coastal Sand Apple – Blackbutt Forest and 4.7 ha of rehabilitation). A total of 12.37 ha of suitable habitat for the species has the potential to be modified within the Subject Land, as it occurs within 50 m of the extraction area. However, this is unlikely to be
(d) (ii) Habitat Fragmentation	The Subject Land occurs on the edge of a large patch of vegetation that extends along the sandbeds to the west and east. Habitat for the species occurs to the north of the Subject Land (Peppermint – Apple – Bloodwood Forest (displayed on Figure 2 of the main body of the report)). The proposal will temporarily remove a total of 40.38 ha of native vegetation from the edge of this corridor. As such, the proposal will not fragment or isolate areas of habitat for <i>E. camfieldii</i> .
(d) (iii) Habitat importance	The proposal will predominantly impact on areas of the population within the Subject Land that have been seeded/planted during rehabilitation. Approximately 11.17 ha of the native vegetation to be impacted was assessed as potential habitat for the species. This habitat typically supports a lower density of the species, compared to the portion of the population occurring within the Coastal Sand Wallum Woodland-Heath and the Tomago Sand Swamp Heath in the Offset Area. As such, the habitat to be impacted is assessed as being more marginal habitat and unlikely to be significant for the long-term survival of the species in the locality.
(f) Recovery Plan	There is no draft or final recovery plan for the species in place (at the time of this assessment). OEH has developed a targeted strategy for this species under the Saving Our Species program. This species has been assigned to the 'site-managed species' management stream as this species is considered to require 'site-based management in order to secure it from extinction in NSW for 100 years'. Four management sites have been established at Mangrove Creek Dam, Kur-ring-gai Chase National Park, North Head Sydney Harbour, and Royal National Park. None of the threat abatement plans are relevant to this species.
(g) КТР	<ul> <li>The proposal would involve 'Clearing of native vegetation' (total of 40.38 ha), which will remove 227 <i>E. camfieldii</i> individuals. The species is listed as being adversely affected by this KTP, however, as outlined above the proposal will not significantly impact on the local population.</li> <li>The proposal will contribute to future climate change through the modification of the environment and use of fossil fuels in the extraction and processing of the quarry material. The species, or the community in which is occurs, is not listed under the determination as being at risk of this KTP.</li> <li>A number of other key threatening processes have the potential to be exacerbated by the proposal and subsequently impact on this species in the locality, including:</li> <li>Infection of native plants by <i>Phytophthora cinnamomi</i>;</li> <li>Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae;</li> <li>Invasion, establishment and spread of <i>Lantana camara</i>; and</li> <li>Invasion of native plant communities by exotic perennial grasses.</li> </ul>



Conclusion	The proposal will remove a relatively small proportion of the <i>E. camfieldii</i> local population (10%; 227 individuals), additionally, 201 of these individuals are seeded/planted). The habitat to be removed is considered to be marginal habitat as it is ecotonal areas which support lower densities of the species, and also areas of rehabilitation. The proposal will not fragment or isolate any areas of habitat for the species. Impacts to the adjacent vegetation to be retained in the Offset Area is unlikely due to the temporary nature of the proposal. As such, the proposal is considered unlikely to have a significant impact on the species in the locality.
	The proposed mitigation measures detailed in Section 6 of the main body of this report are intended to reduce the potential impacts on the retained population within the study area. Additionally, the species will be used within the quarry rehabilitation area, further reducing the impacts on the local population in the long-term. The Biodiversity Offset Strategy, outlined in Section 7 of the main body of this report is intended to compensate for the loss of this species, through the in-perpetuity protection of 1,641 individuals within the Offset Area.

