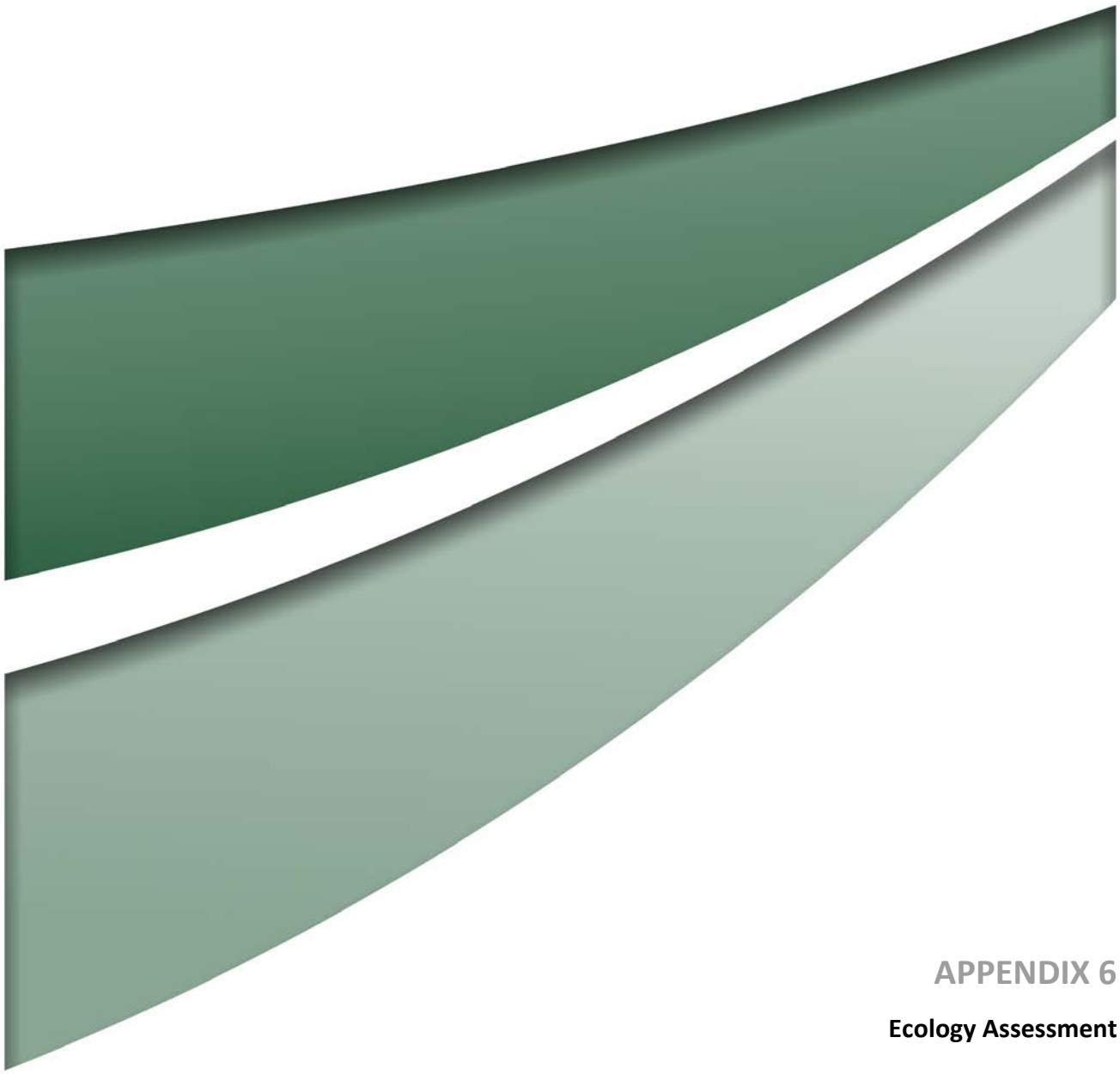

APPENDIX 6

Ecology Assessment

umwelt

Inspired people | Dedicated team
Quality outcomes

Dixon Sand (Penrith) Pty Ltd

HAERSES ROAD QUARRY EXTRACTION AREA MODIFICATION PROJECT

Biodiversity Assessment Report

FINAL

September 2016

Dixon Sand (Penrith) Pty Ltd

HAERSES ROAD QUARRY EXTRACTION AREA MODIFICATION PROJECT

Biodiversity Assessment Report

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Dixon Sand

Project Director:	John Merrell
Project Manager:	Lachlan Sweeney
Technical Director:	Travis Peake
Technical Manager:	Bill Wallach
Report No.	3479/R04
Date:	September 2016

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Executive Summary

Umwelt (Australia) Pty Limited (Umwelt) has prepared this Biodiversity Assessment Report (BAR) on behalf of Dixon Sand to assess the potential ecological impacts of the proposed Modification Project at Haerses Road Quarry. Additionally, Umwelt assessed the potential credits generated at an offset site adjoining the northern boundary of the Development Site. Both assessments were undertaken using the *Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects (FBA)*.

The BioBanking Credit Calculator (BBCC) Version 4.1 (Major Project Assessment Type) was applied following extensive literature reviews, the identification of relevant landscape features and detailed flora and fauna field surveys undertaken in November 2014 and December 2015 of the Development Site, in accordance with FBA methodology (OEH 2014).

Following the application of appropriate avoidance and mitigation measures, the FBA identified the following biodiversity features and subsequent credits required for offsetting as a result of the Modification Project:

- 3 ecosystem credits for Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (HN560)
- 337 ecosystem credits for Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (HN566)
- 538 ecosystem credits for Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (HN582)
- 44 ecosystem credits for Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (HN586)
- 360 species credits for *Darwinia biflora*
- 223 species credits for eastern pygmy-possum (*Cercartetus nanus*)
- 338 species credits for *Grevillea parviflora* subsp. *supplicans*
- 1372 species credits for Dural woodland snail (*Pommerhelix duralensis*) and
- 288 species credits for *Tetratheca glandulosa*.

Additionally, the following biodiversity features and subsequent credits would be generated as a result of securing the Haerses Road Offset Site:

- 11 ecosystem credits for Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (HN560)
- 6 ecosystem credits for Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (HN566)
- 17 ecosystem credits for Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (HN582)
- 4 ecosystem credits for Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (HN586)
- 14 species credits for *Darwinia biflora*
- 11 species credits for eastern pygmy-possum (*Cercartetus nanus*)
- 16 species credits for Dural woodland snail (*Pommerhelix duralensis*) and
- 14 species credits for *Tetratheca glandulosa*.

Glossary

Approved Extraction Area	Area as approved under DA 165-7-2005 as shown on **Figure 1.2**.
BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DECC	NSW Department of Environment and Climate Change (now OEH)
Development Site	The area within the Modification Area that relates to Development Footprint as referred to in the FBA Methodology (OEH 2014).
DoE	Commonwealth Department of the Environment
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site.
EEC	Endangered Ecological Community
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FBA	Framework for Biodiversity Assessment
FM Act	*Fisheries Management Act 1994* (NSW)
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation for Australia (Version 7)
LGA	Local Government Area
LPI	Land and Property Information
MGA	Map Grid of Australia
MNES	Matters of National Environmental Significance
Modification Area	The term used in this report for the Development Site as referred to in the FBA Methodology (OEH 2014)
Modification Project	The subject of this Biodiversity Assessment Report, the Proposed Extraction Area Modification, which includes the proposed development of an additional quarry resource to the west of the currently approved quarry area and associated components.
NSW	New South Wales
OEH	Office of Environment and Heritage (NSW)
PCT	Plant Community Type
PMST	Protected Matters Search Tool
SAT	Spot Assessment Technique

Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database.
TEC	Threatened Ecological Community
tpa	Tonnes Per Annum
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
TSPD	Threatened Species Profile Database
VIS	Vegetation Information System

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Tables

Appendices

1.0 Introduction

1.1 Background

Dixon Sand (Penrith) Pty Limited (Dixon Sand) operate the Haerses Road Quarry located on Haerses Road Maroota, NSW. Haerses Road Quarry extracts Tertiary Maroota Sand from Lot 170 DP 664767, Lots A and B DP 407341, and Lots 176 and 177 DP 752039 (the site) in accordance with development consent DA 165-7-2005.

Dixon Sand was granted development consent for the State Significant Development DA 165-7-2005 under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) by the Minister for Planning on 14 February 2006. The development consent provides for the operation of a sand quarry on Haerses Road at Maroota with a total extraction of 7 million tonnes from the site over 25 years at a rate of 250,000 tonnes per annum (tpa). The consent allows for hauling of 190,000 tpa of screened sand to the processing facility at Dixon Sand's nearby Old Northern Road quarry and hauling of 60,000 tpa of screened sand direct to local and regional markets.

Due to the recent increase in demand for medium to coarse grain sands and specialist sands in the Sydney market, Dixon Sand is seeking a modification to DA 165-7-2006-5 for the Haerses Road quarry to increase the extraction area and to increase the volume of sand sold direct to market from the site. There is no proposal to increase total annual production or the currently approved traffic movements to and from site.

The planning approach for the modification is to modify the existing consent under Section 75W of the EP&A Act. Umwelt (Australia) Pty Limited (Umwelt) has prepared this Biodiversity Assessment Report (BAR) on behalf of Dixon Sand to assess the potential ecological impacts of the proposed modification at the Haerses Road Quarry using the *Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014).

1.1.1 Proposed Modification

The proposed modification to DA 165-7-2006-5, being sought for the Haerses Road Quarry involves increasing the extraction area as well as including a provision for mobile plant and equipment to be utilised on the site to avoid double handling and double processing of the product. The proposed modifications are:

- Increasing the extraction area by approximately 19 hectares to allow extension into the friable sandstone resource within Lots 177 DP 752039 and 216 DP 752039 (refer to **Figure 1.1**). The friable sandstone would be extracted using similar methods and equipment as currently used at the site, being a dozer, excavator, trucks and a loader. The existing dozer would be used to rip the friable sandstone on site which wasn't required for tertiary sand deposit in the original consent. The existing dry screening plant would utilise mobile crushers (one jaw crusher and one rotary crusher) to break sandstone clumps prior to screening

- Utilise existing traffic movements between Old Northern Rd and Haerses Rd Quarries to allow for blending of speciality sands, including importation of up to 100,000 tpa of clean recycled sands (Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM)) from approved sites. No new traffic movements would be generated by the proposal

- Use of mobile washing and processing plant on site

- Installation of detention basins and water management infrastructure

- Establishment of site office, workshop and weighbridge.

The modification does not affect any currently approved activities within the Haerses Road Quarry.

1.2 Development Site Information

For the purposes of this Biodiversity Assessment Report (BAR), the various parts of the quarry have been defined to facilitate the understanding of the existing approved components of the site and the proposed modification.

The total area of land comprising the Haerses Road Quarry is referred to as the Project Site (refer **Figure 1.2**). The existing approved activities occur within the Approved Extraction Area. The portion of the site covered by the modification is the Modification Area which includes the Development Site which comprises the area of land to be impacted by the proposed modification that is outside of the existing approved disturbance area at Haerses Road Quarry. It consists of the proposed extraction area and the proposed processing area.

1.2.1 Location

Haerses Road Quarry is a sand quarry operated by Dixon Sand, located in the Maroota area, approximately 40 kilometres north of Parramatta, NSW (refer to **Figure 1.1**). The Modification Area is located within the Sydney Basin IBRA bioregion and the Yengo IBRA subregion. Refer to **Figures 1.2** to **1.4** for the location of the Development Site and other relevant landscape features that pertain to the FBA assessment.

Table 1.1 Development Site Location in the Landscape

Haerses Road Quarry Modification Area	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Yengo
Major Catchment Area	Hawkesbury/Nepean
Mitchell Landscape	Maroota Sands (majority)
LGA	The Hills
Address	Haerses Road, Maroota, NSW, 2756

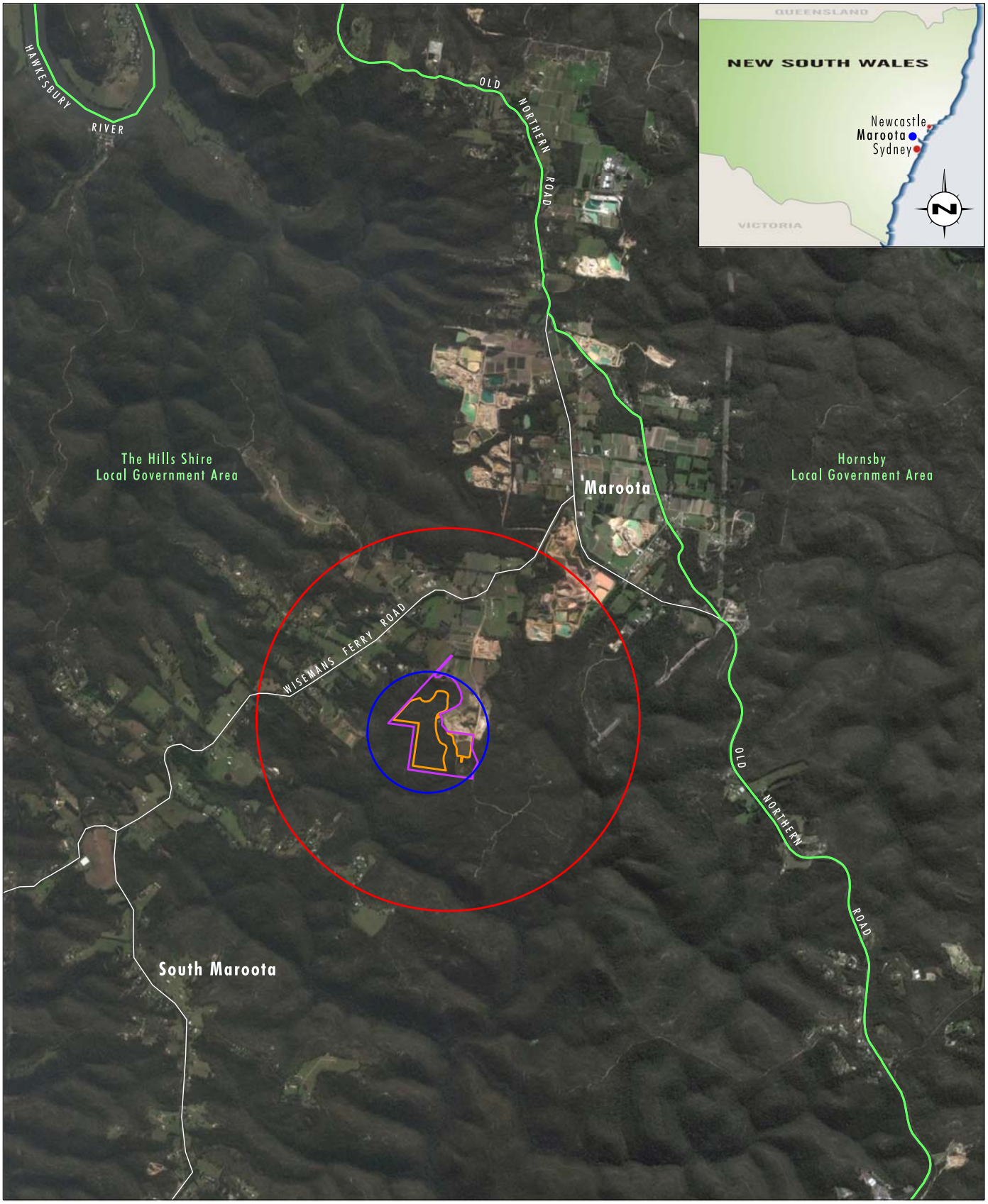

Image Source: Google Earth (2014)
Data Source: LPI (2015)

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1:50 000

Legend

- Development Site
- Modification Area
- Local Government Area Boundary
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle

FIGURE 1.1

Locality Map

File Name (A4): R04/3479_026.dgn
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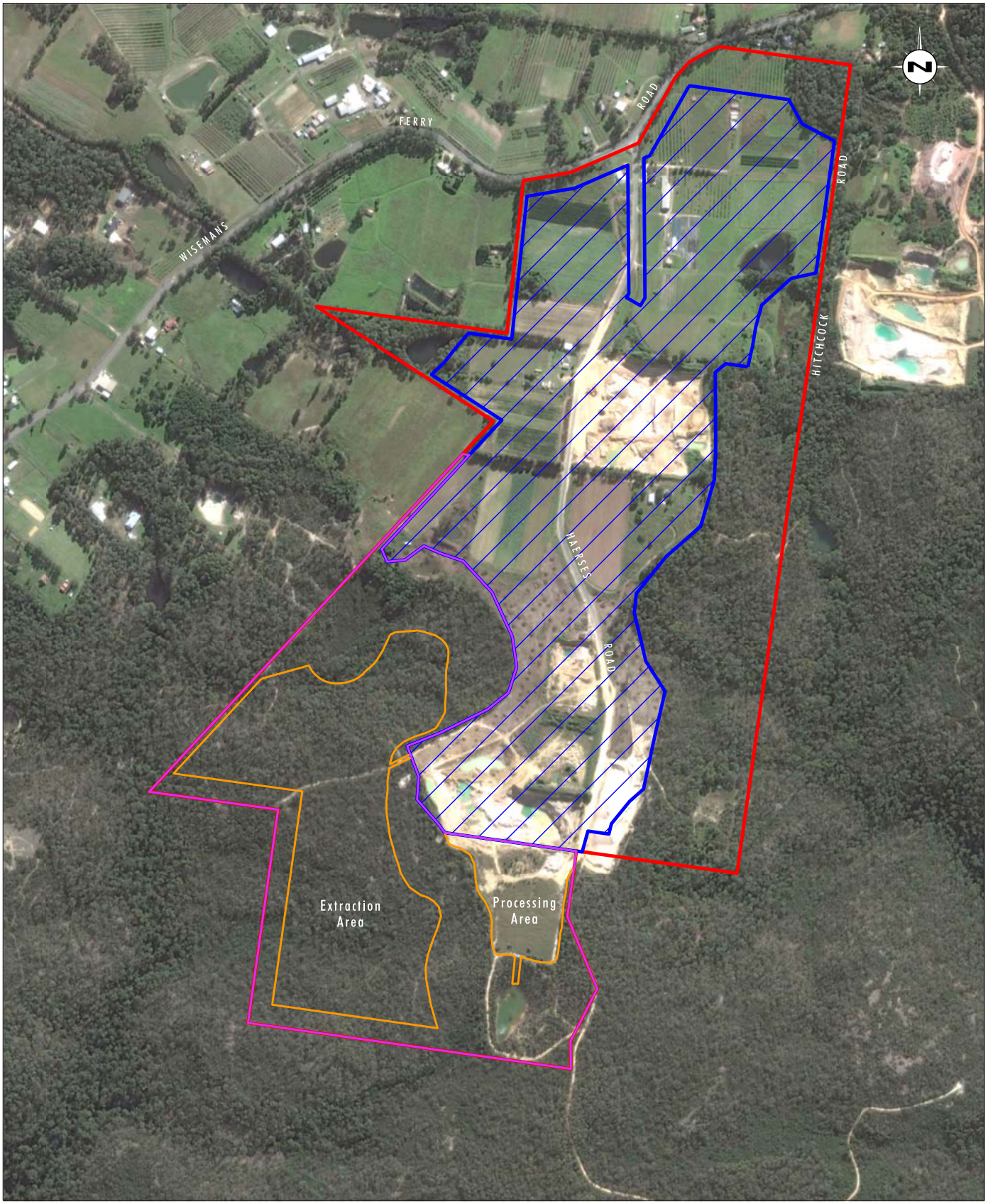

Image Source: Google Earth (2014)
Data Source: Mc Kinlay Morgan & Associates Pty Ltd (2014)

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1:10 000

Legend

- Project Site
- Approved Extraction Area
- Development Site (22.4 Hectares)
- Modification Area (44 Hectares)