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# *Eucalyptus parramattensis* subsp. *decadens*

	<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i> is a small smooth-barked tree to 15 m tall (although generally around 7 m) with white or grey bark that does not shed cleanly. Leaves are 7-20 cm long and 4-3.5 cm wide; discolorous and flowering occurs from November to January (Hill 2002). The species generally occurs in dry sclerophyll woodland with dry heath understorey on deep, low-nutrient sands, in areas subject to periodic inundation or which have relatively high water tables.
	Bell (2006) identifies the <i>E. parramattensis</i> subsp. <i>decadens</i> individuals in the Subject Land as part of one of nine sub-populations of this species on the Tomago Sandbeds; the RAAF Williamtown West sub-population. The assessment conducted by Bell (2006), which is based on Atlas records, identifies the RAAF Williamtown West and the RAAF Williamtown East sub-populations as forming the majority of the meta-population on the Tomago Sandbeds.
	A total of 864 <i>E. parramattensis</i> subsp. <i>decadens</i> individuals were recorded on the Subject Land. Of these individuals, 283 occur within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) and 581 occur naturally in the north of the Subject Land predominantly within the Tomago Sand Swamp Woodland. The individuals within the Subject Land that occur within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) are not considered to be naturally occurring. It is highly unlikely that the species would have been present in this area prior to heavy mineral sand mining in the 1970's as it does not represent potential habitat for the species, due to the elevation of this area. The naturally occurring population of the species on site occurs in lower lying areas subject to periodic inundation. As such, it is likely that all individuals have been planted or seeded into this area during rehabilitation works.
(a) Effect on life cycle	In consideration of the Assessment of Significant Guidelines (DECC 2007), for the purposes of this assessment the local population of the species has conservatively been classified as the RAAF Williamtown West sub-population (as defined by Bell 2006). This is considered to be appropriate for the assessment as: the Subject Land is contiguous with the whole sub-population through vegetated areas; successive records within the sub-population are separated by less than 1 km (Bell 2006); and, the species is likely to be pollinated by foraging birds, bats and insects, as with most eucalypts, hence material has the potential to be spread kilometres (OEH 2011). The size of the local population was estimated as part of this assessment to be 40, 214 individuals (Section 4.2.2 of the main report).
	The proposal would result in the removal of 230 <i>E. parramattensis</i> subsp. <i>decadens</i> individuals within the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) on the Subject Land. This removal represents a total of 27% of the population within the Subject Land. In relation to the total estimated local population, the impact equates to a total removal of 0.57% of the local population.
	The proposal will remove individuals that are not naturally occurring as they have been seeded/ planted following rehabilitation. The area in which they occur was not assessed as potential habitat for the species, due to its elevation. As such, the proposal will not remove any potential habitat for the species.
	There is the potential for indirect impacts on 54 individuals occurring within the rehabilitation area that occur within 50 m of the extraction area. These individuals occur within close proximity to the disturbance area and as such, there is the potential for habitat modification. However, this impact will not be permanent, with progressive rehabilitation occurring within the disturbance area. Additionally, the habitat within which these individuals occur was not identified as suitable habitat for the species (i.e. rehabilitation area). At its closest point, the extraction area occurs approximately 180 m from areas of suitable habitat for the species.
	The proposal was assessed as not significantly modifying the hydrology of the area (surface or groundwater). As such, indirect impacts to the retained population due to changes in hydrology are unlikely to occur.
	Due to the relatively small removal of individuals from the local population and the limited indirect impacts of the proposal, it is unlikely that the proposal will adversely affect the life cycle of the species, such that it would be placed at the risk of extinction.