FIGURE 1.2

Proposed Extraction Area Modification Project

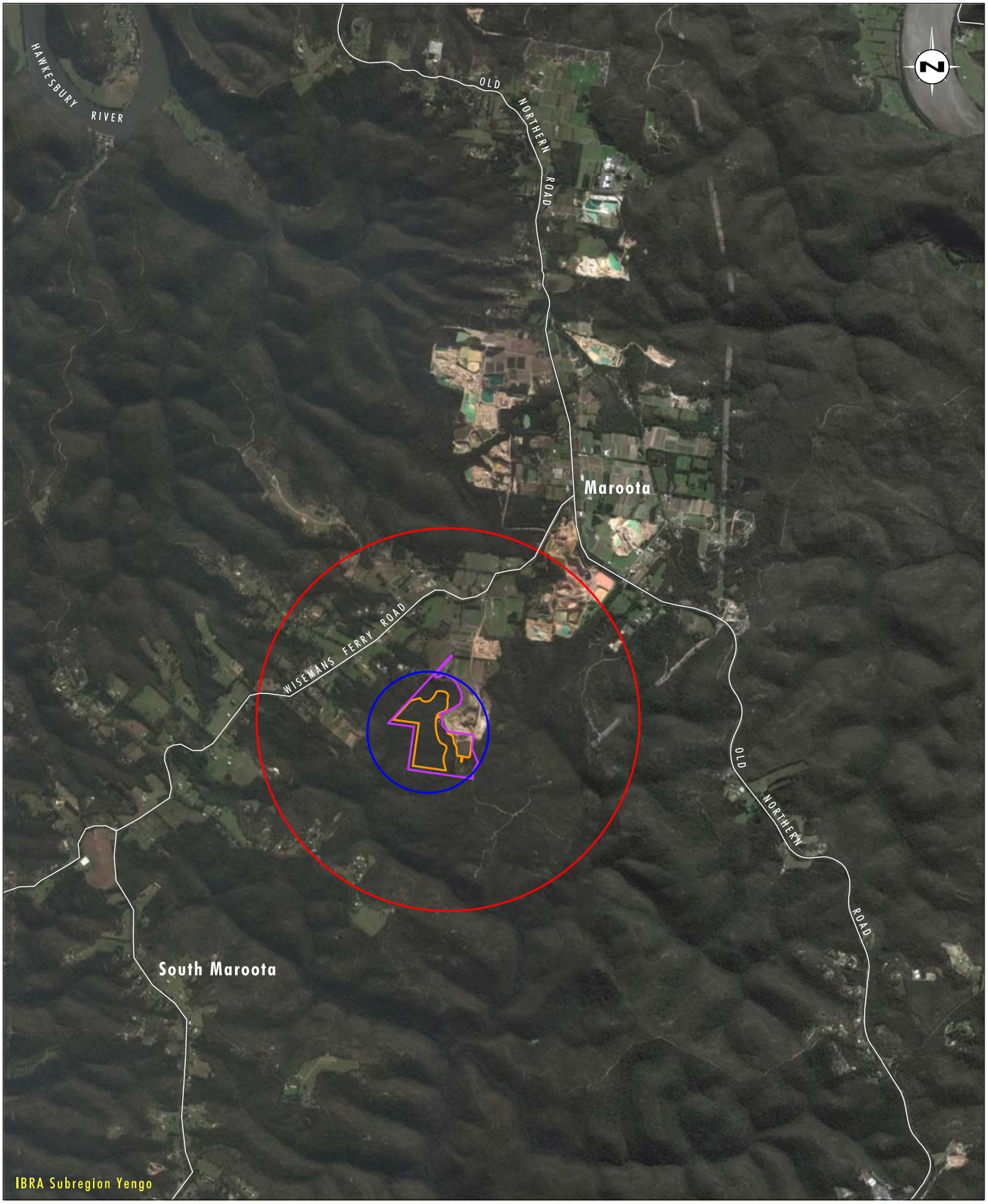

Image Source: Google Earth (2014)
Data Source: IBRA V7 - Australian Government Department of the Environment (2012)

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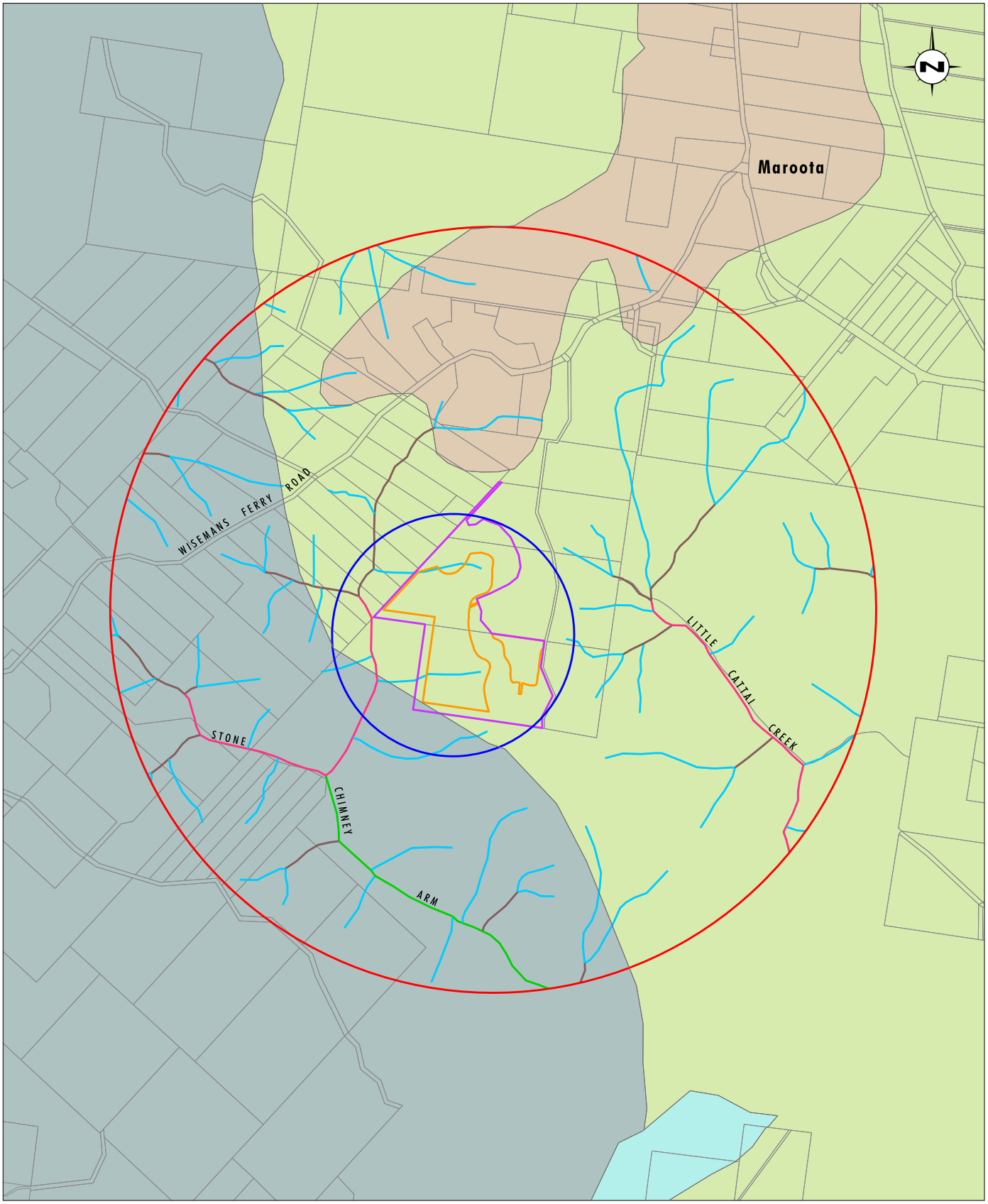
1:50 000

Legend

- Development Site
- Modification Area
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle

FIGURE 1.3

Location Map - IBRA V7 Regions



Data Source: DECC (2008),LPI (2011)

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1:25 000

Legend

- Development Site
- Modification Area
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

Mitchell Landscapes:

- Blaxlands Ridge
- Hornsby Plateau
- Maroota Sands
- Sydney Basin Diatremes

FIGURE 1.4

Location Map - Landscape Features

File Name (A4): R04/3479_029.dgn
20160920 11.11

1.2.2 Size

The Modification Area covers approximately 44 hectares.

The Development Site comprises approximately 22.4 hectares.

1.2.3 Topography and Natural Features

The Modification Area lies in the Sydney Basin bioregion, at the top of the local catchment, and drains towards the west. The gradient decreases from approximately 190 ASL in the east to approximately 130 metres ASL in the west representing a gradient change of approximately 1 metre in every 10 metres. There is negligible gradient change from north to south. The topography is consistent with that of the Yengo subregion, characterised by steep slopes forming narrow valleys with low cliff lines on Narrabeen sandstone and a structurally controlled drainage pattern (Morgan, 2001).

The Modification Area drains to the Hawkesbury River, approximately 12 km south west, via the first order drainage line into the upper reaches of Stone Chimney Arm (creek), a tributary of Little Cattai Creek and the Broadwater Swamp. The Broadwater Swamp is approximately eight kilometres downstream of the site, connecting Little Cattai Creek to the Hawkesbury River. The local catchment of which the site is a part is shown has an area of approximately 9980 hectares (ERM, 2006).

The Modification Area encompasses an area of approximately 44 hectares of which some small areas (~4 ha) in the south have been disturbed by existing quarrying activities. The majority of the Modification Area remains intact native woodland and forest vegetation. The woodland and forest areas of the Modification Area form part of a very large connected area of woodland and forest that extends eastwards towards the coast from Yengo National Park, Wollemi National Park and the Blue Mountains National Park in the west. The Modification Area is part of a remnant of connected woodland and forest vegetation that is among the largest remnants of woodland and forest along the east coast of NSW. The presence of such a large connected remnant that dominates the landscape is considered an outstanding natural feature.

1.3 Key Resources, Policies and Documents

The following key resources, policies and documents were used to prepare the Biodiversity Assessment Report for the Modification Project:

- Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects (OEH September 2014)
- BioBanking Assessment Methodology 2008 (DECC July 2008)
- BioBanking Assessment Methodology 2014 (OEH September 2014)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities –Working Draft (DEC 2004)
- BioBanking Credit Calculator (Major Project Assessment Type) Version 4.1, accessed in April-May 2016
- Vegetation Information System (VIS) Classification Database (OEH 2015), accessed in August 2015
- OEH Atlas of NSW Wildlife database and mapping tool (OEH 2015), accessed in March 2016
- Department of the Environment (DoE) Protected Matters Database (DoE 2015), accessed in March 2016

1.4 Report Preparation

This Biodiversity Assessment Report (BAR) was prepared by Bill Wallach (Senior Ecologist) and Travis Peake (Practice Leader Ecology). Both Bill Wallach and Travis Peake (Practice Leader Ecology) are accredited BioBanking and BioCertification Assessors.

2.0 Methods – Modification Area

2.1 Description

The threatened species and ecological communities known or likely to occur within the Modification Area were identified by a systematic approach comprising appropriate database searches, a review of recent literature, and targeted field surveys.

2.2 Database Searches

Database searches were undertaken to develop a list of Threatened Ecological Communities (TECs) and threatened flora and fauna species that have previously been recorded, or are predicted to occur within 10 kilometres of the boundary of the Modification Area. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring threatened and migratory species and endangered populations. Relevant documents included:

- EPBC Protected Matters Search Tool (30/03/16)
- NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (30/03/16).

Marine species such as albatrosses, petrels, turtles and whales were excluded from the database search results due to an absence of marine habitats in the Modification Area.

A preliminary assessment using the BioBanking Credit Calculator was undertaken, which provided a list of species credit species that might require survey and the suitable survey periods for each species. The results of the database searches, literature review and preliminary assessment using the BioBanking Credit Calculator were used to design the survey requirements for species credit species to ensure that adequate surveys were undertaken.

The Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC 2004) was considered when undertaking the threatened species surveys in the Development Site.

2.3 Systematic Quadrat Surveys

Systematic vegetation quadrats were undertaken across two field surveys, the first in November 2014 and the second in December 2015. Detailed information on the timing of these two surveys is provided below in **Section 2.8**.

Systematic vegetation quadrat sites were selected by considering a vast array of attributes that were likely to influence or determine the type of vegetation communities present in the Modification Area. This stratification was done intuitively, based on existing topographic, soil, vegetation and geological mapping. Other factors considered included the spatial coverage of sites across the Modification Area, as well as the topographic position and aspect.

Each vegetation quadrat comprised 20 metres by 20 metres (400 m^2); a standard size used widely for systematic flora surveys throughout NSW and is recognised by OEH and the Royal Botanic Gardens Sydney. Each quadrat was searched between 45 to 60 minutes for all vascular flora species present. Two ecologists conducted surveys at each quadrat sampled. The highest effort was spent examining the groundcover

vegetation, as this stratum supported the majority of species at most sites. Furthermore, effort was also made to search the canopy and trunks of trees for mistletoes, vines and epiphytes.

Information on the structural characteristics of the vegetation in each quadrat was also recorded, and included the height range, canopy cover of each stratum and the dominant species in each stratum. Any species observed outside the quadrat but within the vegetation community being sampled were recorded. Such species were noted as being present but were not assigned cover-abundance values. Flora species cover-abundance data were recorded on a proforma.

2.3.1 Plot/Transect Selection and Stratification of the Development Site

Designing an appropriate survey requires consideration of both survey methods and effort. Reference was made to the VIS Classification Database to identify Plant Community Types (PCTs), as well as reviews of other regional and local vegetation mapping and reporting (refer to **Section 3.2.1**) when designing the field survey. The Development Site PCTs were further stratified into Vegetation Zones (condition states) following the initial field survey of the site to determine the appropriate number of transect/plots required in accordance with the FBA methodology (OEH 2014) as outlined in **Table 2.1**. Broad condition states include vegetation in 'Moderate/Good' condition.

Table 2.1 Minimum Number of Plots/Transects Required per Zone Area (OEH 2014)

Vegetation Zone Area (ha)	Minimum Number of Plot/Transect
0-4	1 transect/plot per 2 ha (or part thereof) or 1 transect/plot if vegetation is in low condition
>4-20	3 transects/plots or 2 transects/plots if vegetation is in low condition
>20-50	4 transects/plots or 3 transects/plots if vegetation is in low condition
>50-100	5 transects/plots or 3 transects/plots if vegetation is in low condition
>100-250	6 transects/plots or 4 transects/plots if vegetation is in low condition
>250-1000	7 transects/plots or 5 transects/plots if vegetation is in low condition (More transects/plots may be needed if the condition of the vegetation is variable across the zone)
>1000	8 transects/plots or 5 transects/plots if vegetation is in low condition or in a homogenous landscape in the Western Division (More transects/plots may be needed if the condition of the vegetation is variable across the zone)

Table 2.2 below outlines the adequacy of the plot-based flora survey with respect to the BioBanking Methodology (OEH 2014) pertinent to the Development Site. All Vegetation Zones identified also occur outside the Development Site, but within the Modification Area and were sampled during the surveys undertaken for this assessment as the boundary of the Development Site was refined.

Table 2.2 Adequacy of Vegetation Survey in the Development Site

Vegetation Zone	BVT and Condition Class (does not include cleared areas)	Area in the Development Site (ha[1])	No. Plots and Transects Sampled (No. Required in parentheses)		
			Plot	Transect	Rapid Sampling
1	HN560_Moderate/Good	0.08^	1 (1)	1 (1)	1
2	HN566_Moderate/Good	6.76^	3 (3)	3 (3)	1
3	HN582_Moderate/Good	11.46^	3 (3)	3 (3)	4
4	HN586_Moderate/Good	1.20^	1 (1)	1 (1)	4
Total		**19.50**	**8 (8)**	**8 (8)**	**10***

[1] All areas are approximate areas despite being shown at two decimal places. Areas are approximate as vegetation type boundaries are based on a combination of field survey and desktop assessment. Additionally, precise boundaries between communities can be difficult or impossible to determine in the field due to the overlap of species in common occurring among vegetation types.

^ These vegetation zones also occur in the wider Modification Area and were sampled during the two field surveys undertaken for this assessment prior to the refinement of the Development Site. Consequently, all eight plots/transects were completed within the Modification Area but not exclusively within the Development Site.

* Three additional Rapid Sampling points were completed but occurred in cleared land and therefore is not identified in this table.

2.3.2 Plot/Transect Data Collected

At each plot/transect data was recorded according to Appendix 2 of the BioBanking Assessment Methodology (BBAM) and Credit Calculator Operational Manual (DECC 2014). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. The location of the 8 plots/transects undertaken within the Modification Area is shown on **Figure 2.1**.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

Species within the plot were also assigned a cover-abundance value to reflect their relative cover and abundance in the plot. Species located outside the plot (recorded to assist in vegetation community identifications and mapping) were marked as present but were not assigned a cover-abundance value. A modified Braun-Blanquet 6-point scale was used to estimate cover-abundances of all plant species within each quadrat (Braun-Blanquet 1927), with selected modifications sourced from Poore (1955) and Austin *et al*. (2000). **Table 2.3** shows the cover-abundance categories used. Voucher specimens were collected of species that could not be identified in the field for later identification. The following specimens were sent to NSW Royal Botanic Gardens and formally identified:

- crimson bottlebrush (*Callistemon citrinus*)

- *Darwinia biflora*
- *Darwinia fascicularis*
- *Grevillea parviflora* supbsp. *supplicans*
- *Hibbertia superans*
- peach blossom tea-tree (*Leptospermum squarrosum*) and
- *Tetratheca glandulosa*.

Table 2.3 Modified Bran-Blanquet Crown Cover-Abundance Scale

Class	Cover-abundance^	Notes
1	Few individuals (less than 5% cover)	Herbs, sedges and grasses: <5 individuals Shrubs and small trees: <5 individuals
2	Many individuals (less than 5% cover)	Herbs, sedges and grasses: 5 or more individuals Shrubs and small trees: 5 or more individuals Medium-large overhanging tree
3	5 – less than 20% cover	Applies to all species.
4	20 – less than 50% cover	
5	50 – less than 75% cover	
6	75 – 100% cover	

Note: at the time of survey, the updated BioBanking and FBA Methodology (OEH 2014) had not been released including the new requirements for abundance ratings and therefore the modified Braun-Blanquet 6-point scale was used for Cover-Abundance measures. Modified Braun-Blanquet scale (Poore 1955; Austin *et al*, 2000).

At each standard flora quadrat, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover, and
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other), and
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

2.4 Semi-quantitative Rapid Sampling

A total of 13 semi quantitative rapid assessments plots were completed in the Modification Area (consisting of 10 within the development site and three outside) to collect information about the vegetation. Assessment areas were not fixed area-based, but were generally confined to an area similar to that of a 10 x 10 metre quadrat. Rapid assessments were used to document the characteristics of vegetation over large areas.

Rapid vegetation assessment points were located within distinct vegetation community units (rather than within ecotones) to allow data collection for each community without confounding effects from adjacent communities. Dominant, common and some uncommon plant taxa were recorded within each rapid vegetation assessment points, along with cover abundance scores as per **Table 2.3**. The vegetation structure at each rapid vegetation assessment point was documented, including each stratum's height, percent foliage cover and dominant species. Rapid assessment plots were later transferred into a geographical information system (GIS) to aid vegetation community mapping and description. **Figure 2.1** shows the location of the 13 rapid assessment plots completed across the Modification Area.

2.5 Plant Identification and Nomenclature Standards

All vascular plants recorded or collected within plots and quadrats were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Jacobs *et al.* (2008). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2016), the online plants name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name. Where the identity of a specimen was unknown or uncertain, it was lodged with the National Herbarium of New South Wales at the Royal Botanic Gardens Sydney.

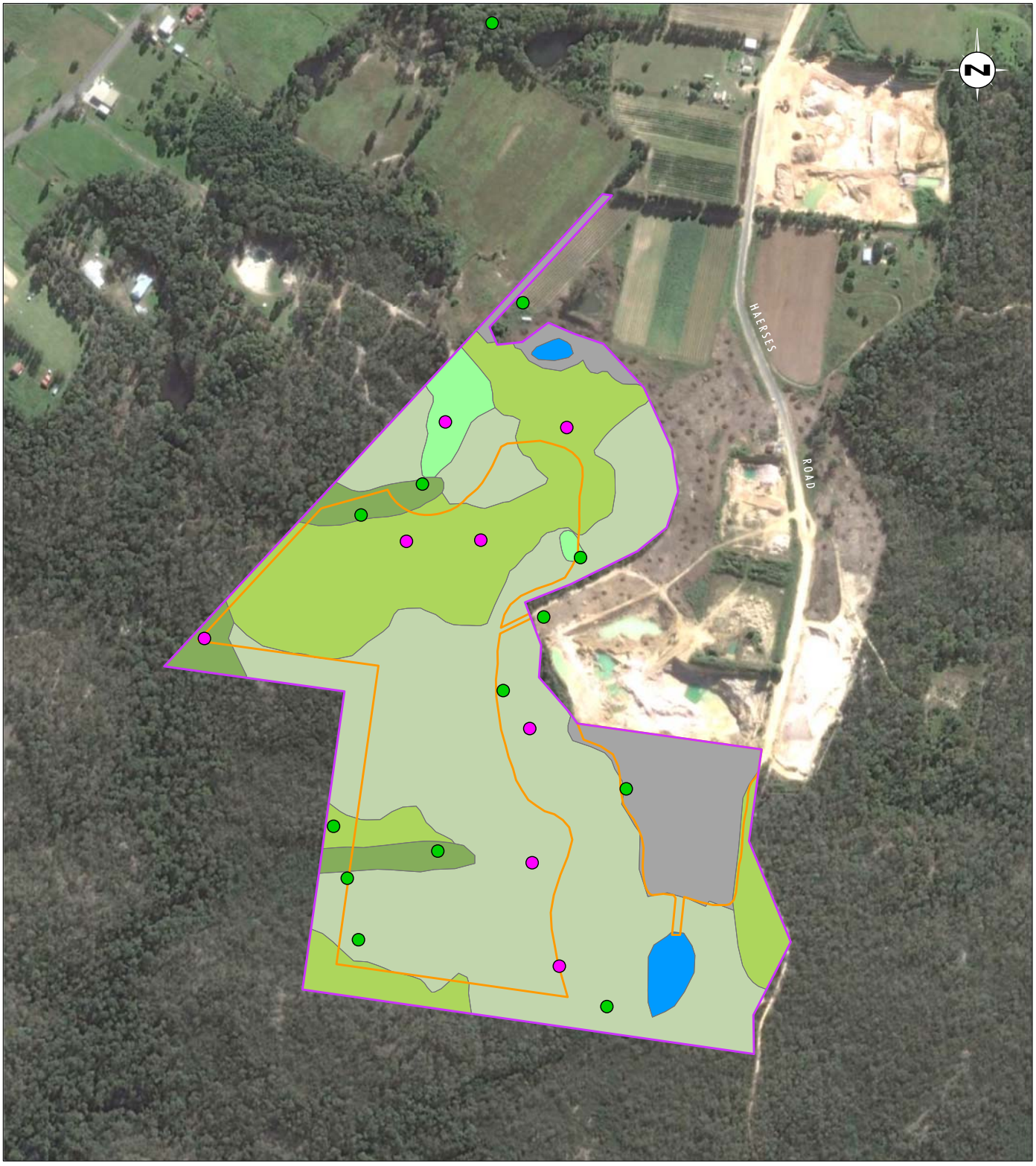

Image Source: Google Earth (2014)

0 100 200 400m
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Legend

- Development Site
- Modification Area
- Cleared
- Dam
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition
- Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition
- Flora Plot/Transects
- Semi-quantitative Rapid Sampling Plot

FIGURE 2.1

Flora Survey Locations

2.6 Targeted Threatened Ecological Community Investigations

Vegetation communities identified in the Modification Area were compared to TECs listed under the Commonwealth EPBC Act and NSW TSC Act and an assessment of similarity with the NSW Scientific Committee Final Determinations and the Commonwealth Threatened Species Scientific Committee Listing and Conservation Advice.

Six TECs were identified as potentially occurring in the Modification Area. The six listed communities are:

- Coastal Upland Swamps in the Sydney Basin Bioregion (EEC – TSC Act and EEEC – EPBC ACT)
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (EEC – EPBC Act)
- Shale/Sandstone Transition Forest (CEEC – TSC Act)
- Subtropical and Temperate Coastal Saltmarsh (VEC – EPBC Act)
- Turpentine-Ironbark Forest in the Sydney Basin Bioregion and (EEC – TSC Act and CEEC – EPBC Act)
- Western Sydney Dry Rainforest and Moist Woodland on Shale (CEEC – EPBC Act).

2.7 Targeted *Darwinia biflora* Survey

Given the potential for large numbers of *Darwinia biflora* present in the Modification Area, it was impractical to count and mark each individual plant. Instead, the numbers of *D. biflora* were counted within standard 10 x 10 metre or 20 x 20 metre plots (depending on density) during the initial survey in November 2014. This species was recorded in the Sandstone Heath (Heath/Woodland Complex) and Sandstone Ridgetop Woodland.

Further targeted survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot.

Due to the sporadic nature in which the species occurs in the Modification Area, the impacts to *D. biflora* were assessed by area of habitat rather than the number of individuals. Typically, impacts to flora species should be assessed based on the number of individuals as indicated in Section 10.4.4.2 of the FBA methodology (OEH, 2014). However in the case of sporadically occurring plant species like *D. biflora* it is permitted to assessed the impacts by area of habitat. The NSW Guide to Surveying Threatened Plants (OEH, 2016b) states that impacts to a threatened species can be assessed as area of habitat as long as the surveyor considers the history of land use and/or disturbance and previous surveys of the species at the site. This approach was discussed with OEH during the course of the project. The survey effort undertaken by Umwelt in the Modification Area identified that the population of *D. biflora* could not be accurately measured due to the sporadic nature in which it occurs.

2.8 Flora Survey Timing and Effort

The vegetation of the Modification Area was surveyed in two events. The first was during spring, from 25 to 27 November, 2014 and the second was in summer, from 14 to 17 December, 2015. All surveys were completed by two Ecologists. A total of 14 person-days, six initially and eight later, were completed to sample the vegetation communities and flora species within the Modification Area.

The following survey effort was completed across the Modification Area (refer to **Figure 2.1**):

- Eight 400 m^2 flora plots and
- Thirteen semi-qualitative rapid assessment plots.

2.9 Fauna Survey Timing and Effort

Fauna surveys across the Modification Area were undertaken from 25 to 27 November 2014 as well as on 16 December 2015. Fauna survey effort was designed in consideration of the following survey guidelines:

- Department of Environment, Water, Heritage and the Arts (DEWHA) (2010a). Survey Guidelines for Australia's Threatened Birds
- DEWHA (2010b). Survey Guidelines for Australia's Threatened Frogs
- DEWHA (2011a). Survey Guidelines for Australia's Threatened Reptiles and
- DEWHA (2011b). Survey Guidelines for Australia's Threatened Mammals.

2.10 Trapping and Remote Surveys

Terrestrial Hair Funnels

Terrestrial Faunatech hair funnels were baited with a rolled oats and peanut butter mixture. All terrestrial hair funnels were positioned amongst habitat features such as logs, fallen bark, rocks and ground cover. Three lines of 20 hair funnels were left in position from 25 November 2014 to 23 December 2014 (refer to **Figure 2.2**). All hair samples collected were identified by Barbara Triggs (a recognised expert in the field of hair and scat identification).

Remote Cameras

During November and December 2014, remote camera surveys were conducted to target terrestrial mammal species at 10 locations across the Modification Area. At each site, a Bushnell Trophy Cam HD remote camera was mounted approximately 1 metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey. Cameras were set to take three photos in quick succession when movement was detected. Remote cameras were set at each site for 28 days resulting in a total of 280 camera day/nights of survey. The locations of the remote cameras are displayed on **Figure 2.2**.

Micro-bat Echolocation Recordings

Echolocation calls emitted by micro-bats were detected using an Anabat II Bat Detector. Echolocation calls were recorded using an Anabat CF storage ZCAIM or an Anabat SD2 unit. The combination of detector and recording device is hereafter collectively referred to as the 'Anabat echolocation recorder'. The Anabat echolocation recorders were positioned at an approximate 30 degree angle and 1 metre above the ground

in waterproof housing. While micro-bat activity is likely to be reduced during rain, calls were still able to be collected during dry parts of the night (particularly nights with brief thunderstorms).

Anabat echolocation recorders were positioned within the vicinity of potential micro-bat flyways. The recorders were automated and programmed to start recording one hour before dusk and to stop recording one hour after sunrise the following morning. Recordings were collected over two to four nights at each Anabat echolocation recording location.

All micro-bat species were identified by Anna McConville of Echo Ecology Pty Limited (a recognised expert in the identification of micro-bat calls). The location of Anabat surveys are shown on **Figure 2.2**. Micro-bat echolocation recordings were undertaken at three locations.

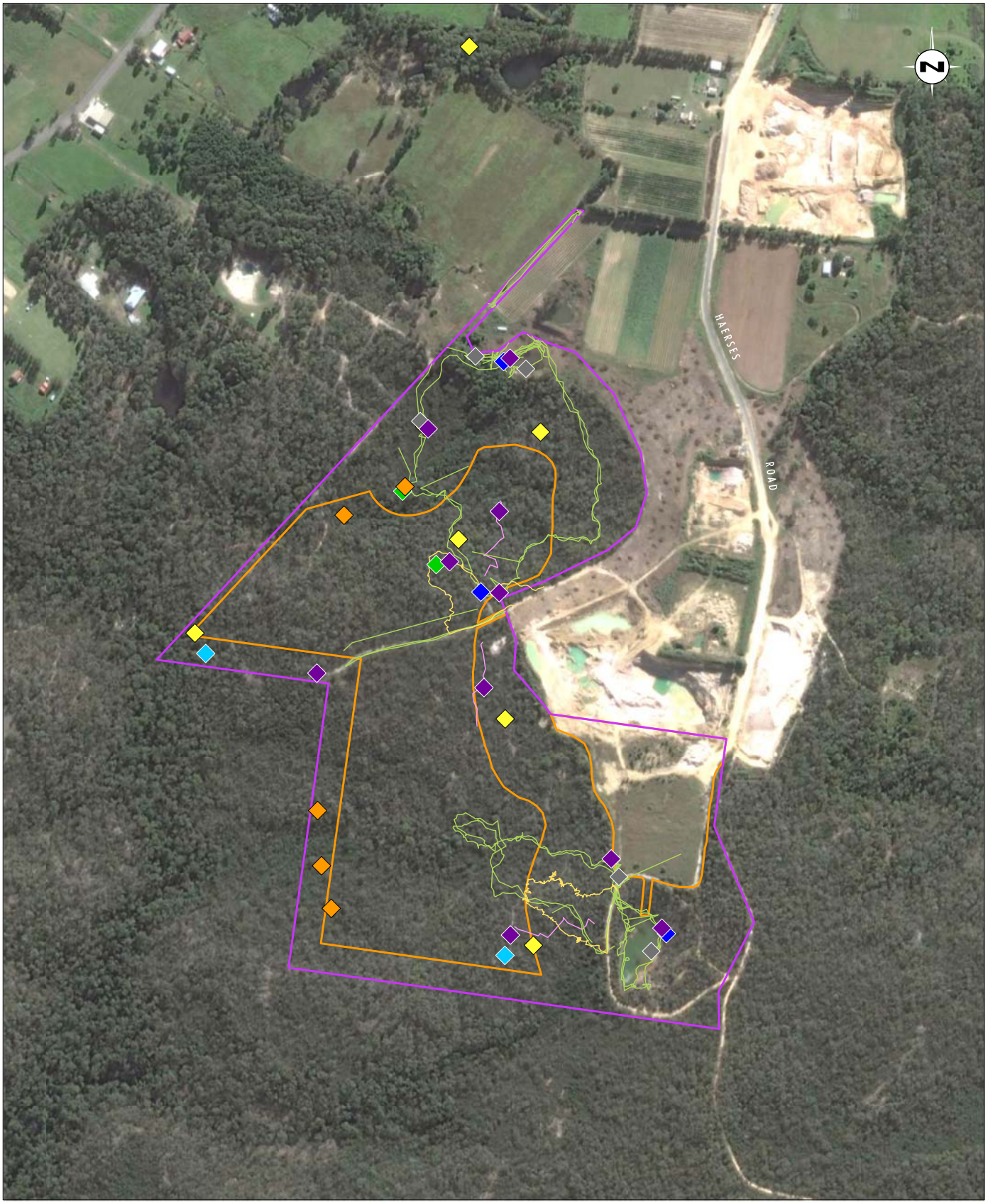

Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Development Site
- Modification Area
- Dural woodland snail search
- Spotlighting Search
- Terrestrial Hair Funnel Line
- Anabat
- Bird Search
- Habitat Assessments and SAT Test
- Nocturnal Call Playback
- Remote Camera
- Reptile Search
- SAT Test

FIGURE 2.2

Fauna Survey Locations

File Name (A4): R04/3479_031.dgn
20160920 11.14

2.11 Area-based Searches

Spotlighting Searches

Spotlighting searches were undertaken both on foot and from a moving vehicle (refer to **Figure 2.2**). Walking spotlighting searches were undertaken by two observers for a period of one hour (total of two person hours) on each occasion. Vehicle spotlighting searches were undertaken by the passenger(s) from a slow moving vehicle along vehicle tracks between trapping sites. Both walking and vehicle spotlighting searches were conducted using 30 watt Lightforce spotlights.

Reptile and Amphibian Searches

Diurnal searches targeting the Broad-headed snake, *Hoplocephalus bungaroides*, and Rosenberg's goanna, *Varanus rosenbergi*, were undertaken during the warmest parts of the day. Diurnal searches were undertaken by a single person for half an hour on two separate days (refer to **Figure 2.2**). Nocturnal searches targeted the red-crowned toadlet, *Pseudophryne australis*, and giant burrowing frog, *Heleioporus australiacus*. Nocturnal reptile and amphibian searches were undertaken by two people for one hour on two occasions using Petzl headlamps and/or 30 watt Lightforce spotlights. Diurnal and nocturnal searches were undertaken by two ecologists for a period of at least 30 minutes during each search.

Habitat features investigated during reptile and amphibian searches included water bodies, emergent vegetation, wet soak areas, logs, rocks, loose bark on tree trunks, exposed bedrock, leaf litter, and open grassland areas. Amphibians not identifiable from their calls were captured for visual identification. All amphibians were handled according to the hygiene protocol for the control of disease in frogs (Wellington and Haering 2001). Non-venomous snake species and small lizards were captured for identification where necessary.

Bird Searches

Bird searches were undertaken at the trap and hair funnel sites (refer to **Figure 2.2**) at various times of the day, primarily during early to mid morning and mid to late afternoon. Bird searches were undertaken for one person hour (by one or two observers) at two locations. Opportunistic observations were recorded during all other aspects of the field surveys, particularly while checking traps and when travelling between survey sites. Bird species were identified by characteristic calls and by observation using 10 x 24 binoculars.

Dural Woodland Snail Searches

Targeted spotlighting searches for the Dural woodland snail (*Pommerhelix duralensis*) were completed on 16 December 2016 by two observers. These searches were completed on foot at two separate locations within the Development Area (refer to **Figure 2.2**) for a period of 40 and 70 minutes (total of 1.3 and 2.3 person hours). Walking spotlighting searches were conducted using Petzl headlamps and/or 30 watt Lightforce spotlights. Photographs and specimen measurements of the recorded Dural woodland snail were sent to the Australian Museum for identification.

Signs of Presence Searches

Searches for indirect evidence of animal presence were conducted opportunistically during all survey activities, particularly during habitat searches and reptile and amphibian searches. Due to the opportunistic nature of signs of presence surveys, the level of survey effort was not recorded. Evidence of presence included scats, feathers, nests, burrows, bones, tufts of hair and scratch marks on trees. All hair, scat and bone samples were identified by Barbara Triggs.

Habitat Assessments

Seven habitat assessments were undertaken across the range of habitat types present in the Modification Area (refer to **Figure 2.2)**. The assessment targeted potential habitat and resources for fauna species, particularly threatened fauna species. Records of a number of habitat features were made at each site, including:

- Evidence of disturbance such as fire, weeds, feral animals, dumping, erosion and logging
- Presence of stumps and stags
- Presence of fallen timber/logs
- Presence of dieback and/or insect attack
- Mistletoe presence
- Presence of perch sites, fallen and loose bark
- Vegetation strata and composition
- Tree size class (trunk diameter), and age (old growth, mature, regenerating, saplings)
- Presence of other specific feed tree species (such as for cockatoos and honeyeaters) and
- Collection of detailed hollow data, including tree species and height, hollow size, orientation, position, and height of hollow).

Habitat features such as tree hollows and fallen logs were inspected for any evidence of fauna occupation such as scratches on the trunks of trees, chewed entrances to hollows, scratching or diggings near logs and scats at the base of trees or near logs.

Nocturnal Call Playback

Nocturnal call playback sessions were undertaken at five sites within the first 4 hours after dusk. Calls were broadcast using a 10 watt directional loud hailer. Call playback sessions commenced and ended with a quiet listening period of approximately two minutes. Each species' call was played for a minimum of four minutes followed by a listening period of two minutes before the beginning of the next species' call. Mammal calls were played before bird calls to prevent the calls of predators (such as owls) decreasing the likelihood of prey species (such as gliders) responding to call playback. Call playback sessions included the calls of the following species:

- Giant burrowing frog (*Heleioporus australiacus*)
- Red-crowned toadlet (*Pseudophryne australis*)
- Squirrel glider (*Petaurus norfolcensis*)
- Koala (*Phascolarctos cinereus*)
- Masked owl (*Tyto novaehollandiae*)
- Sooty owl (*Tyto tenebricosa*)

- Barking owl (*Ninox connivens*) and
- Powerful owl (*Ninox strenua*).

Fauna Survey Effort Summary

Table 2.4 summarises the trapping and remote camera survey effort undertaken across the Modification Area during spring 2014.

Table 2.4 Summary of Fauna Trapping and Remote Survey Effort

Trapping Method	Number of trap nights – Spring 2014
Terrestrial hair funnel	1680
Anabat echolocation (entire nights)	6
Remote cameras	280

Note: One trap night equals one trap/camera/detector set for one night.

Table 2.5 summarises the area search effort undertaken across the Modification Area during spring 2014.

Table 2.5 Summary of Fauna Area Search Effort

Survey Method	Spring 2014	Summer 2015
Bird surveys (person hours)	2	-
Koala SAT survey points	12	-
Diurnal reptile and amphibian surveys (person hours)	1	-
Nocturnal reptile and amphibian surveys (person hours)	4	-
Walking spotlight	4	-
Dural woodland snail spotlight (person hours)	-	7.2
Driving spotlight	Undertaken opportunistically, kilometres not recorded	-
Nocturnal call playback	5	-

2.12 Threatened Species

2.12.1 Species-credit Flora Surveys

Species-credit flora surveys were undertaken over 7 days and 2 survey periods:

- 25 to 27 November 2014
- 14 to 17 December 2015.

The November 2014 field survey was undertaken at a time which was suitable for detection of most targeted species. An additional targeted species survey was undertaken in December 2015 to focus primarily on threatened flora species as the earlier survey was combined with fauna survey efforts. It should be noted that all threatened flora species are species-credit species under the BioBanking Assessment Methodology (OEH 2014).

A preliminary list of species-credit flora species with potential to occur in the Development Site was generated during the literature review, completion of database searches and preliminary assessment using the BioBanking Credit Calculator. The preliminary list of potentially occurring species credit species was reviewed to remove species that are not known to occur in the local area or species for which there was a lack of suitable habitat in the Development Site. **Table 2.6** identifies the species-credit flora species that were identified through the BioBanking Credit Calculator, we have amended the table to identify those species that have potential to occur in the Development Site and required targeted and seasonal surveys, as well as those that do not.