(d) (i) Habitat Removal	The proposal will not remove any suitable habitat for the species as the rehabilitation was not assessed as suitable for <i>E. parramattensis</i> subsp. <i>decadens</i> . The proposal will remove 19.01 ha of occupied habitat (removal of the Coastal Sand Apple – Blackbutt Forest). It is unlikely that there will be any significant indirect impacts on areas of suitable habitat. At its closest, the extraction area occurs approximately 180 m from areas of suitable habitat for this species.
(d) (ii) Habitat Fragmentation	The Subject Land occurs on the edge of a large patch of vegetation that extends along the sandbeds to the west and east. Habitat for the species occurs to the north of the Subject Land, throughout the sub-population area (Clay Wallum Scrub and Earp's Gum Sedge Woodland displayed on Figure 4 of the main body of the report shows the distribution of habitat for the species in the sub-population area; total of 393.13 ha).
	The proposal will temporarily remove a total of 40.38 ha of native vegetation from the edge of this corridor. As such, the proposal will not fragment or isolate areas of habitat for <i>E. parramattensis</i> subsp. <i>decadens</i> .
(d) (iii) Habitat importance	The proposal will only impact on areas of the population within the Subject Land that have been seeded/planted during rehabilitation. As the Coastal Sand Apple – Blackbutt Forest (Rehabilitation) does not represent potential habitat for the species, it is not of high importance to the long-term survival of the local population. A large area (393.13 ha) of potential habitat was assessed as occurring outside the Subject Land, within the locality (assessed as Clay Wallum Scrub and Earp's Gum Sedge Woodland vegetation communities mapped by Bell and Driscoll (2006)).
	A Draft National Recovery Plan (OEH 2011) has been prepared for this species. Four specific recovery objectives are identified in this plan, including:
	Distribute information that assists in conserving and managing Earp's Dirty Gum;
	Ensure appropriate use of Earp's Dirty Gum in rehabilitation projects;
	<ul> <li>Raise awareness of Earp's Dirty Gum and facilitate community involvement in the recovery plan; and</li> </ul>
(f) Recovery Plan	Ensure appropriate protection of the Fern Bay form.
	The proposal would not interfere with these objectives.
	Additionally, OEH has developed a targeted strategy for this species under the Saving Our Species program. This species has been assigned to the 'keep-watch species' management stream as this species is considered to be secure in NSW without targeted management as 'relatively large populations of this species occur within reserves (e.g. Werakata National Park) where current management is sufficient to ensure their long term security'.
	None of the threat abatement plans are relevant to this species.



	The proposal would involve 'Clearing of native vegetation' (total of 40.38 ha), which will remove 230 <i>E. parramattensis</i> subsp. <i>decadens</i> individuals. The species is listed as being adversely affected by this KTP, however, as outlined above the proposal will only impact on 0.57% of the local population which was assessed as not significant.
	The proposal will contribute to future climate change through the modification of the environment and use of fossil fuels in the extraction and processing of the quarry material. The species, or the community in which is occurs, is not listed under the determination as being at risk of this KTP.
(a) KTP	A number of other key threatening processes have the potential to be exacerbated by the proposal and subsequently impact on this species in the locality, including:
(3)	Infection of native plants by Phytophthora cinnamomi;
	<ul> <li>Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae;</li> </ul>
	<ul> <li>Invasion, establishment and spread of Lantana camara; and</li> </ul>
	<ul> <li>Invasion of native plant communities by exotic perennial grasses.</li> </ul>
	Mitigation measures detailed in Section 6 of the main body of this report would be implemented to reduce the impacts of these threatening processes on retained/adjacent habitat for this species.
Conclusion	The proposal will remove a small proportion of the local population of <i>E. parramattensis</i> subsp. <i>decadens</i> (0.57%; 230 individuals). Additionally, these individuals are not naturally occurring and do not occur within an area of suitable habitat for the species. The proposal will not isolate or fragment any areas of potential habitat for the species, or significantly impact on the remaining suitable habitat in the Subject Land. As such, the proposal is considered unlikely to have a significant impact on the species in the locality.
	The proposed mitigation measures detailed in Section 6 of the main body of this report are intended to reduce the potential impacts on the retained population within the study area. The Biodiversity Offset Strategy, outlined in Section 7 of the main body of this report is intended to compensate for the loss of this species, through the in-perpetuity protection of 634 individuals within the Offset Area.