Table 2.6 Species-credit Flora Species Requiring Targeted Survey

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Potential to Occur					
Acacia gordonii	*Acacia gordonii*	E	E	All Year	BBCC
Ancistrachne maidenii	*Ancistrachne maidenii*	V	-	December – February	BBCC
Asterolasia elegans	*Asterolasia elegans*	E	E	All Year	BBCC
brown Pomaderris	*Pomaderris brunnea*	E	V	All Year	BBCC
Bynoes wattle	*Acacia bynoeana*	E	V	September – March	BBCC
clandulla geebung	P*ersoonia marginata*	V	V	All Year	BBCC
Darwinia biflora	*Darwinia biflora*	V	V	September – February	BBCC

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Darwinia fascicularis subsp. *oligantha* population, Baulkham Hills and Hornsby Local Government Areas	*Darwinia fascicularis* subsp. *oligantha* - endangered population	EP	-	All year	BBCC
Darwinia peduncularis	*Darwinia peduncularis*	V	-	All Year	BBCC
Grevillea parviflora subsp. *supplicans*	*Grevillea parviflora* subsp. *supplicans*	E	-	All year	BBCC
hairy geebung	*Persoonia hirsuta*	E	E	December – May	BBCC
Hibbertia superans	*Hibbertia superans*	E	-	July – December	BBCC
Kunzea rupestris	*Kunzea rupestris*	V	V	All Year	BBCC
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E	-	All Year	BBCC
Micromyrtus blakelyi	*Micromyrtus blakelyi*	V	V	All Year	BBCC
Olearia cordata	*Olearia cordata*	V	V	All Year	BBCC
Pimelea curviflora subsp. *curviflora*	*Pimelea curviflora* subsp. *curviflora*	V	V	All Year	BBCC
spreading guinea flower	*Hibbertia procumbens*	E	-	December - March	BBCC
Tetratheca glandulosa	*Tetratheca glandulosa*	V	-	July – November	BBCC
Zieria involucrata	*Zieria involucrata*	E	-	All Year	BBCC

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Unlikely to Occur					
downy wattle	*Acacia pubescens*	V	V	All Year	BBCC
Epacris purpurascens subsp. *purpurascens*	*Epacris purpurascens* subsp. *purpurascens*	V	-	All Year	BBCC
Eucalyptus sp. Cattai	*Eucalyptus* sp. Cattai	CE	-	All Year	BBCC
groves paperbark	*Melaleuca groveana*	V	-	All Year	BBCC
Gyrostemon thesioides	*Gyrostemon thesioides*	E	-	All Year	BBCC
Hibbertia puberula	*Hibbertia puberula*	E	-	September – February	BBCC
Leptospermum deanei	*Leptospermum deanei*	V	V	All Year	BBCC
netted bottle brush	*Callistemon linearifolius*	V	-	September – March	BBCC
Pultenaea parviflora	*Pultenaea parviflora*	E	V	All Year	BBCC
singleton mint bush	*Prostanthera cineolifera*	V	V	All Year	BBCC
Velleia perfoliata	*Velleia perfoliata*	V	V	September - November	BBCC

^ Months that surveys are required according to the Threatened Species Profile Database for the Hawkesbury Nepean CMA.

Throughout flora surveys of the Development Site, targeted searches were carried out for threatened flora species that are known to occur in the vicinity of the Development Site or were considered likely to occur based on the species' known distribution and the presence of suitable habitat. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot and transect surveys.

Further survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot. The methodology is described in full for the targeted *Darwinia biflora* survey above in **Section 2.7.**

The seasonal requirements of all species-credit flora species with potential to occur within the Development Site were met between the combination of the November 2014 and December 2015 survey periods.

2.12.2 Species-credit Fauna Surveys

Species-credit fauna surveys were undertaken over **6** days and **two** survey periods:

- 25 to 27 November 2014
- 14 to 17 December 2015.

A preliminary list of species-credit fauna species with potential to occur in the Development Site was generated during the literature review, completion of database searches and preliminary assessment using the BioBanking Credit Calculator (BBCC). The preliminary list of potentially occurring species-credit fauna species was reviewed to remove species that are not known to occur in the local area or species for which there was a lack of suitable habitat in the Development Site. **Table 2.7** identifies the species-credit fauna species that were identified through the BioBanking Credit Calculator. The table has been amended to identify those species that have potential to occur in the Development Site and required targeted and seasonal surveys, as well as those that do not.

Table 2.7 Species-credit Fauna Species Requiring Targeted Survey

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Potential to Occur					
brush-tailed phascogale	*Phascogale tapoatafa*	V	-	All Year	
eastern pygmy-possum	*Cercartetus nanus*	V	-	Not specified	BBCC

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	EP	-	All Year	BBCC
giant burrowing frog	*Heleioporus australiacus*	V	V	September - May	BBCC
koala	*Phascolarctos cinereus*	V	V	All Year	BBCC
red-crowned toadlet	*Pseudophryne australis*	V	-	All Year	BBCC
regent honeyeater	*Anthochaera phrygia*	CE	CE	All Year	BBCC
Rosenbergs goanna	*Varanus rosenbergi*	V	-	November – February	BBCC
squirrel glider	*Petaurus norfolcensis*	V	-	All Year	BBCC
Unlikely to Occur					
giant barred frog	*Mixophyes iteratus*	E	E	October – April	BBCC

^ Months that surveys are required according to the Threatened Species Profile Database for the Hawkesbury Nepean CMA.

Targeted surveys were undertaken for the species listed in **Table 2.7** that included a range of survey techniques including targeted searches, hair funnel trapping, call playback, anabat echolocation, spotlighting and remote detection camera surveys. Throughout surveys of the Development Site, opportunistic surveys for these species were undertaken in suitable habitat along numerous walking meandering transects. The seasonal requirements of all species-credit fauna species with potential to occur within the Development Site were met between the combination of the November 2014 and December 2015 survey periods. The details of these surveys are discussed in the sections below and specific survey locations are shown on **Figure 2.2.**

2.12.2.1 Regent Honeyeater Surveys

Diurnal bird surveys, each of one person-hour, were undertaken in two locations within the Development Site in November 2014. Bird surveys were undertaken at various times of the day, primarily in early to mid morning and mid to late afternoon. Each survey consisted of a slow walking transect within a Development Site. The bird surveys targeted areas of flowering eucalypt woodlands containing other nectarivorous species such as lorikeets and honeyeaters.

Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10 x. Opportunistic observations were recorded during all other aspects of the field survey.

2.12.2.2 Eastern Pygmy Possum and Squirrel Glider Surveys

Eastern pygmy possum and squirrel glider were targeted by conducting spotlighting and remote camera surveys. Additionally, nocturnal call playback surveys were undertaken for squirrel glider.

Nocturnal spotlighting surveys, each of two person-hours repeated over two nights, were undertaken in three locations within the Development Site. Spotlighting was conducted on foot using 30 watt Lightforce hand-held spotlights and head torches. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk. In addition, spotlighting was undertaken from a slow-moving vehicle along vehicle tracks and while travelling between trapping locations at night.

Bushnell Trophy Cam HDs (remote cameras) were mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey to increase the likelihood of detecting the eastern pygmy possum. The cameras were set to take three photos in quick succession when movement was detected. The remote cameras were programmed to record movement on an ongoing basis until removed from the site. The cameras were installed for 28 nights in 10 locations, totalling 280 nights of remote camera survey.

Nocturnal call-playback sessions targeting squirrel glider were undertaken at four locations within the Development Site. An additional location was surveyed immediately north of the Development Site for context. Call-playback sessions commenced with a quiet listening period of approximately five minutes. The squirrel glider call was played on a 15 watt directional loud hailer for a minimum of 4 minutes followed by a listening period of 2 minutes.

2.12.2.3 Koala Surveys

Koalas were targeted by conducting nocturnal call playback and walking and driving spotlighting surveys.

Nocturnal spotlighting surveys, each of one person-hour repeated over two nights, were undertaken in three locations within the Modification Area. Walking spotlighting searches were conducted by two observers for a period of one hour (total of two person hours) on each occasion. Vehicle spotlighting searches were undertaken by the passenger(s) from a slow moving vehicle along vehicle tracks between trapping sites. Both walking and vehicle spotlighting searches used a 30 watt Lightforce hand-held spotlight and head torch for detecting fauna. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk.

Nocturnal call-playback sessions targeting koala were undertaken at four locations within the Development Site. An additional location was surveyed immediately north of the Development Site for context. Call-playback sessions commenced with a quiet listening period of approximately five minutes. The koala call was played on a 15 watt directional loud hailer for a minimum of 4 minutes followed by a listening period of 2 minutes.

Searches for signs of the presence of koalas were undertaken at 12 locations across the Modification Area in using the Spot Assessment Technique (SAT). Searches were conducted on and around the base of 10 – 30 trees at every survey site. The searches focussed on signs of presence including scats at the base of trees and characteristic scratches on tree trunks.

2.12.2.4 Amphibian Surveys

The BioBanking Calculator predicted the occurrence of red-crowned toadlet (*Pseudophryne australis*) and giant burrowing frog (*Heleioporus australiacus*) due to the geographic habitat feature of land within 100 metres of a waterbody and land within 40 metres of woodland within the Hawkesbury/Nepean catchment area, respectively. Despite these habitat features being present at the site in the form of woodland and two dams, no permanent streams with substantial fringing vegetation occur in the Development Site.

Despite this, diurnal herpetological searches were undertaken in 2 locations across the Development Site. During the search likely micro-habitats were examined including around waterbodies, beneath rocks and logs, in tree bark and in ground litter. Each survey consisted of approximately one person hour of survey, totalling 1 hour of diurnal herpetological surveys.

Nocturnal spotlighting surveys, each of two person-hours repeated over two nights, were also undertaken in three locations within the Modification Area. Spotlighting was conducted on foot using 30 watt Lightforce hand-held spotlights and head torch. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk and targeted relevant habitat features such as water bodies, emergent vegetation, wet soak areas and riparian zones.

2.12.2.5 Micro-bat Habitat Surveys

The presence of threatened micro-bat species was also surveyed using Anabat SD1 recorders at two locations within the Development Site. At each site, the Anabat was positioned at an approximate 30 degree angle one metre above the ground in waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over waterbodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Anna McConville of Echo Ecology Pty Limited (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three levels of confidence:

- confident
- probable, and
- possible.

3.0 Results – Development Site

3.1 Landscape Value

3.1.1 Landscape Features

The outer assessment circle contains some prominent landscape features including sections of 4th order streams, Stone Chimney Arm Creek and Little Cattai Creek. The outer assessment circle also covers multiple Mitchell landscapes and an extensive area of native vegetation predominantly in the east, south and west of the circle. These landscape features are shown in **Figures 1.3** and **1.4**.

Landscape features that were considered in the connectivity value scores for the Development Site are outlined in **Table 3.1** below.

Table 3.1 Landscape Features in the Development Site

Landscape Features	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Yengo – Hawkesbury/Nepean
Mitchell Landscape	Hornsby Plateau
Rivers, Streams, Estuaries	1st order streams from Stone Chimney Arm Creek
Wetlands	None identified
Native Vegetation	82.19 hectares in the inner assessment circle 745.59 hectares in the outer assessment circle
State or Regional Biodiversity Links	None identified

3.1.2 Landscape Value Scores

3.1.2.1 Percent Native Vegetation Cover

Table 3.2 details the percent native vegetation cover before and after the proposed disturbance in the Development Site and the native vegetation per cent class entered into the BioBanking Calculator as per Table 9 of Appendix 4 of the FBA (OEH 2014).

Table 3.2 Native Vegetation Cover in Assessment Circles

Assessment Circle	Before Development			After Development		
	Area of Native Vegetation (ha)	Native Vegetation Cover (%)	Native Vegetation Percent Class	Area of Native Vegetation (ha)	Native Vegetation Cover (%)	Native Vegetation Percent Class
Outer (1,000 ha)	745.59	74.6	71-75	725.65	72.6	71-75
Inner (100 ha)	82.19	82.2	81-85	62.69	62.7	61-65

3.1.2.2 Connectivity Value

No state or regional significant biodiversity links were identified within a plan approved by the Chief Executive of OEH in the Yengo – Hawkesbury/Nepean. Although a number of first order streams of tributaries of Stone Chimney Arm Creek run through the Development Site, these are not defined as state or regional significant biodiversity links under the FBA (OEH 2014) (refer to **Figure 3.1**).

Connecting links using moderate to good condition native vegetation were found on the site to occur in all woodland communities in the Development Site. The entire Development Site comprises remnant native vegetation and thus the current narrowest point of these links is estimated to be approximately greater than 500 metres wide (refer to **Figure 3.1**). After the development of the Modification Project, this link would remain, not in the Development Site but surrounding it. Therefore it is considered that the connectivity width class after the development of the Modification Project would be greater than 500 metres wide (refer to **Table 3.3**).

Woody PCTs within the outer assessment circle were assumed to be in good condition for overstorey foliage cover and midstorey foliage cover. This assumption was based on the location of the Development Site, abundance of adjacent remnant vegetation and quality of the vegetation within the Development Site. The overstorey per cent foliage cover in the woody vegetation in the outer assessment circle was assumed, on the whole, to be within benchmark. The midstorey per cent foliage cover in the woody vegetation in the outer assessment circle was assumed, on the whole, to be within benchmark. These are likely to remain the same after the Modification Project.

Details of the connectivity value scores entered into the BioBanking Credit Calculator are shown in **Table 3.3** below.

Table 3.3 Connectivity Value Scores

Attribute	Before Development	After Development
Connectivity Width Class	>500m	>500m
Connectivity Overstorey Condition	PFC at benchmark	PFC at benchmark
Connectivity Midstorey Condition	PFC at benchmark	PFC at benchmark

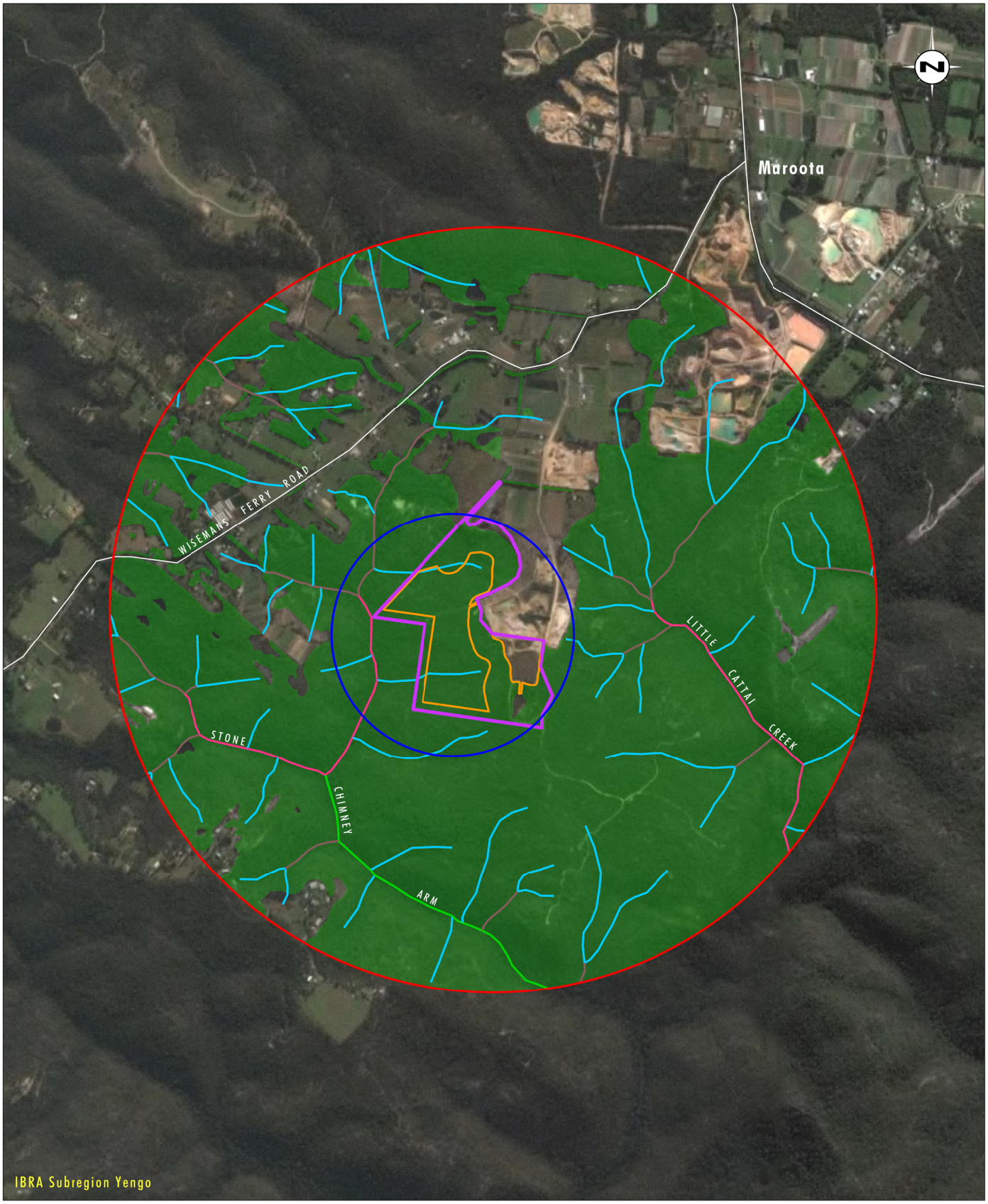

Image Source: Google Earth (2014)
Data Source: LPI (2011)

0 0.5 1.0 1.25km
1:25 000

Legend

- Development Site
- Modification Area
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle
- Native Vegetation
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

FIGURE 3.1

Connectivity Value

File Name (A4): R04/3479_032.dgn
20160920 11.15

3.1.2.3 Patch Size

Table 3.4 below details the parameters that determined the Patch Size score as per Table 15 of Appendix 4 of the FBA (OEH 2014).

Table 3.4 Patch Size Score Parameters

Mitchell Landscape	Hornsby Plateau
Percent Native Vegetation Cleared	14%
Patch Size Class	1001 hectares
Patch Size Score	**12**

3.1.2.4 Landscape Value Score

The landscape value score for the Development Site is 13.20.

3.2 Native Vegetation within the Development Site

3.2.1 Biometric Vegetation Types and Vegetation Zones

Surveys of the Development Site identified four Biometric Vegetation Types (BVTs) (excluding exotic pastures) being:

- HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion
- HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
- HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion and
- HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion.

These BVTs were aligned with types described as part of the NSW Biometric vegetation types database (OEH 2014b), the Sydney Basin Vegetation Inventory (Tozer *et al.* 2010) and the Baulkham Hills Vegetation Mapping. The BVTs were then categorised into four vegetation condition zones (refer to **Figure 3.2**). The composition of these vegetation zones are outlined in **Tables 3.5** to **3.8** below.