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Kaala	
Koala	
	The Koala occurs from north-eastern Queensland, south along the coast and ranges to south- western South Australia, including areas west of the Great Dividing Range (DECC 2008).
	The species inhabits eucalypt woodlands and forests and feeds on the foliage of Eucalypt and non-Eucalypt species. Across their range, the species has been recorded as foraging or sitting in 69 different Eucalypt species and almost 30 non-Eucalypt species, however, most studies of Koala foraging habits noted that the species predominantly feeds on one or a few Eucalypt species at any site (Moore and Foley 2000). Within the Port Stephens area, <i>Eucalyptus robusta, E. parramattensis</i> and <i>E. tereticornis</i> were identified as preferred feed trees by Lunney <i>et al.</i> (1998). Additionally, vegetation associations containing <i>Eucalyptus signata</i> were also identified as important in this study.
	The species is generally solitary (OEH 2015), but they have a complex social hierarchy, living in breeding aggregations comprising of the territory of a dominant male overlapping a small number of mature females, also juveniles of various ages occur (DECC 2008; OEH 2014). Across their range, adult Koalas generally exhibit long-term fidelity to their individual home range. Within the Port Stephens area studies have established home ranges of 0.2 ha to 500 ha, with an average of 80 – 90 ha (DECC 2008).
	There is evidence that the population within the Port Stephens area is in decline. The mortality rate in 1995 was estimated to be $5 - 10\%$ of the population. Since 1995 this rate has declined linearly to less than half that level. As trends in road mortality rates of animals can provide a good surrogate for animal abundance, this may indicate a substantial decline in the population at Port Stephens (TSSC 2012). Modelling of the impacts of fire and dogs on the Port Stephens population conducted by Lunney <i>et al.</i> (2007) also identified that these two pressures are impacting on the local population. The research estimated the population to be between 350 and 800 individuals, and modelled that under basic assumptions (impacts from dogs and fire), the population was unlikely to survive 50 years (Lunney <i>et al.</i> 2007).
(a) Effect on life cycle	The Subject Land falls within a key Koala population (Tomago Sandbeds Koala Management Unit (KMU); CKPOM 2002) in the Port Stephens LGA. There is a high number of records of the species within 1 km of the site. There are a total of 9 Atlas records within the Subject Land; one from 2011 (accuracy of 10 m), one from 2008 (accuracy of 1,000 m) and the remaining seven in 1992 or prior (all accuracy of 1,000 m). Additionally, there are 37 records within 1 km of the Subject Land, of which five are within the last 10 years. This suggests that the area is potentially of high importance to the Koala in the area, particularly due to the occurrence of areas of preferred habitat.
	The species was identified in the south of the Subject Land during surveys conducted by RPS (2011). However, surveys conducted by Umwelt (2015) in September 2015 did not return any activity during SAT surveys, which was attributed to the fire which occurred two years prior to the field surveys (October 2013). While the SAT surveys conducted by Umwelt in 2015 did not identify any Koala activity, the Subject Land would have contained habitat suitable for utilisation by the species. Matthews <i>et al.</i> (2007) identified that burnt trees could be utilised by Koalas from as little as three months after fire, as the epicormic growth provides sufficient nutrients. Un-burnt areas are important during wildfire events to maintain the population and service as source of colonising individuals into areas of burnt bush (Matthews <i>et al.</i> 2007). It is likely that Koala re-colonisation of the habitat burnt in 2013 fire, including the Subject Land. Post 2013 fire event, there are seven records of the species within 5 km of the Subject Land. Post 2013 fire event, there are seven records of the species within 5 km of the Subject Land (within the KMU). These occur along Medowie Road approximately 3 to 4 km to the east/north-east (4 records from 2014) and approximately 4 km north along Richardson Road (two records from 2014 and one record from 2015). The four records along Medowie Road all occur within areas that were not burnt during the fire and the three records along Richardson Road occur within 1 km of the mapped fire extent.
	Due to the recent fire disturbance (October 2013), the precautionary principle was applied and the preferred habitat within the Subject Land is assumed to have the potential to support a medium (normal) usage category. As outlined by Phillips and Callaghan (2011), "low activity levels recorded in what might otherwise be med-high carrying capacity <i>P. cinereus</i> habitat may be a result of contemporary population dynamics, landscape configuration and/or historical disturbances including logging, mining, fire, agricultural activities and/or urban development".
	During clearing there is the potential for displacement of an individual if the extraction area forms part of its home-range. The removal of an area of an individual's home range may force it to move.

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	potentially impeding on the home range of another individual. This could result in conflicts in the local area due to the high fidelity the species exhibit to their home range. Based on the assessment of an average home range in the Port Stephens area of $80 - 90$ ha (DECC 2008), the proposal has the potential to impact on the home range of approximately one to two adult Koalas. While there is the potential to displace one to two individuals, this impact is unlikely to be significant due to the large area of available habitat within the Tomago Sandbends KMU. Lunney <i>et al.</i> (2007) modelled the carrying capacity of the Port Stephens area to be a maximum of 2,500 individuals. However, the population within the same area was estimated to be only $350 - 800$ individuals (Lunney <i>et al.</i> 2007). Based on this assessment, habitat availability is not the limiting factor for the Koala population in Port Stephens area and it is likely that there is a large amount of available habitat within the locality that is either un-occupied, or could potentially support a higher density of Koalas.
	The decline of the Koala population has historically been attributed to habitat loss, however, impacts from fires, dogs (Lunney <i>et al.</i> 2007) and motor vehicles (Phillips <i>et al.</i> 1996) have been identified as significant threats to the species. The habitat loss due to the proposal (19.19 ha of preferred habitat and 21.19 ha of supplementary habitat) has been assessed as minor in the context of the sandbeds (approximately 1.01% of the preferred habitat within the KMU; see d (i) below). The proposal also has the potential for increased impact to the species from vehicle strikes as there will be an increase in traffic. However, traffic assessments concluded that the proposal will only cause a minor increase in traffic volume. At absolute maximum extraction rates, the proposal will increase traffic along Cabbage Tree Road by less than 3% in a 24 hour period. However, it is expected under average operational conditions that traffic increases along Cabbage Tree Road will be less than 1%. Additionally, the proposal will not increase dog numbers in the locality.
	Based on this information, it is unlikely that the proposal would impact on the life cycle of the local population, such that it would place it at the risk of extinction.
	The proposal would remove 19.19 ha of preferred and 21.19 ha of supplementary Koala habitat (definitions as per the Port Stephens CKPoM). This equates to 19.86% of the preferred Koala habitat within the Subject Land and 42.36% of the supplementary habitat.
(d) (i) Habitat Removal	An assessment of the extent of mapped Koala habitat within the Tomago Sandbeds KMU was conducted ( <b>Section 0</b> ). In relation to the available habitat mapped within the Tomago Sand Beds KMU, the proposal will impact on 1.01% of the mapped preferred Koala habitat (1,900ha) and 0.78% of the mapped supplementary habitat (2,694 ha).
	While the proportion of habitat removal from within the Subject Land will be high, the removal of habitat within the Tomago Sandbeds KMU would be low (approximately 1%). Due to this relatively low proportion of habitat removal, it is considered unlikely that this removal would place the local population at the risk of extinction.
	The Subject Land occurs on the edge of a large patch of vegetation that extends along the sandbeds to the west and east, with preferred and supplementary Koala habitat occurring along this corridor. The proposal will temporarily remove a total of 40.38 ha of native vegetation from the edge of this corridor. As such, the proposal will not fragment or isolate areas of habitat for the Koala extending off the site.
(d) (ii) Habitat Fragmentation	Within the Subject Land the proposal will cause fragmentation of habitat in the west/ south-west of the site. Fragmentation of two areas of preferred habitat will occur due to the proposal. The extraction area will impact on an area mapped as a habitat link, between areas of preferred habitat. The proposed extraction area has been revised to ensure no areas of Koala habitat will be isolated. As such, movement corridors within the Subject Land will be maintained. All areas of vegetation retained within the Subject Land will be linked to other areas of vegetation both within and adjacent to the site. Along the western boundary, areas of habitat will be linked through a retained strip of vegetation that is either 20 m or 50 m wide (depending on the point along the boundary). A corridor of vegetation between the northern and southern extraction areas will also be retained.