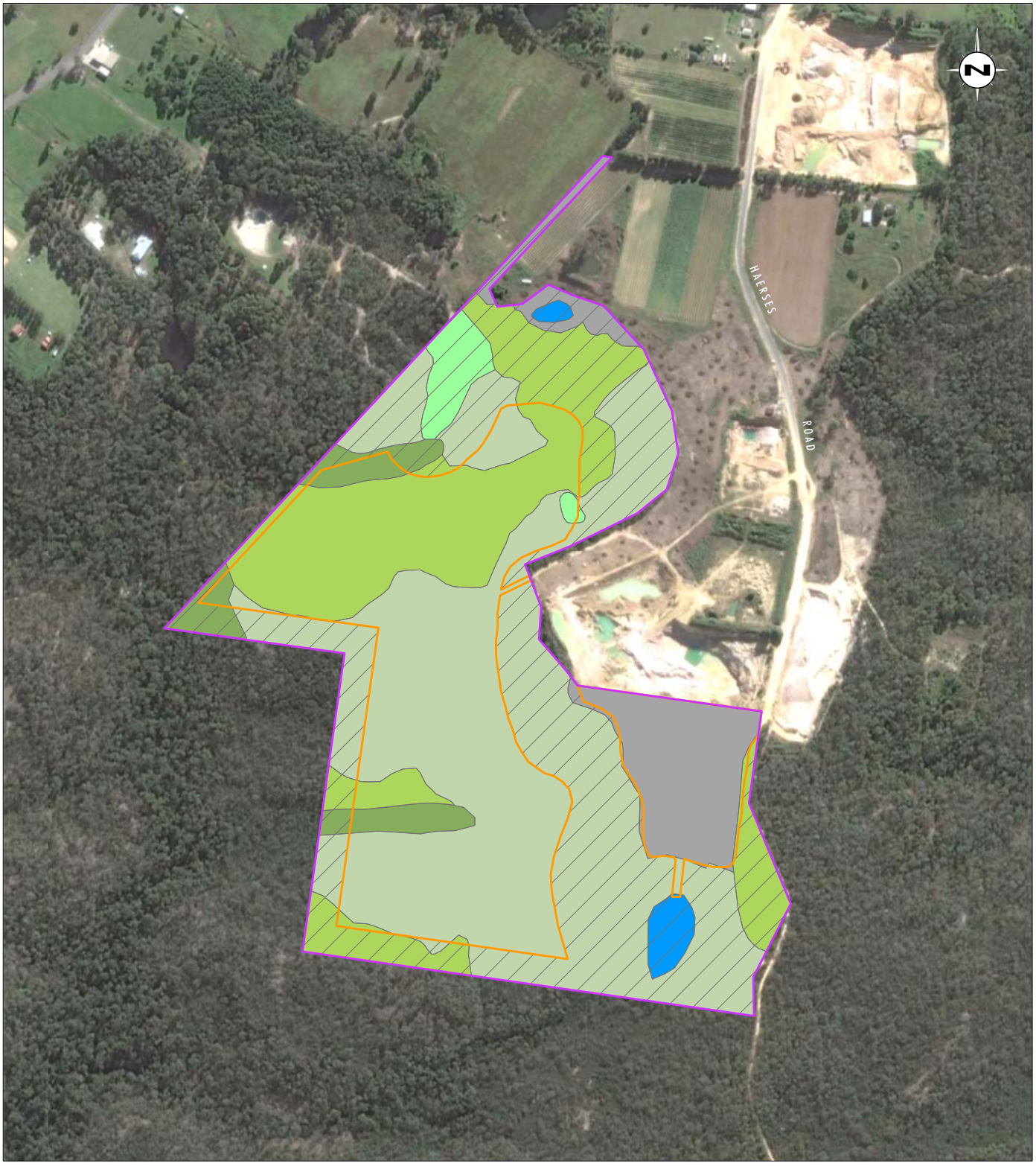

Image Source: Google Earth (2014)

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1:7500

Legend

- Development Site
- Area Mapped Outside The Development Site
- Modification Area
- Cleared
- Dam
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition
- Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition

FIGURE 3.2

Vegetation Zones in the Development Site

Table 3.5 Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN560
PCT ID	978
Vegetation Formation	Freshwater Wetlands
Vegetation Class	Coastal Heath Swamps
Hectares in Modification Area	1.03
Hectares in Development Site	0.08
Tozer *et al.* (2010) Equivalent	FrW p129: Coastal Upland Swamp
AES Environmental Consultancy (2001) Equivalent	N/A
Plots/Transects Undertaken	One (P04)
Floristic Description	This vegetation zone occurs at two locations where ground water seeps to the surface. This vegetation zone is characterised by a mid-dense shrub layer dominated by dwarf apple (*Angophora hispida*), prickly tea-tree (*Leptospermum juniperinum*), heath-leaved banksia (*Banksia ericifolia*), fern-leaved banksia (*Banksia oblongifolia*), *Leucopogon esquamatus*, crimson bottlebrush (*Callistemon citrinus*) and heath myrtle (*Baeckea imbricata*). The dense ground layer is dominated by zig-zag bog rush (*Schoenus brevifolius*), *Ptilothrix deusta*, *Leptocarpus tenax*, spreading rope-rush (*Empodisma minus*), *Drosera spatulata* and pouched coral fern (*Gleichenia dicarpa*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	*Coastal Upland Swamp in the Sydney Basin Bioregion EEC*
EPBC Status	*Coastal Upland Swamps in the Sydney Basin Bioregion EEC*

Feature	Description
Photo	

Table 3.6 Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN566
PCT ID	1083
Vegetation Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
Hectares in Modification Area	11.46
Hectares in Development Site	6.67
Tozer *et al.* (2010) Equivalent	DSF p131 Coastal Sandstone Ridgetop Woodland
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Ridgetop Woodland
Plots/Transects Undertaken	Three (SR1, P01 and P06)

Feature	Description
Floristic Description	This vegetation zone supports a sparse canopy dominated by yellow bloodwood (*Corymbia* eximia), red bloodwood (*Corymbia gummifera*), narrow-leaved stringybark (*Eucalyptus sparsifolia*) and grey gum (*Eucalyptus punctata*). A dense shrub layer is present and comprises flakey-barked tea-tree (*Leptospermum trinervium*), mountain devil (*Lambertia formosa*), needlebush (*Hakea sericea*), heath-leaved banksia (*Banksia ericifolia*), *Darwinia biflora* and conesticks (*Petrophile pulchella*). The ground layer generally comprises lesser flannel flower (*Actinotus minor*), wiry panic (*Entolasia stricta*), *Lepyrodia scariosa*, *Austrostipa pubescens* and oat speargrass (*Anisopogon avenaceus*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.
Photo	

Table 3.7 Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN582
PCT ID	1134
Vegetation Formation	Heathlands
Vegetation Class	Sydney Coastal Heaths
Hectares in Modification Area	24.49
Hectares in Development Site	11.14

Feature	Description
Tozer *et al.* (2010) Equivalent	Coastal Sandstone Plateau Heath
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Heath
Plots/Transects Undertaken	Three (SH1, P02 and P03)
Floristic Description	This vegetation zone is dominated by a dense cover of shrubs, with emergent eucalyptus scattered throughout and forming an open woodland community in some areas. Emergent eucalypts include scribbly gum (*Eucalyptus haemastoma*), red bloodwood (*Corymbia gummifera*) and scaly bark (*Eucalyptus squamosa*). Common shrubs include flakey-barked tea-tree (*Leptospermum trinervium*), dwarf apple (*Angophora hispida*), heath-leaved banksia (*Banksia ericifolia*), mountain devil (*Lambertia formosa*), *Darwinia biflora*, grey spider flower (*Grevillea buxifolia*) and conesticks (*Petrophile pulchella*). The ground layer generally comprises grasstree (*Xanthorrhoea* sp.), lesser flannel flower (*Actinotus minor*), heath bog-rush (*Schoenus ericetorum*), wiry panic (*Entolasia stricta*) and *Ptilothrix deusta*. Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.
Photo	

Table 3.8 Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN586
PCT ID	1181
Vegetation Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
Hectares in Modification Area	1.91
Hectares in Development Site	0.99
Tozer *et al.* (2010) Equivalent	DSF p142 Coastal Sandstone Gully Forest
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Gully Forest
Plots/Transects Undertaken	One (P05)
Floristic Description	This vegetation zone supports a sparse to mid-dense canopy dominated by smooth-barked apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), grey gum (*Eucalyptus punctata*), yellow bloodwood (*Corymbia eximia*), and old-man banksia (*Banksia serrata*), with occurrences of red bloodwood (*Corymbia gummifera*), turpentine (*Syncarpia glomulifera* subsp. *glomulifera*) and red mahogany (*Eucalyptus resinifera* subsp. *resinifera*). A mid-dense shrub layer is present and comprises flakey-barked tea tree (*Leptospermum trinervium*), white wattle (*Acacia linifolia*), tantoon (*Leptospermum polygalifolium*), heath-leaved banksia (*Banksia ericifolia*), spiny bossiaea (*Bossiaea obcordata*), hairpin banksia (*Banksia minor*), and *Dillwynia retorta*. The ground layer generally comprises lesser flannel flower (*Actinotus minor*), spiny-headed mat-rush (*Lomandra longifolia*), wiry panic (*Entolasia stricta*), *Lepyrodia scariosa*, *Gahnia* sp. and common bracken (*Pteridium esculentum*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.

Feature	Description
Photo	

3.2.2 Current Site Value

Table 3.9 below details the current site value scores for each of the vegetation zones in the Development Site. The raw site condition attribute data for each of the vegetation zones is provided in **Appendix B**.

Table 3.9 Vegetation Zone Site Value Scores

Vegetation Zone No.	Vegetation Zone	Current Site Value Score (out of 100)
1	HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion	56.52
2	HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion	81.77
3	HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion	69.10
4	HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion	63.77

3.2.3 Threatened Ecological Communities

One TEC, listed under the TSC or EPBC Act, was recorded in the Development Site (**Figure 3.3**) being:

- *Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC* under the TSC Act (refer to **Sections 3.2.3.1)** and EPBC Act (refer to **Sections 3.2.3.2)**.

Analysis of consistency to the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act, respectively.

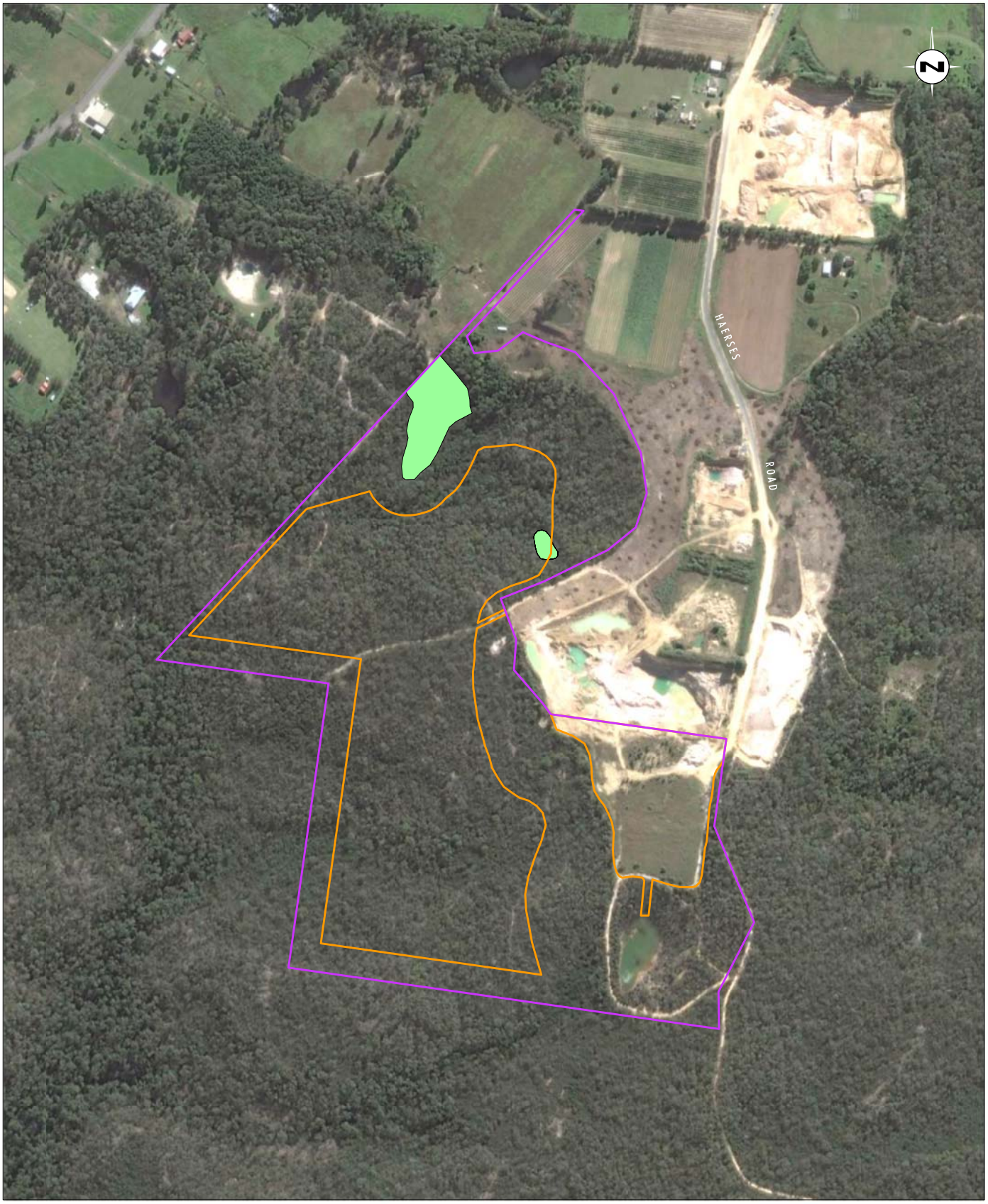

Image Source: Google Earth (2014)

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1:7500

Legend

- Development Site
- Modification Area
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition (Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act)

FIGURE 3.3

Threatened Ecological Communities within the Development Site

3.2.3.1 *Coastal Upland Swamp in the Sydney Basin Bioregion* EEC under the TSC Act

Coastal Upland Swamp in the Sydney Basin Bioregion is listed as an endangered ecological community under the TSC Act. The community is known to occur on periodically waterlogged soils on Hawkesbury sandstone plateaus, where the mean annual rainfall generally exceeds 950 millimetres. The community is often associated with acid soils ranging from yellow or grey mineral sandy loams that have a shallow organic horizon to highly organic spongy black peats with pallid subsoils, as described in the Final Determination (NSW Scientific Committee 2012).

The vegetation of this community varies from tall scrub, open heath to sedgelands and is usually dominated by sclerophyll shrubs and/or sedges. This EEC is generally treeless however scattered trees may occur.

The Development Site supports a total of 0.08 hectares of Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act within HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition) (**Figure 3.3**). A comprehensive analysis of this vegetation community was undertaken to determine if it conformed to the Final Determination for this community (NSW Scientific Committee 2012).

Constituent Species

The species recorded within Coastal Upland Swamp EEC in the Development Site comprises an assemblage of species consistent with the Final Determination under the Act (NSW Scientific Committee 2012).

This includes a ground layer dominated by zig-zag bog-rush (*Schoenus brevifolius*) and *leptocarpus tenax* below an upper stratum of peach blossom tea-tree (*Leptospermum squarrosum*) and heath-leaved Banksia (*Banksia ericifolia*).

Assemblage of Species

The NSW Scientific Committee (2012) lists 71 species as characterising the assemblage of species for the *Coastal Upland Swamp* EEC. As part of ecological investigations for the Project, one systematic 20 metre x 20 metre quadrat was sampled in *Coastal Upland Swamp* EEC due to the small area present in the Development Site.

A total of 21 species were recorded in the Coastal Upland Swamp EEC quadrat, of these 13 (62 per cent) of the species listed in the Final Determination were present within this community.

Particular Area

In relation to the particular area of the *Coastal Upland Swamp* EEC, the NSW Scientific Committee (2012) states that the community occurs within the Sydney Basin Bioregion on Hawkesbury sandstone plateaus.

The Development Site is located in the Sydney Basin Bioregion on a Hawkesbury sandstone plateau.

Supplementary Descriptors

In relation to supplementary descriptors, the NSW Scientific Committee (2012) includes the following key information pertaining to the *Coastal Upland Swamp* EEC:

- generally has a mean annual rainfall exceeding 950 millimetres
- soils that are acidic and vary from yellow or grey mineral sandy loams with a shallow organic horizon to highly organic spongy black peats with pallid subsoils and

- the vegetation of this community varies from tall scrub, open heath to sedgelands and is usually dominated by sclerophyll shrubs and/or sedges. This EEC is generally treeless however scattered trees may occur.

Of the above supplementary descriptors, the *Coastal Upland Swamp* EEC present in the Development Site occurs on waterlogged soils and comprises dark brown peaty soils above sands, a relatively fertile soil in comparison to adjacent remnant vegetation. The mean annual rainfall for the local area is 919 millimetres, but of the last seven years (2009 – 2015) five have exceeded the required mean annual rainfall of 950 millimetres. The vegetation is dominated by multiple shrubs and sedges, and trees are absent.

3.2.3.2 *Coastal Upland Swamps in the Sydney Basin Bioregion* EEC under the EPBC Act

Coastal Upland Swamps in the Sydney Basin Bioregion is listed as an endangered ecological community under the EPBC Act. This community includes a range of vegetation and fauna associated with periodically waterlogged soils on Hawkesbury sandstone plateaus (TSSC 2014). The listing describes a community that includes open graminoid heath, sedgeland and tall scrub.

The Development Site supports a total of 0.08 hectares of Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act within HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition) (**Figure 3.3**). A comprehensive analysis of this vegetation community was undertaken to determine if it conformed to the Conservation Advice (including Listing Advice) provided by the Department of the Environment under the EPBC Act (TSSC 2014).

Particular Area

The Coastal Upland Swamps in the Sydney Basin Bioregion EEC under the EPBC Act is endemic to NSW and occurs in the eastern part of the Sydney Basin IBRA bioregion (TSSC 2014).

The Development Site is within the Sydney Basin Bioregion.

Additional Criteria

The Conservation Advice (including Listing Advice) for the EEC identifies that it occurs primarily on permeable sandstone plateaux in the low relief headwater valleys with abundant seepage moisture (TSSC 2014). Soils are described to vary from yellow or grey sandy loams with a shallow organic horizon to highly organic spongy black peats (TSSC 2014). Additionally, the EEC swamps predominantly occur at elevations between 200 – 450 metres above sea level, but are also known to occur as low as 20 metres and up to 600 metres above sea level.

The swamp vegetation identified at the Development Site occurs on waterlogged soils and comprise dark brown peaty soils above sands. Specifically, a high degree of seepage moisture was recorded during the field survey. Additionally the development site occurs at approximately 160 metres above sea level.

Vegetative Criteria

A description of the vegetation composition for the EEC is provided in the Conservation Advice (including Listing Advice). It describes a variable mosaic of vegetation that are characterised by soil conditions, size, recent rainfall, fire regimes and disturbance history (TSSC 2014). The EEC is essentially treeless, however trees may be present as scattered individuals or isolated clumps. The advice also provides a list of indicative list of vascular plant species characteristic of the EEC, a list that comprises 73 flora species. However the advice also notes that the total number of vascular plants within the community is likely to exceed 200 species.

As part of ecological investigations for the Project, one systematic 20 metre x 20 metre quadrat was sampled in *Coastal Upland Swamp* EEC due to the small area present in the Development Site.

A total of 21 species were recorded in the Coastal Upland Swamp EEC quadrat, of these 13 (18 per cent) of the species listed in the Conservation Advice (including Listing Advice) were present within this community.

HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition) within the Development Site is deemed to meet the criteria discussed above. It therefore conforms to the Coastal Upland Swamps in the Sydney Basin Bioregion endangered ecological community under the EPBC Act.

3.3 Threatened Species within the Development Site

3.3.1 Ecosystem-credit Species

3.3.1.1 Predicted Species

Table 3.10 below outlines the predicted ecosystem-credit species predicted to occur by the BioBanking Calculator and whether they are considered to occur on site.