(d) (iii) Habitat importance	The proposal would result in the relatively low removal of preferred and supplementary Koala habitat within the Tomago Sandbeds KMU (approximately 1%). While the proposal will impact on preferred Koala habitat, this habitat within the disturbance area is rehabilitation. It is unlikely that this area is of as high importance to the species as naturally occurring preferred habitat within the surrounding area. Resident individuals within the Subject Land would form part of a larger population to the north along the Tomago Sandbeds and likely beyond to other areas within Port Stephens LGA (due to high vegetation connectivity). Within the Tomago Sandbeds, there is a large amount of preferred and supplementary habitat. It is therefore unlikely that the habitat to be removed and temporarily fragmented is of such importance to the local population such that it would be placed at the risk of extinction.
(f) Recovery Plan	The Approved Recovery Plan for the Koala ( <i>Phascolarctos cinereus</i> ) (DECCW 2008) identifies mechanisms to conserve Koala habitat and increase our understanding of the biology and ecology of this species. The proposal does not contravene the objectives of the plan.
	None of the threat abatement plans are relevant to this species in the context of the proposal.
	The proposal would involve 'Clearing of native vegetation' (total of 40.38 ha), which will remove 19.19 ha of preferred habitat and 21.19 ha of supplementary habitat. The species is listed as being adversely affected by this KTP, however, as outlined above the proposal will only impact on less than 2% of the potential habitat for the species within the Tomago Sandbeds KMU.
	The proposal will contribute to future climate change through the modification of the environment and use of fossil fuels in the extraction and processing of the quarry material. The species, or the community in which is occurs, is not listed under the determination as being at risk of this KTP.
(g) KTP	A number of other key threatening processes have the potential to be exacerbated by the proposal and subsequently impact on this species in the locality, including:
	Infection of native plants by <i>Phytophthora cinnamomi</i> ; and
	<ul> <li>Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.</li> </ul>
	Mitigation measures detailed in Section 6 of the main body of this report would be implemented to reduce the impacts of these threatening processes on retained/adjacent habitat for this species.
Conclusion	Based on the assessment of available preferred and supplementary habitat within the Tomago Sandbeds KMU, the proposal will only removal a small proportion of the available preferred (1.01%) and supplementary habitat (0.78%). The proposal will cause some fragmentation of habitat within the Subject Land, however, habitat corridors within the site will be maintained.
	The proposal also has the potential for increased impact to the species from vehicle strikes as there will be an increase in traffic. However, mitigation measures will be implemented to minimise these impacts (fencing along Cabbage Tree Road and appropriate speeds along the project frontage). Additionally, feral animal control will be implemented within the impact and offset areas of the Subject Land, with feral dogs being one of the target species.
	As such, due to the relatively small area of impact on the specie's habitat, the proposal is unlikely to significantly impact on the local population, such that it would be placed at the risk of extinction.

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# Wallum Froglet

(a) Effect on life cycle	The Wallum Froglet is one of a group of wallum-dependent frog species of coastal south-east Queensland and eastern New South Wales. All of the species in this group are wholly or largely restricted to Wallum or Wallum-equivalent habitat (Meyer <i>et al.</i> 2006). The Wallum is a system of silicious sand plains and dunes that support varying vegetation types including eucalypt forests and woodland, rainforest and heathland (Coaldrake 1961). Tanin-stained water collects above organic hardpan layers forming swamps and lakes within the Wallum. Often these water bodies are acidic (pH <5.5) and oligotrophic (nutrient poor).
	While commonly occupying wallum habitat, the Wallum Froglet may also be found in wallum- equivalent habitat (sub-coastal wet heath in areas of sandy soil) outside of the wallum (Stewart 1995) and is more commonly associated with ephemeral swamps and soaks than lakes. The Wallum Froglet is most likely to be encountered in wet heath, <i>Melaleuca</i> swamps and sedge swamps in areas of sandy soil although it has been found to breed in disturbed wallum habitat including pine plantations and drainage ditches more readily than other species of Wallum- dependent frogs. The species has also been recorded in habitat well away from water during dry periods (Meyer <i>et al.</i> 2006).
	The Wallum Froglet has been recorded breeding after rain in all four seasons although it is believed to breed most frequently from late autumn to early spring. Generally breeding behaviour is associated with heavy periods of rain often >50 mm. Breeding often occurs in shallow ephemeral water bodies where males call from on top of matted sedges or from near the water at the base of sedges (Anstis 2002). The pH of water at breeding sites is usually quite acidic (pH 4.3 - 5.2) (Barker <i>et al.</i> 1995).
	The proposal will impact on 0.13 ha of preferred and 0.57 ha of supplementary habitat for the species. There is the potential for the modification of a small area of core habitat (at two locations) in the west/south-west of the Subject Land, where the extraction area boundary occurs directly adjacent to areas of core habitat (Swamp Mahogany – Paperbark Swamp Forest). The impacts to the core habitat along Cabbage Tree Road will be permanent as this area will be part of the acceleration lane for exiting trucks. As such, there is the potential for indirect impacts on the adjacent habitat though modification from weeds and run-off from the road. Stormwater management and weed control will be conducted as part of the proposal, therefore the potential habitat that occurs adjacent to the disturbance footprint will be temporary as this area will be rehabilitated. It is unlikely that any indirect impacts (habitat modification) will be significant.
	While areas of habitat will be removed from the Subject Land, the level of removal is not considered to be large enough to significantly impact on the long-term survival of the species due to the large amount of habitat retained within the Offset Area. Additionally, based on Bell and Driscoll (2006) vegetation mapping, there is a large amount of breeding habitat (Swamp Forest) in the locality.
	Due to the minimal impact on habitat for the species, with only minor impacts on core breeding habitat, it is unlikely that the proposal will impact on the life cycle of the local population, such that it would be placed at risk of extinction.
(d) (i) Habitat Removal	The proposal will remove approximately 0.13 ha core (breeding) and 0.57 ha of supplementary (foraging) habitat for the species. There is the potential for the modification of some areas of habitat due to their proximity to the disturbance area (see item (a) above).
	The proposal was assessed as not significantly modifying the hydrology of the area (surface or groundwater). As such, indirect impacts to the retained habitat due to changes in hydrology are unlikely to occur.