Table 3.10 Predicted Ecosystem-credit Species

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	2.2	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 7 km north west of the site from 2014 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
eastern freetail-bat *Mormopterus norfolkensis*	V	-	2.2	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 5 km south east of the site from 2008 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
eastern grass owl *Tyto longimembris*	V	-	1.3	Yes	Species has not been recorded in the Development Site. There are no known records of this species within 10 kilometres of the Development Site (OEH 2015).
gang-gang cockatoo *Callocephalon fimbriatum*	V	-	2.0	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 2 km south of the site from 2009 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
glossy black-cockatoo *Calyptorhynchus lathami*	V	-	1.8	Yes	Species was not recorded in the Development Site but it was recorded nearby along the eastern boundary of the Project Area during the surveys undertaken for this assessment (refer to **Figure 3.4** and **Section 3.3.1.2**). The Development Site contains foraging habitat for the species.
greater broad-nosed bat *Scoteanax rueppellii*	V	-	2.2	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 5 km south of the site from 2006 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
little eagle *Hieraaetus morphnoides*	V	-	1.4	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 4 km north west of the site from 1994 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
little lorikeet *Glossopsitta pusilla*	V	-	1.8	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 5 km east of the site from 2009 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
New Holland mouse *Pseudomys novaehollandiae*	-	V	2.6	Yes	Species has not been recorded in the Development Site. There are no known records of this species within 10 km of the Development Site (OEH 2015).
scarlet robin *Petroica boodang*	V	-	1.3	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 5 km south of the site from 1975 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
spotted-tailed quoll *Dasyurus maculatus*	V	E	2.6	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 6 km north west of the site from 1979 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
square-tailed kite *Lophoictinia isura*	V	-	1.4	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 9 km south west of the site from 2006 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
swift parrot *Lathamus discolor*	E	E	1.3	Yes	Species has not been recorded in the Development Site. There are no known records of this species within 10 km of the Development Site (OEH 2015).
varied sittella *Daphoenositta chrysoptera*	V	-	1.3	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 3 km south west of the site from 1996 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
yellow-bellied glider *Petaurus australis*	V	-	2.3	Yes	Species has not been recorded in the Development Site. There are several records within approximately 3 km of the site (OEH 2015). The Development Site may contain marginal foraging habitat for the species.
yellow-bellied sheathtail-bat *Saccolaimus flaviventris*	V	-	2.2	Yes	Species has not been recorded in the Development Site. The closest record occurs approximately 9 km south west of the site from 2013 (OEH 2015). The Development Site may contain marginal foraging habitat for the species.

^ As entered into the 'Site Survey Details' tab in the BBCC.

3.3.1.2 Survey Results

One ecosystem credit species, large-eared pied bat (*Chalinolobus dwyeri*), was recorded in the Development Site during the surveys undertaken. One other ecosystem credit species, little bentwing-bat (*Miniopterus australis*), was recorded within the Modification Area (refer to **Figure 3.4**). The Glossy Black-cockatoo was recorded to the east of the Modification area.

A discussion on these records is provided below and a full fauna species list from the surveys undertaken by Umwelt in 2014 and 2015 is included in **Appendix C**.

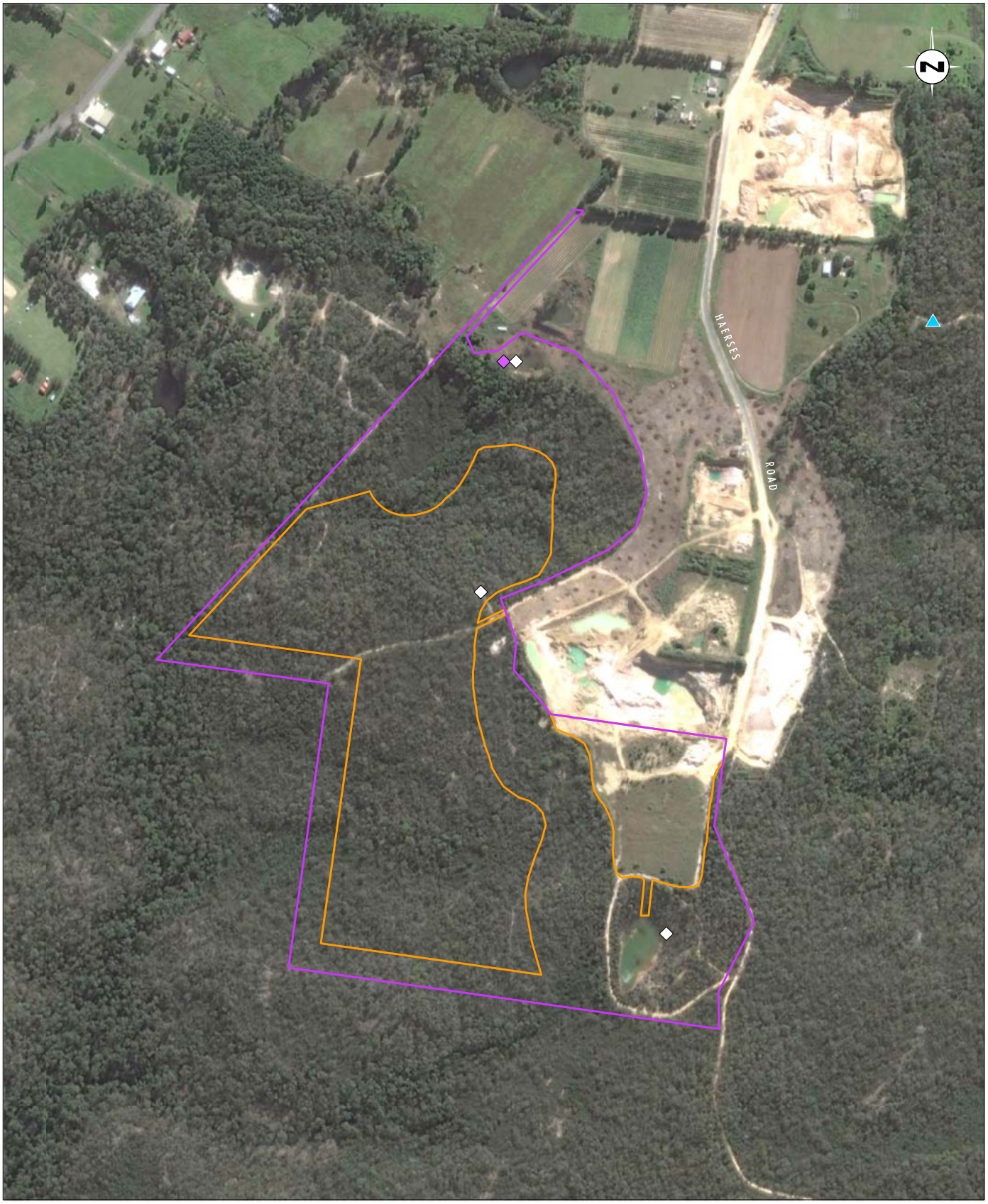

Image Source: Google Earth (2014)

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1:7500

Legend

- Development Site
- Modification Area
- Glossy Black-cockatoo (2 recorded)
- Little Bentwing-Bat
- Large-Eared Pied-Bat

FIGURE 3.4

Ecosystem-credit Species Recorded in the Development Site

Large-eared Pied Bat – *Chalinolobus dwyeri*

The large-eared pied-bat is listed as vulnerable under the TSC Act and EPBC Act. The species is found in areas with extensive cliffs and caves from Rockhampton, Queensland to Bungonia in New South Wales.

Large-eared pied-bat was not recorded in the Development Site, but rather in the north of the Development Site. It was recorded through use of bat echolocation recordings using an Anabat II Bat Detector. These recordings were then professionally identified by Anna McConville of Echo Ecology Pty Limited.

The Development Site does not contain any roosting habitat for the species but is considered to comprise marginal foraging habitat for this species as part of a wider foraging range in the locality.

Little Bentwing-bat – Miniopterus australis

The little bentwing-bat is listed as vulnerable under the TSC Act. The species is occurs along the eastern coast and ranges of Australia, extending from Cape York, Queensland to Wollongong, New South Wales.

This species was recorded in the Development Site.. It was recorded through use of bat echolocation recordings using an Anabat II Bat Detector. These recordings were then professionally identified by Anna McConville of Echo Ecology Pty Limited.

The Development Site does not contain any roosting habitat for the species but is considered to comprise marginal foraging habitat for this species as part of a wider foraging range in the locality.

3.3.2 Species-credit Species

3.3.2.1 Geographic and Habitat Features

Seven geographic and habitat features (refer to **Table 3.11**) were chosen in the BioBanking Credit Calculator as having broad features that match site habitats at the Development Site. Other geographic and habitat features were considered as not having broad features that match the Development Site habitats and were therefore not relevant to the Development Site and were filtered out of the subsequent steps of the assessment.

Table 3.11 Geographic and Habitat Features in the Development Site

Geographic/Habitat Feature	Relevant Species-credit Species
Land within 250 metres of termite mounds or rock outcrops	Rosenbergs goanna (*Varanus rosenbergi*)
Heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 metres of, ephemeral or intermittent drainage lines	red-crowned toadlet (*Pseudophryne australis*)
Land within 40 metres of heath, woodland or forest	giant burrowing frog (*Heleioporus australiacus*)
Ridgetops	*Hibbertia superans*
Sandstone rock outcrops	*Kunzea rupestris*

Geographic/Habitat Feature	Relevant Species-credit Species
Land within Maroota area of Baulkham Hills and Hornsby LGAs in Yengo CMA subregion	*Darwinia fascicularis* subsp. *oligantha* population, Baulkham Hills and Hornsby Local Government Areas (*Darwinia fascicularis* subsp. *oligantha* - endangered population)
Land below 1000 metres in altitude and within 40 m of rainforest or eucalypt forest with deep leaf litter	giant barred frog (*Mixophyes iterates*)

3.3.2.2 Predicted Species

Table 3.12 below outlines the predicted species-credit species predicted to occur by the BioBanking Credit Calculator (Major Project Assessment Type) and whether they are considered to occur on the Development Site.

Table 3.12 Predicted Species-credit Species

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Acacia gordonii	E	E	2.6	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Ancistrachne maidenii	V	-	2.2	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Asterolasia elegans	E	E	1.8	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
brown Pomaderris *Pomaderris brunnea*	E	V	1.5	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
brush-tailed phascogale *Phascogale tapoatafa*	V	-	2.0	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted remote camera surveys being done for this species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Bynoes wattle *Acacia bynoeana*	E	V	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Clandulla geebung P*ersoonia marginata*	V	V	1.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Darwinia biflora	V	V	2.0	Yes	A population of this species was recorded throughout the Modification Area, including the Development Site during the original survey in 2014. The second field survey in December 2015 was designed to further detail the population of this species within these areas. The surveys suggested the total size of the population could not be determined due to the sporadic habit of the species. For this reason the impacts to this species within the Development Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.
Darwinia fascicularis subsp. *oligantha* endangered population, Baulkham Hills and Hornsby Local Government Areas	EP	-	1.4	No	A potential specimen of this species was collected during the November 2014 survey. This specimen was sent to the National Herbarium of New South Wales at the Royal Botanic Garden Sydney (RBGS) for formal identification. The RBGS was unable to identify the specimen as being *Darwinia fascicularis* subsp. o*ligantha*, therefore this endangered population was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys. The identification letter from RBGS is attached as **Appendix E**.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Darwinia peduncularis	V	-	1.8	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Deanes paperbark *Melaleuca deanei*	V	V	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
downy wattle *Acacia pubescens*	V	V	1.9	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
eastern pygmy-possum *Cercartetus nanus*	V	-	2.0	Yes	This species was recorded at two locations within the Modification Area through a targeted remote camera survey for the species. Both locations of this species occur outside the boundary of the Development Site but impacts have been assumed due to the consistency in habitat and proximity of the records to the Development Site.
Epacris purpurascens subsp. *purpurascens*	V	-	1.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Eucalyptus sp. Cattai	CE	-	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	E	-	2.0	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
giant barred frog *Mixophyes iteratus*	E	E	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
giant burrowing frog *Heleioporus australiacus*	V	V	1.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted call playback and spotlighting surveys being done for this species.
Grevillea parviflora subsp. *supplicans*	E	-	2.6	Yes	This species was recorded within the Development Site and the Modification Area. A total of 13 plants occur within the Development Site while 206 individuals were recorded outside the disturbance boundary in the Modification Area.
Groves paperbark *Melaleuca groveana*	V	-	1.4	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Gyrostemon thesioides	E	-	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
hairy geebung *Persoonia hirsuta*	E	E	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Hibbertia puberula	E	-	4.0	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Hibbertia superans	E	-	2.6	No	This species was recorded at one location within the Modification Area and is outside the western boundary of the Development Site. It has been determined that this

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
					species will not be impacted by the Development Site under the strict assumption that no works will extend beyond the development site boundary.
koala *Phascolarctos cinereus*	V	V	2.6	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Kunzea rupestris	V	V	2.6	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Leptospermum deanei	V	V	1.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Leucopogon fletcheri subsp. *fletcheri*	E	-	1.6	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Micromyrtus blakelyi	V	V	2.6	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Dural woodland snail [1] *Pommerhelix duralensis*	-	E	7.7	Yes.	Targeted spotlight surveys undertaken in December 2015 recorded one individual of this species. It was recorded outside the Development Site in the Modification Area. Impacts to this species were considered due to the consistency in suitable habitat within the Development Site.
netted bottle brush *Callistemon linearifolius*	V	-	1.4	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Olearia cordata	V	V	1.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Pimelea curviflora subsp. *curviflora*	V	V	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Pultenaea parviflora	E	V	1.5	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
red-crowned toadlet *Pseudophryne australis*	V	-	1.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted call playback and spotlighting surveys being done for this species.
regent honeyeater *Anthochaera phrygia*	CE	CE	7.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Rosenbergs goanna *Varanus rosenbergi*	V	-	3.3	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Singleton mint bush *Prostanthera cineolifera*	V	V	1.4	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
spreading guinea flower *Hibbertia procumbens*	E	-	1.8	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
squirrel glider *Petaurus norfolcensis*	V	-	2.2	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Tetratheca glandulosa	V	-	1.6	Yes	This species was recorded within the Development Site and the Modification Area. The impacts to this species were applied on a habitat basis due to the cryptic nature of this species. For this reason the impacts to this species within the Development Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.
Velleia perfoliata	V	V	1.7	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.
Zieria involucrata	E	-	1.5	No	This species was not recorded within the Development Site or the larger Modification Area during either of the two extensive field surveys.

^ As entered into the 'Threatened Species Survey Results' tab in the BBCC.

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

3.3.2.3 Survey Results

Five species-credit species were recorded in the Development Site during the surveys undertaken for this assessment (refer to **Figure 3.5**). These were:

- *Darwinia biflora*,
- Eastern pygmy-possum (*Cercartetus nanus*),
- *Grevillea parviflora* subsp. *supplicans*,
- Dural woodland snail (*Pommerhelix duralensis*), and
- *Tetratheca glandulosa*.

Another species-credit species, *Hibbertia superans*, was also recorded during these surveys outside the Development Site. A discussion on these records is provided below and a full species list from the surveys is included in **Appendix C**.

Darwinia biflora

Darwinia biflora is listed as vulnerable under the TSC and EPBC Acts. It is an erect to spreading shrub recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas. It occurs on the edges of weathered shale-capped ridges at the integration with Hawkesbury Sandstone.

A population of this species was recorded throughout the Modification Area, including the Development Site during the original survey in 2014. Further survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot.

Eastern pygmy-possum – *Cercartetus nanus*

The eastern pygmy-possum is listed as vulnerable under the TSC Act. The species occurs in south-eastern Australia, from southern Queensland, predominantly along the New South Wales coastline around to eastern South Australia and also Tasmania.

Eastern pygmy-possum was recorded at two locations within the Modification Area during the initial field survey in November 2014. Both records occur outside the Development Site boundary. These records were made through targeted remote camera surveys. Bushnell Trophy Cam HDs (remote cameras) were mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey to increase the likelihood of detecting the eastern pygmy possum. The cameras were set to take three photos in quick succession when movement was detected. The remote cameras were programmed to record movement on an ongoing basis until removed from the site. The cameras were installed for 28 nights in 10 locations, totalling 280 nights of remote camera survey.

Grevillea parviflora* subsp. *supplicans

Grevillea parviflora subsp. *supplicans* is listed as endangered under the TSC Act. This species is a low shrub less than 1 metre tall and has characteristic arching branches. *Grevillea parviflora* subsp. *Supplicans* has a very restricted known distribution that is confined to the north west of Sydney in the Arcadia, Maroota and Marramarra Creek area.

Grevillea parviflora subsp. *supplicans* was recorded in two areas within the Modification Area, one of which occurs in the Development Site and one outside the western boundary. A total of 219 individuals of this species were recorded within the Modification Area, 13 of which occur in the Development Site. An additional 7 plants were recorded on the eastern boundary of the larger Project Area to the east of the Modification Boundary.

Dural woodland snail – *Pommerhelix duralensis*

Dural woodland snail is listed as endangered under the EPBC Act. This species is a medium sized snail with dark brown to black semi-translucent, almost spherical shaped shell. It is a shale-influenced habitat specialist that occurs in low densities along the western and north west fringes of the Cumberland IBRA subregion on shale-sandstone transitional landscapes.

Targeted spotlighting searches for the Dural woodland snail (*Pommerhelix duralensis*) were completed on the December 2015 survey. Walking spotlighting searches were conducted at two separate locations within the Development Site. One specimen of the Dural woodland snail was located just outside the eastern boundary of the Development Site, but within the Modification Area.

Tetratheca glandulosa

Tetratheca glandulosa is listed as vulnerable under the TSC Act. A small, spreading shrub that produces stems often becoming entwined among other plants within the ground stratum. The species is associated with shale-sandstone transition habitat.

Similarly to *Darwinia biflora* the impacts to this species were applied on a habitat basis due to the cryptic nature of this species. For this reason the impacts to this species within the Development Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.

3.3.2.4 Species Habitat Polygons

Species habitat polygons have been prepared for all the species that are being assessed based on area of occupancy that were recorded and assumed present at the site as per **Table 3.14** above. The species polygons were prepared:

- using satellite imagery dated 2009 (LPI 2014)
- using the unit of measurement identified for those species in the Threatened Species Profile Database
- including the location of the species or areas likely occupied by the species
- containing the specific habitat feature associated with the species at the Development Site, and
- using GPS to confirm the location of the species polygon on the best available aerial image of the Development Site.

Species polygons are shown on **Figure 3.5**. Additionally, threatened species records for *Grevillea parviflora* subsp. *supplicans* are also shown in **Figure 3.5**.

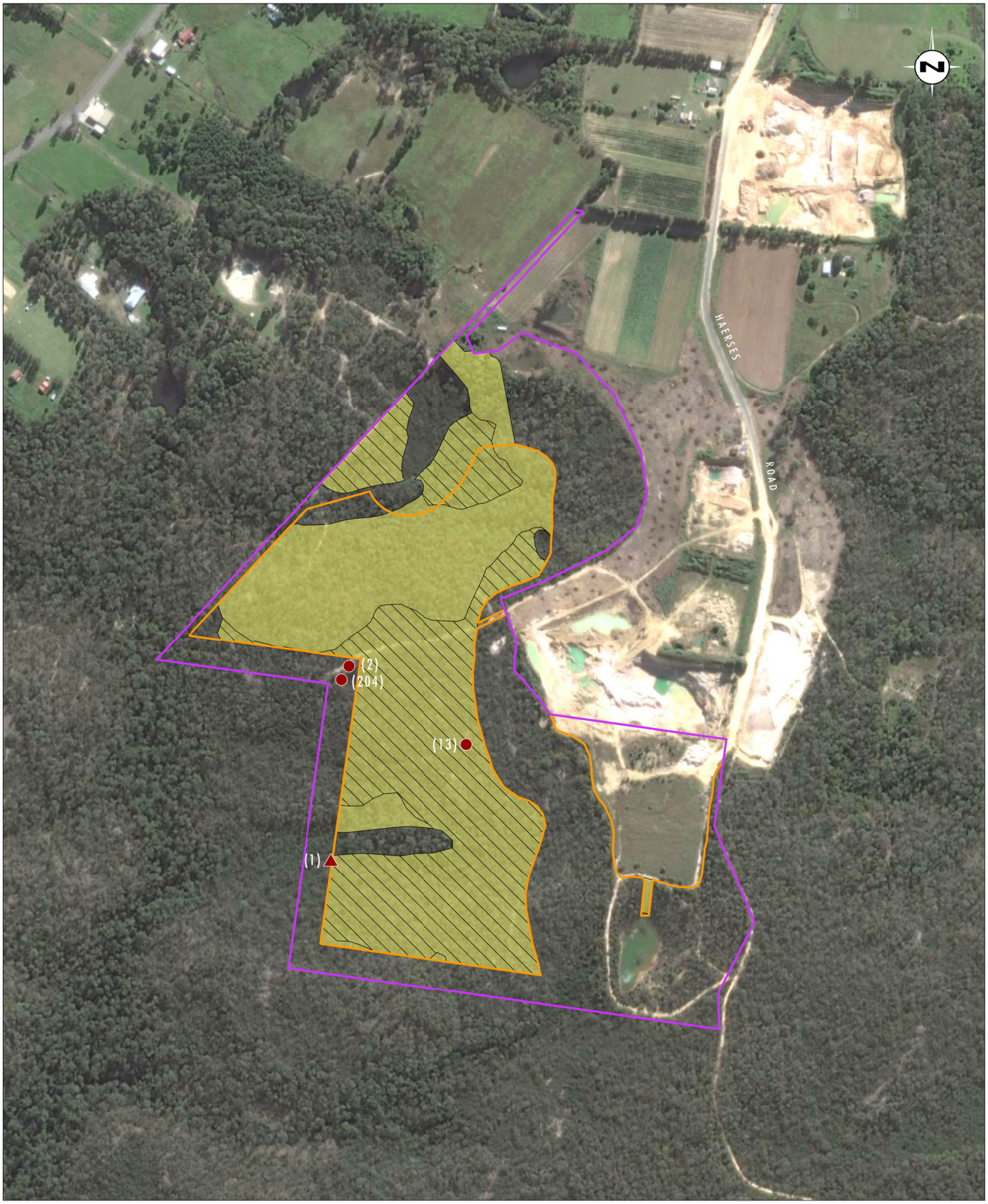


Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Development Site
- Modification Area
- Darwinia biflora, Tetratheca glandulosa and Dural woodland snail
- Eastern pygmy-possum
- *Grevillea parviflora* subsp. *supplicans*
- *Hibbertia superans*

FIGURE 3.5

Species-credit Polygons

File Name (A4): R04/3479_036.dgn
20160920 11.49

4.0 Avoidance and Minimisation Measures

4.1 Site Selection and Planning Phase Avoidance

4.1.1 Site Selection

Dixon Sand undertook initial ecological field surveys within the Modification Area to inform its design process for the proposed Development Site. Through this process, different quarry boundaries were considered and Dixon Sand has sought to minimise the biodiversity impacts associated with the project whilst providing an economic resource. Key factors in selecting the location of the quarry included the likely impacts on significant ecological features, including threatened species, TECs and/or their habitats.

Ecological field surveys were undertaken in November 2014 and December 2015 within the Modification Area that encompasses the Development Site. The boundary of the Development Site has undergone several revisions based on the extent of sandstone material as well as the location of key ecological and groundwater features. In particular, the latest revision to the boundary of the Development Site was made to provide a minimum 50 metre buffer around the Coastal Upland Swamp(s) EEC listed under TSC and EPBC Acts that occurs in the proposed onsite offset area that occurs north of the Development Site.

4.1.2 Planning Phase

Once the quarry expansion location was selected, Dixon Sand then assessed the preliminary opportunities and constraints in relation to ecological values within the proposed extraction and original offset areas at Haerses Road, Maroota (Cumberland 2014). The project has undergone a range of variations to the design of the proposed quarry to get to what is now the Development Site. Additionally, the location of onsite offsets has also undergone similar changes. Key ecological constraints that have been considered by Dixon Sand during the design phase of the Development Site are the location and extent of the Upland Coastal Swamp TEC and the population of threatened flora species *Darwinia biflora*. Dixon Sand engaged Umwelt to undertake significant survey effort for *Darwinia biflora* to try and identify key locations of the species within the Modification Area and areas where the species did not occur that could ultimately facilitate the design of the Development Site to minimise or avoid impacts to the species. Unfortunately surveys identified that the species occurs throughout much of the Modification Area and that impacts to the species could not be avoided completely.

Project planning also focussed on seeking to use areas of non-native vegetation where practicable and the proposed processing and plant area was located in an area of cleared land, reducing the impacts of the proposed development on native vegetation and fauna habitat.

Dixon Sand have limited the extent of the Development Site and thus minimised the impacts to *Darwinia biflora*. Additionally, only a very small portion of Coastal Upland Swamp TEC is now being impacted by the proposed development. The latest revision of the Development Site boundary included incorporating a 50 metre buffer around the Coastal Upland Swamp TEC that occurs within the onsite offset site.

Figure 4.1 shows the final Development Site in relation to the BVTs mapped within the Development Site and the areas of avoidance.

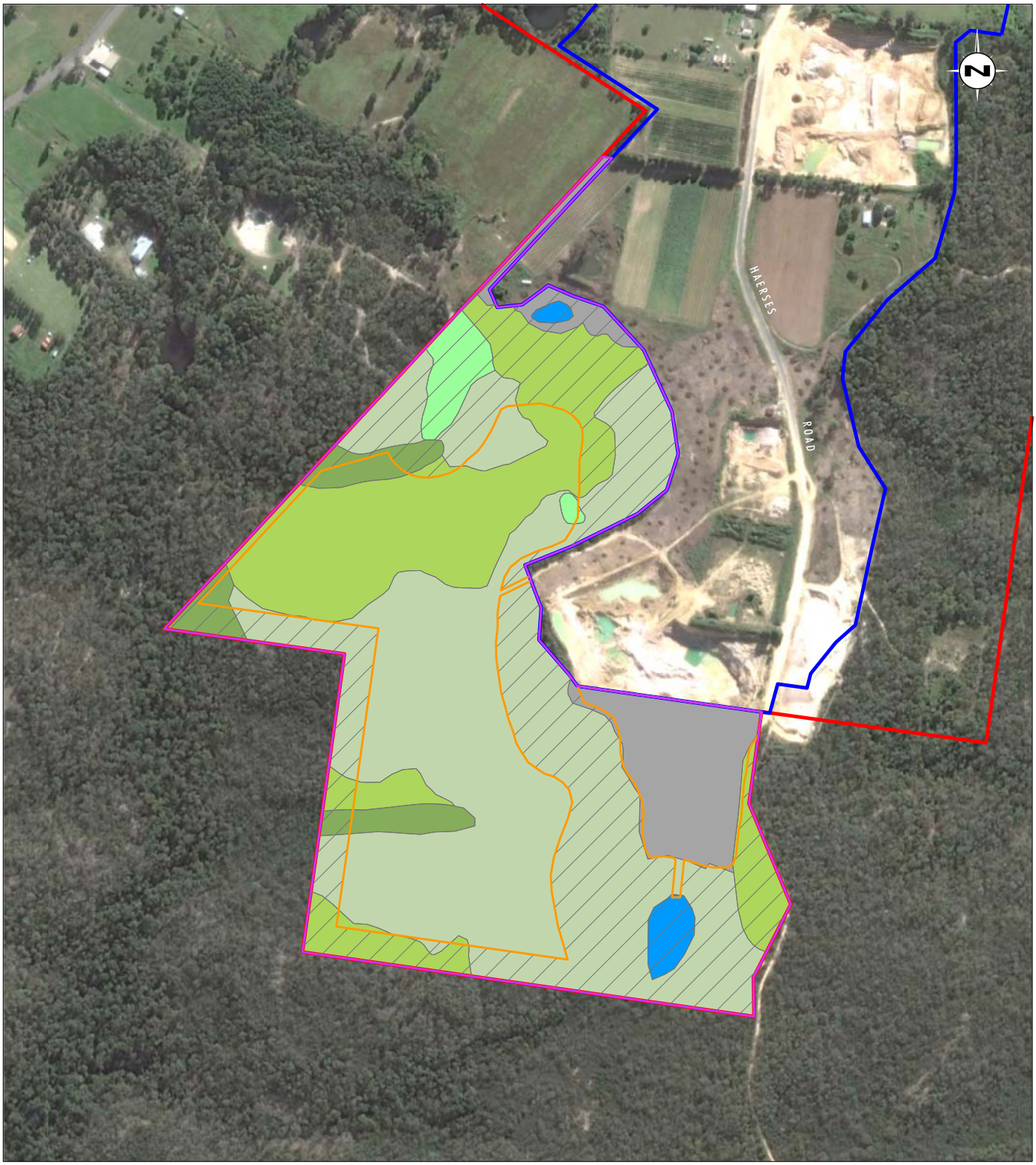


Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Project Site
- Approved Extraction Area
- Development Site
- Modification Area
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition
- Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition
- Cleared
- Dam
- Area Mapped Outside The Development Site (not impacted)

FIGURE 4.1

Final Development Footprint

Table 4.1 Vegetation Community and Habitat Avoidance

Vegetation Community	Area in the Modification Area (ha)	Area to be Impacted in the Development Site (ha)	Area to be Retained (Avoided) in the Modification Area (ha)
Moderate Quality Woodlands			
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	1.03	0.08	0.95
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	11.46	6.67	4.79
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	24.49	11.15	13.34
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	1.91	0.99	0.92
Total	**38.89**	**18.89**	**20.00**
Cleared			
Cleared	4.23	3.46	4.23
Dam			
Dam	0.63	0.00	0.63
All Vegetation			
Total	43.75	22.35	24.86

4.2 Construction (Site Clearance) Phase

Dixon Sand has committed to the design and implementation of a comprehensive strategy to mitigate adverse impacts during the construction phase of the Modification Project. This includes specific measures to manage potential impacts on fauna species in the Development Site during vegetation clearing and construction of the quarry.

Dixon Sand has an existing ecological management regime in place for Haerses Road quarry, including management plans approved under both NSW and Commonwealth approvals. This existing management regime will be updated and applied to the Modification Project as part of the implementation of the project. Further discussion of the proposed management and mitigation measures to be implemented is included in the following sections.

Additionally, two threatened flora species were recorded just outside of the western boundary of the Development Site, namely *Grevillea parviflora* subsp. *supplicans* and *Hibbertia superans*. *Grevillea parviflora* subsp. *supplicans* also occurs in the Development Site at another location and impacts to this species have only been calculated based on the records within the boundary, of which there were 13 plants. The plants of *Grevillea parviflora* subsp. *Supplicans* and *Hibbertia superans* outside of the Development Site have not been entered into the calculator under the strict assumption that no construction works will occur up to the exact boundary to ensure that there will be no indirect impacts to them. Such an assumption will need to be incorporated into the existing ecological management regime.

4.2.1 Management of Arboreal Species and Habitat

A tree felling procedure will be implemented to minimise the potential for impacts on native fauna species (focusing on threatened species) as a result of the clearing of hollow-bearing trees. The tree felling procedure is designed to minimise impacts to hollow-dependent fauna, particularly the threatened eastern pygmy possum and hollow-dependent micro-bats.

4.2.1.1 Pre-clearance Surveys

Pre-clearance surveys will be required within areas of woody native vegetation (including scattered trees within grassland) that are to be cleared. Pre-clearance surveys will be undertaken by suitably qualified and experienced person and involve the following:

- the demarcation of areas approved for clearing to reduce risk of accidental clearing
- habitat resources and habitat trees should be identified and marked (Note: habitat trees are those containing hollows, cracks or fissures and spouts, active nests, dreys or other signs of recent fauna usage. Other habitat features to be identified include fallen timber/hollow logs, burrows and boulder piles)
- the potential presence of threatened flora and fauna species, endangered populations and TECs should be identified
- the identification of species or habitat features that are suitable for translocation or salvage
- the presence of weed species and vertebrate pest species should be assessed, if relevant, and
- disturbance activities should be targeted for specific times of the year to minimise impacts to target species usage of habitat features for breeding and roosting, where practicable.

4.2.1.2 Tree-felling Supervision

Tree clearing will be completed as close to the completion of pre-clearance surveys as practicable to limit the potential for new issues to arise (such as new active nests being built). Tree felling supervision will be undertaken by an appropriately qualified and experienced person after pre-clearance surveys have identified potential threatened species habitat. The supervising person will be licensed by the relevant field survey and ethics authorities to allow for capture, housing, transport and possibly ethical euthanizing of injured fauna. The tree-felling procedure will include the following:

- Prior to clearing identified habitat trees, the felling of non-habitat trees will be completed as close to the felling of habitat trees as possible, with all surrounding habitat trees to be vigorously shaken with heavy machinery.

- On the day of habitat tree felling, the following is to be undertaken:
    - all habitat trees will be subject to a visual inspection to survey for threatened species
    - trees previously identified as containing fauna will be shaken and then felled, providing no threatened species are identified
    - all reasonable attempts will be made to reduce the impact of felling on all fauna species. This may include delaying felling trees with fauna present or felling in sections to reduce potential for injury
    - the lowering of hollow-bearing trees will be done as gently as possible with heavy machinery
    - if a threatened species is identified in a habitat tree on the day of felling, the supervising person is to advise the most appropriate method to minimise potential harm. This may include leaving the tree overnight, further shaking to encourage the animal to vacate the tree, gradual removal of branches to discourage ongoing use, soft-felling of the tree with the animal in the tree, or measures to capture and relocate the animal to secure habitats
    - uninjured animals should be released on the day of capture into nearby suitable secure habitat and should not be held for extended periods of time, and
    - injured animals will be taken to the nearest veterinary clinic or wildlife carer as soon as possible for assessment and treatment. If required, the supervising person may ethically euthanize fauna
- Following felling, habitat trees will be inspected for remaining or injured fauna species and to ensure that no hollows are blocked against the ground. This may require the tree to be rolled to ensure adequate access
- All felled habitat trees should remain in place for a least one night to allow any fauna still present to move on
- Habitat features identified for translocation or salvage operations should be extracted and stored appropriately, and
- Detailed records should be maintained regarding the type and number of habitat features cleared, the type and number of fauna encountered and their fate. This will assist in informing mitigation programs such as nest boxes and habitat augmentation programs.

4.2.2 Weed Control

Weed species could be inadvertently brought into the Modification Area with imported materials, or could invade naturally through removal of native vegetation. The increased presence of weed species within the Development Site has the potential to decrease the value of extant vegetation to native species, particularly threatened species that will remain in the Modification Area.

The following management measures will be undertaken to minimise the potential impacts and spread of weeds during the modification to the Development Site:

- Any vehicles or equipment being brought onto the Dixon Sand site to be involved in ground disturbance activities and/or travelling around the site must be inspected and cleaned prior to commencing work to limit the spread of seeds and plant material between sites.

- The limits of ground disturbance will be clearly demarcated and no unnecessary disturbance will be undertaken outside of these areas.

- Regular inspections will be undertaken in the Development Site to monitor the spread of weed species.

- Training of environmental personnel on the identification of target weed species.

Any outbreak of noxious weeds will be controlled and eradicated as required under the *Noxious Weeds Act 1993*, and as required by the Local Land Services and other relevant authorities. Weed control and eradication techniques may include:

- spraying with herbicides

- physical removal e.g. chipping, or

- minimisation of area available for weed infestation, through prompt revegetation of bare areas.

4.2.3 Sediment and Erosion Control

Surface water management procedures currently used within the existing Haerses Road are proposed for the Modification Project. This will involve ensuring the direction of clean water flows around the quarry site where practicable and the containment of dirty water within the quarry water management system for treatment.

Erosion and sediment control will be undertaken in accordance with the *Haerses Road Sand Quarry Site Water Management Plan (WMP)* (ERM, 2006b), which will be updated as part of the implementation of the Modification Project. The WMP provides a framework for the management of erosion and sedimentation at Haerses Road Quarry.

As part of construction works, the specific inspection, maintenance and revegetation requirements for each works area will be determined and implemented. These control measures will be in accordance with relevant guidelines for erosion and sediment control, including the relevant volumes of the Blue Book, including:

- Landcom (2004) Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.

- Department of Environment and Climate Change (DECC) (2008) Managing Urban Stormwater – Soils and Construction, 2C – Unsealed Roads.

- Department of Environment and Climate Change (DECC) (2008) Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

4.2.4 General Mitigation Measures

A range of general mitigation measures will be employed across the site during the construction phase to minimise impacts to biodiversity values, including:

- Employee education and training including inductions for staff, contractors and visitors to the site will be conducted to inform personnel of the biodiversity issues present at the site and so they know their role and responsibilities in relation to the protection and/or minimisation of impacts to native biodiversity.

- Areas of biodiversity value outside the Development Site will be fenced or signposted, where appropriate, to prevent the unnecessary disturbance during the construction phase.

- Traffic control measures/speed limits/signage will be enforced on haul roads and access roads to minimise fauna injury/road kills, as much as possible.

4.3 Operational Phase

Dixon Sand has committed to the implementation of a comprehensive strategy to mitigate the adverse impacts during the operational phase of the Modification Project. This includes specific measures to minimise the potential impacts on the biodiversity of the Development Site and the locality. As discussed in **Section 4.2**, an existing ecological management regime is in place for the Haerses Road Quarry and it will be updated and implemented for the Modification Project.

4.3.1 Ongoing Weed Management

Dixon Sand will refer to the existing Environmental Management Plan to incorporate details of the design and implementation of a robust weed management program for the Development Site.

Regular inspections of the Development Site will be undertaken for weed infestations and to assess the need for control measures. Areas not impacted by quarrying activities will be subject to six monthly weed assessments, to be undertaken by the Environmental Officer. These inspections will identify any weed infestations, the need for any control measures and the effectiveness of past weed control activities. Rehabilitated areas will also be regularly inspected to reduce the potential for weed infestations in these areas.

As outlined in **Section 4.2.2**, any outbreak of noxious weeds will be controlled and eradicated as required under the *Noxious Weeds Act 1993*, and as required by the Local Land Services and other relevant authorities. Noxious and other undesirable weed species within the Development Site will be controlled to an acceptable level, and where possible eliminated. Weed control and eradication techniques may include:

- spraying with herbicides

- physical removal e.g. chipping, or

- minimisation of area available for weed infestation, through prompt revegetation of bare areas.

4.3.2 Ongoing Sediment and Erosion Control

During the operational phase, additional water management system components will be constructed as work progresses. The operational phase will involve the ongoing management of the water management system, and be consistent with the relevant requirements of:

- Landcom (2004) Managing Urban Stormwater – *Soils and Construction, Volume 1, 4th Edition,* and

- Department of Environment and Climate Change (DECC) (2008) Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

Specific erosion and sediment control measures proposed to be implemented for the Modification Project will also include those measures outlined the existing Environmental Management Plan.

4.3.3 General Mitigation Measures

The general mitigation measures outlined in **Section 4.2.4**, are also applicable during the operational phase of the Modification Project.

4.4 Direct Impacts

The construction and operation of the Modification Project will result in a range of direct impacts on biodiversity values within the Disturbance Site. Direct impact includes loss of native vegetation and fauna habitats as a result of direct clearance works and construction of the quarry.

Table 4.2 below outlines these impacts as they were entered into the BioBanking Credit Calculator (Major Project Assessment Type). Avoidance and mitigation measures associated with minimising the impacts of these direct impacts are discussed in **Sections 4.1**, **4.2** and **4.3** above.

Table 4.2 Direct Impacts of the Modification Project

Ecological Feature	Area within the Development Site Impact (ha)
Biometric Vegetation Types	
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	0.08
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	6.67
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	11.15
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	0.99

4.5 Indirect Impacts

The Modification Project is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands during the construction or operational phases of the Modification Project.

The latest revision to the boundary of the Development Site was made to provide a minimum 50 metre buffer around the Coastal Upland Swamp(s) EEC listed under TSC and EPBC Acts that occurs in the proposed onsite offset area that occurs north of the Development Site. The EEC Final Determination under the TSC Act (NSW Scientific Committee 2012) and Listing Advice under the EPBC Act (TSSC 2014) do not provide a recommended buffer zone around areas of the EEC to ensure that indirect impacts to the community are avoided. We have recommended the minimum buffer of 50 metres around areas of vegetation identified as conforming with the EEC. The vegetation in the buffer zone however is not part of the EEC and not formally protected under either of the TSC or EPBC Acts.