(d) (ii) Habitat Fragmentation	In the south-west of the Subject Land, areas of habitat for the species are already naturally fragmented from one another as areas of unsuitable habitat occur between patches (unsuitable due to distance from core habitat and elevation). However, these vegetated areas not assessed as suitable habitat may be used by the species for dispersal.
	While the prosed activity will not isolate any areas of habitat for the species, it will cause some habitat fragmentation due to the removal of potential dispersal areas. This occurs in the southwest of the Subject Land where an isolated patch of Swamp Mahogany – Paperbark Swamp Forest occurs, and to some extent, the long 'finger' of the extraction area that extends to the east will cause some fragmentation. However, it should be noted that there is still connectivity in the east of the Subject Land. Additionally, the disturbance to potential dispersal areas will be temporary, due to the progressive rehabilitation of the disturbance areas.
	As such, the minor and temporary habitat fragmentation that will occur due to the proposal is unlikely to significantly impact on the local population.
	The habitat to be removed is unlikely to be of high importance to the species as only a small area (total 0.71 ha) of habitat is to be directly impacted.
(d) (iii) Habitat	The habitat that has the potential to be modified is core habitat, with the species being recorded within this larger patch during field surveys. However, due to the small area of habitat that has the potential to be modified and the temporary nature of the disturbance, it is unlikely that this habitat modification will significantly impact on the species.
Importance	The habitat that will be temporarily fragmented through the removal of potential dispersal areas occurs in the south-west of the Subject Land. These are areas of core habitat and as such are potentially important to the species. However, it is unlikely that this minor fragmentation will significantly impact on the local population as no areas of habitat will be completely isolated and the disturbance area will be progressively rehabilitated post-extraction.
	The National Recovery Plan for the wallum sedge-frog and other wallum-dependent frog species (Meyer <i>et al.</i> 2006) outlines a number of key objectives to manage habitat for this species. The proposal is not consistent with the objectives of this plan.
(f) Recovery	One threat abatement plan, Predation by <i>Gambusia holbrooki</i> – The Plague Minnow, is applicable to this species. The proposal does not contravene the objectives of the plan.
Plan	Additionally, OEH has developed a targeted strategy for this species under the Saving Our Species program. This species has been assigned to the 'keep-watch species' management stream. The 'keep-watch' status has been applied to the species as "These species require no immediate investment because they are either naturally rare, have few known threats, or are more abundant than previously assumed when they were listed as threatened."
	The proposal would involve 'Clearing of native vegetation' (total of 40.38 ha), which will remove 0.13 ha of core and 0.57 ha of supplementary habitat for the Wallum Froglet. The species is not listed under the determination as being at risk of this KTP.
	The proposal will contribute to future climate change through the modification of the environment and use of fossil fuels in the extraction and processing of the quarry material. The species, or the community in which is occurs, is not listed under the determination as being at risk of this KTP.
(g) КТР	Two other KTPs have the potential to be exacerbated by the proposal and subsequently impact on this species in the locality, including:
	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis; and
	Removal of dead wood and dead trees.
	Mitigation measures detailed in Section 6 of the main body of this report would be implemented to reduce the impacts of these threatening processes on retained/adjacent habitat for this species
Conclusion	The proposed activity will remove approximately 0.13 ha of core and 0.57 ha of supplementary habitat for the species. There is the potential for some habitat modification as the extraction area occurs adjacent to an area of core habitat, however, it was concluded that this will be minor and temporary. The assessment identified that there is the potential for some habitat fragmentation, however, it was concluded that this will be minor and temporary. As such, the proposal is unlikely to significantly impact on the local population of this species.



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# APPENDIX 5. STAFF CONTRIBUTIONS



# The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Aaron Mulcahy	BEnv Sc & Mgt MScStud (Botany)	Senior Ecologist	Vegetation mapping and threatened species surveys
Adam Blundell	B.EnvSc (Hons)	Principal Ecologist	Report review
Dan Pedersen	BSCEngTech GIFireE, BDAP-A	Senior Ecologist/ Bushfire Consultant	Vegetation mapping
Gayle Joyce	BSc (Forestry) (Hons)	GIS Specialist	GIS and figure preparation
Luke O'Brien	BEnvSc&Mgt	Ecologist	Hollow-bearing tree survey
Samara Schulz	BEnvSc & Mgt (Hons)	Ecologist	Vegetation mapping, threatened species surveys and report preparation
Kristy Peters	BParkMgt (Hons)	Senior Ecologist	Peer review



# APPENDIX 6. LICENSING



Kleinfelder employees involved in the current study are licensed or approved under the *National Parks and Wildlife Act 1974* (License Number: SL100730, Expiry: 31 March 2019) and the *Animal Research Act 1985* to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.