4.5.1 Noise and Dust Impacts

Construction and operational noise and dust impacts have the potential to adversely impact native species. Potential impacts include:

- dust covering vegetation thereby reducing vegetation health and growth
- noise disturbing the roosting and foraging behaviour of fauna species, and
- noise reducing the occupancy of areas of suitable habitat.

The design of the Modification Project will include inherent measures to minimise the potential for adverse noise and dust impacts. These include:

- the use of physical barriers adjacent to operational quarry areas, where practical such as earthen bunds and noise walls
- dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions
- the minimisation of vegetation clearance where it is not required
- progressive rehabilitation and stabilisation of disturbed land
- equipment maintenance to minimise noise generation.

Further details of the noise controls that will be implemented as part of the Modification Project are outlined in the Environmental Assessment report.

4.5.2 Weed and Feral Animal Encroachment

Weed species could be inadvertently brought into the Modification Area with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species within the Modification Area has the potential to decrease the value of extant vegetation to native species, particularly threatened species. Mitigation measures outlined in **Sections 4.2.2** and **4.3.2** will minimise the potential for weed encroachment into surrounding areas around the Development Site.

5.0 Impact Assessment

5.1 Impacts Not Requiring Further Assessment

Impacts not requiring further assessment under the FBA include areas of land without native vegetation. Areas of cleared land and bodies of water were identified within the Modification Area, but not within the Development Site. Therefore, all the vegetation in the Development Site is involved in the further assessment under the FBA.

5.2 Impacts Not Requiring Offset

Impacts on native vegetation not requiring offsets under the FBA include native vegetation that has a site value score of less than 17, including native vegetation that is an endangered or critically endangered ecological community, and/or vegetation that is associated with threatened species habitat (as represented by ecosystem credits).

Impacts on species and populations not requiring offsets under the FBA include threatened species habitat associated with a PCT that has a site value score of less than 17 or species or populations that are not threatened and do not form part of a EEC or CEEC.

A range of non-threatened flora and fauna species were recorded within the Development Site during the surveys undertaken for this assessment. These species do not require offsets under the FBA. Additionally, as no BVTs within the Development Site have a site value score of less than 17 and are predicted to be habitat for threatened ecosystem species, all will require offsetting as discussed in **Section 5.3**.

5.3 BVTs and Threatened Species Requiring Offset

A range of BVTs, ecosystem-credit species and species-credit species were found to require offsetting as discussed in the sections below.

5.3.1 Ecosystem Credits

Table 5.1 outlines the ecosystem-credit species requiring offset as a result of the Modification Project. The highest threatened species offset multiplier will determine the credit requirements for the BVTs these species are predicted to occur in.

Table 5.1 Ecosystem-credit species requiring offset as a result of the Modification Project

Common Name	Species Name	Threatened Species Offset Multiplier
eastern false pipistrelle	*Falsistrellus tasmaniensis*	2.2
eastern freetail-bat	*Mormopterus norfolkensis*	2.2
eastern grass owl	*Tyto longimembris*	1.3
gang-gang cockatoo	*Callocephalon fimbriatum*	2.0

Common Name	Species Name	Threatened Species Offset Multiplier
glossy black-cockatoo	*Calyptorhynchus lathami*	1.8
greater broad-nosed bat	*Scoteanax rueppellii*	2.2
little eagle	*Hieraaetus morphnoides*	1.4
little lorikeet	*Glossopsitta pusilla*	1.8
New Holland mouse	*Pseudomys novaehollandiae*	2.6
scarlet robin	*Petroica boodang*	1.3
spotted-tailed quoll	*Dasyurus maculatus*	2.6
square-tailed kite	*Lophoictinia isura*	1.4
swift parrot	*Lathamus discolor*	1.3
varied sittella	*Daphoenositta chrysoptera*	1.3
yellow-bellied glider	*Petaurus australis*	2.3
yellow-bellied sheathtail-bat	*Saccolaimus flaviventris*	2.2

Table 5.2 below outlines the BVTs to be impacted as a result of the Modification Project and the ecosystem credits required to offset those impacts. A full Credit Calculator report is included in **Appendix D**.

Table 5.2 Biometric Vegetation Types Requiring Offset and the Ecosystem Credits Required

Biometric Vegetation Type	Vegetation Zone	Area to be Impacted (ha)	Loss in Landscape Value	Current Site Value Score	Future Site Value Score	Threatened Species Offset Multiplier	Ecosystem Credits Required
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	1	0.08	13.20	56.52	0.00	2.6	3
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	2	6.67	13.20	81.77	0.00	2.6	377
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	3	11.15	13.20	69.10	0.00	2.6	538
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	4	0.99	13.20	63.77	0.00	2.6	44

5.3.2 Species Credits

Table 5.3 below outlines the species-credit species to be impacted as a result of the Modification Project and the species credits required to offset those impacts. A full Credit Calculator report is included in **Appendix D**.

Table 5.3 Species-credit Species Requiring Offset and the Species Credits Required

Common Name	Species Name	Threatened Species Offset Multiplier	Species Credits Required
Darwinia biflora	*Darwinia biflora*	2.0	360
eastern pygmy-possum	*Cercartetus nanus*	2.0	223
Grevillea parviflora subsp. *supplicans*	*Grevillea parviflora* subsp. *Supplicans*	2.6	338
Dural woodland snail [1]	*Pommerhelix duralensis*	7.7	1,372
Tetratheca glandulosa	*Tetratheca glandulosa*	1.6	288

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

5.4 Impacts that Require Further Consideration

Under the FBA, certain impacts on biodiversity values may require further consideration by the consent authority. These are impacts that are considered to be complicated or severe and include:

- impacts on landscape features, being:
    - impacts that will reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas, or
    - impacts that will prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state, and
- impacts on native vegetation that are likely to cause the extinction of an EEC/CEEC from an IBRA subregion or significantly reduce its viability, and
- impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability.

The Modification Project will not have an impact on any biodiversity features that would result in one or more of the above severe impacts. Therefore there are no impacts that require further consideration by the consent authority.

5.5 Impacts on Aquatic Species

No *Fisheries Management Act 1994* (FM Act) listed threatened aquatic flora or fauna species has been recorded within the Development Site. The Development Site contains minimal aquatic habitats being two small dams occurring in the western and southern portions of the Development Site.

5.6 Seven Part Tests of Significance

Threatened species impact assessment is an integral part of environmental impact assessment. The objective of s. 5A of the EP&A Act, the *assessment of significance*, is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

Although it is understood that the preparation of a BioBanking Assessment under the FBA supersedes the requirement to prepare Seven Part Tests, DPE has previously advised that some consideration of s. 5A is required. The preparation of a BAR under the FBA addresses the components of the Seven Part Tests by use of the BBCC. A summary of the requirements of the Seven Part Tests of Significance and where they are addressed in the FBA Assessment is outlined in **Table 5.4** below.

Table 5.4 Seven Part Tests of Significance and the FBA

Seven Part Test of Significance	Where Addressed in the FBA Process
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;	Threatened species (ecosystem-credit and species-credit) are predicted in the BBCC by the landscape features of the Development Site (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014) identify impacts on critically endangered threatened species, impacts that may cause the extinction of a species in a IBRA subregion and impacts that significantly reduce the viability of a species.

Seven Part Test of Significance	Where Addressed in the FBA Process
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	Endangered populations are predicted in the BBCC by the landscape features of the Development Site (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014) identify impacts that may cause the extinction of an endangered population in a IBRA subregion and impacts that significantly reduce the viability of a population.
c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed; i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; and 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;	Endangered ecological communities are predicted in the BBCC by the plant community types and biometric community types identified from the field surveys and entered into the BBCC. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014) are identified as impacts on any critically endangered or endangered ecological community that may cause the extinction of the EEC/CEEC in a IBRA subregion or significantly reduce the viability of an EEC/CEEC.

Seven Part Test of Significance	Where Addressed in the FBA Process
d) in relation to the habitat of a threatened species, population or ecological community; i. the extent to which habitat is likely to be removed or modified as a result of the action proposed; ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;	Habitat loss is assessed in the BBCC via the 'Site Values' tab and the loss in site value score entered for each vegetation zone. Fragmentation of habitat is addressed as part of the 'Landscape Value' score including consideration of features before and after the development including per cent native vegetation cover, connectivity value and vegetation condition. The per cent cleared scores for the dominant Mitchell Landscape is also calculated in the 'Landscape Value' score. Important habitat features are identified through determining geographic and habitat features relevant for particular species-credit species and the assessment of landscape features (such as riparian buffers, important wetlands and state or regionally significant biodiversity links). The extent of habitat loss is ultimately determined by the measure of ecosystem credits and species credits calculated in the BBCC.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);	Critical habitat is addressed under impacts that require further consideration by the consent authority (refer to Section 9.2 of the FBA (OEH 2014)).

Seven Part Test of Significance	Where Addressed in the FBA Process
f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and	Recovery plans are not directly addressed in the FBA. National recovery plans have been prepared for large-eared pied bat (*Chalinolobus dwyeri*) (DERM 2011). It is likely that the Modification Project would be inconsistent with any recovery plans prepared for the threatened species impacted by the Project as it relates to impacts on habitat for the species. However the Modification Project will not impede the implementation of these recovery plans. If supplementary offsetting measures are used (as per Appendix B of the NSW Biodiversity Offset Policy for Major Projects) to offset species or communities impacted by projects, reference can be made to the key objectives and actions in the relevant recovery plans.
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.	Key threatening processes are not directly assessed under the FBA. In the case of the Modification Project, the Project may contribute to the following key threatening processes: • Aggressive exclusion of birds by noisy miners (*Manorina melanocephala*); • Clearing of native vegetation; • Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*); • Competition and land degradation by unmanaged goats (*Capra hircus*); • Loss and degradation of native plant and animal habitat by invasion of escaped garden plants; • Predation by the European red fox (*Vulpes vulpes*); and • Predation by feral cats.

5.7 Impacts on Matters of National Environmental Significance

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance (MNES). These matters are:

- listed threatened species and communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- World Heritage properties
- National Heritage places
- nuclear actions, and
- a water resource, in relation to coal seam gas development and large coal mining development.

A Referral to the Commonwealth Environment Minister was submitted in November 2015. Confirmation from the Department of Environment was received in February 2016 that the proposed modification is a 'Controlled Action' due to likely significant impacts on listed threatened species and communities.

6.0 Offsetting Requirements

6.1 Biodiversity Credit Report

A full Credit Calculator report is included in **Appendix E**.

Table 6.1 below provides a summary of the ecosystem and species credits that require offsetting as a result of this Modification.

Table 6.1 Ecosystem and Species Credits Generated at the Development Site

Name	Credits Required
Ecosystem Credits	
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	3
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	377
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	538
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	44
Total	**962**
Species Credits	
Darwinia biflora	360
eastern pygmy-possum (*Cercartetus nanus*)	223
Grevillea parviflora subsp. *supplicans*	338
Dural woodland snail (*Pommerhelix duralensis*)[1]	1,372
Tetratheca glandulosa	288
Total	**2581**

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

6.1.1 Offsetting Options for Ecosystem Credits

Ecosystem credits for any of the PCTs in the Development Site can be located in any IBRA subregion that adjoins the IBRA subregion in which the Modification Project occurs. The Modification Project occurs in the Yengo – Hawkesbury/Nepean IBRA subregion and therefore, ecosystem credits can be sourced from the following IBRA subregions:

Sydney Basin Bioregion

- Cumberland
- Hunter
- Kerrabee
- Pittwater
- Wollemi
- Wyong or
- Yengo – Hawkesbury/Nepean.

Through finalising the FBA calculator a full Credit Calculator report is produced and within this report a list of offset options for each of the vegetation zones impacted on within the Development Site is provided. A copy of the full Credit Calculator report is provided in **Appendix D**. A summary of suitable offsetting PCTs for each of the vegetation zones being impacted within the Development Site are provided below.

6.1.1.1 HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion

The following PCTs could be used to offset HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion under the FBA:

- HN560 Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion
- HN563 Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion or
- HN633 Baeckea linifolia - Grevillea acanthifolia subsp. acanthifolia shrub/sedge swamp on sandstone, Sydney Basin Bioregion.

6.1.1.2 HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion

The following PCTs could be used to offset HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion under the FBA:

- HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
- HN587 Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion

- HN567 Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion
- HN586 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion
- HN642 Spotted Gum - Grey Ironbark open forest in the Pittwater area, Sydney Basin Bioregion or
- HN644 Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion.

6.1.1.3 HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion

The following PCTs could be used to offset HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion under the FBA:

- HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion or
- HN580 Sandstone cliff soak moist shrubland of the Sydney Basin Bioregion.

6.1.1.4 HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion

The following PCTs could be used to offset HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion under the FBA:

- HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion
- HN587 Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion
- HN566 Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
- HN567 Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion
- HN642 Spotted Gum - Grey Ironbark open forest in the Pittwater area, Sydney Basin Bioregion or
- HN644 Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion.

6.1.1.5 Offsetting Options for Species Credits

A required species credit must be offset with a species credit created for the same species, determined in accordance with the BBAM. Under the FBA and strictly in accordance with the rules set out in Section 10.5.7 of the FBA methodology (OEH 2014), the consent authority may also approve:

a) a variation of the offset rules for matching species credits by allowing a different species to that impacted by the proposed development to be used to meet the offset requirement, or

b) a supplementary measure to be proposed as an offset for the species impacted by the development.

6.2 Haerses Road Offset Site

Dixon Sand is committed to delivering a Biodiversity Offset Strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Modification Project under the NSW *Biodiversity Offsets Policy for Major Projects* (OEH 2014). Firstly, Dixon Sand has, where possible, altered the Modification Project to substantially avoid and minimise ecological impacts in the project planning stage, and a range of impact mitigation strategies have been included in the Modification Project to mitigate the impact on ecological values (refer to **Section 4.0**) prior to the consideration of offsetting requirements.

The NSW *Biodiversity Offset Policy for Major Projects* commenced on 1 October 2014. Fulfilling offset requirements under the Policy will be undertaken using one or a combination of the following offset strategies:

- On-site in-perpetuity conservation of applicable credits.
- Offsetting through a site secured by a BioBanking Agreement.
- Potentially securing required credits through the open credit market, off site, if required.
- If suitable offsets are unavailable, contributing money to supplementary measures in accordance with relevant conservation or recovery actions will be investigated.

The following sections present an offset site for the Modification Project that is part of the larger Project Site, hereafter this site will be referred to as the Haerses Road Offset Site.

6.2.1 Location

Table 6.2 below provides a summary of the Haerses Road Offset Site and **Figure 6.1** shows the location of the Offset Site in relation to the Development Site.

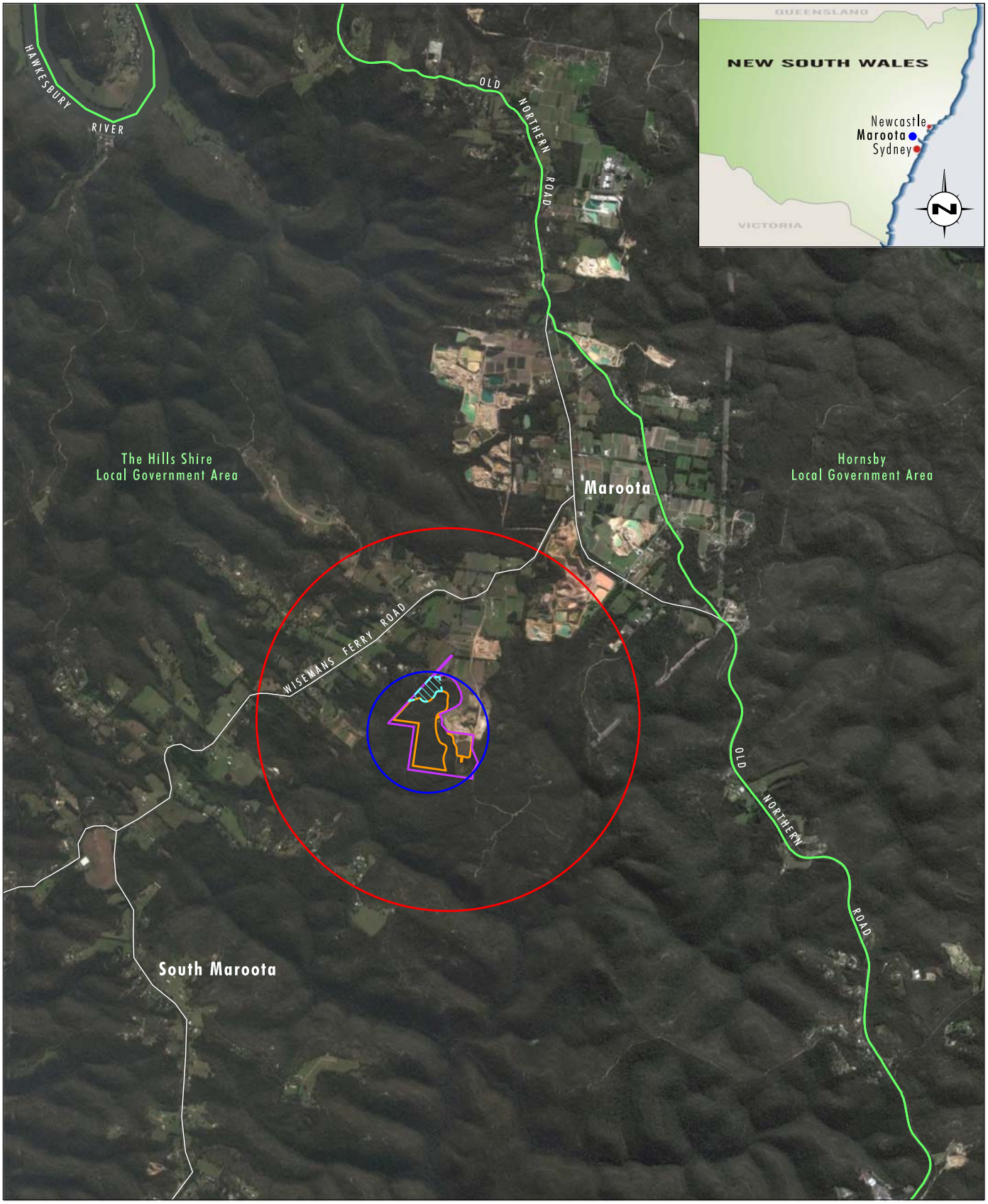


Image Source: Google Earth (2014)
Data Source: LPI (2015)

0 0.5 1.0 2.0km
1:50 000

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Local Government Area Boundary
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle

FIGURE 6.1

Proposed Haerses Road Offset Site

File Name (A4): R04/3479_038.dgn
20160920 11.27

Haerses Road Offset Site adjoins the Development Site to the north, as part of the Modification Project. It occurs on land owned by Dixon Sand, located in the Maroota area, approximately 40 kilometres north of Parramatta, NSW (refer to **Figure 6.1**). Haerses Road Offset Site is located within the Sydney Basin IBRA bioregion and the Yengo IBRA subregion. Refer to **Figure 6.2** and **Figure 6.3** for the location of the offset site and other relevant landscape features.

Table 6.2 Offset Site Location in the Landscape

Haerses Road Offset Site	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Yengo
Major Catchment Area	Hawkesbury/Nepean
Mitchell Landscape	Hornsby Plateau
LGA	The Hills
Address	Haerses Road, Maroota, NSW, 2756

6.2.2 Size

The Haerses Road Offset Site covers approximately 4 hectares.

6.2.3 Topography and Natural Features

The Haerses Road Offset Site lies in the Sydney Basin bioregion, at the top of the local catchment, and drains towards the west. The gradient decreases from approximately 180 ASL in the north to approximately 150 metres ASL in the south west.

Haerses Road Offset Site drains to the Hawkesbury River, approximately 12 km south west, via the first order drainage line into the upper reaches of Stone Chimney Arm (creek), a tributary of Little Cattai Creek and the Broadwater Swamp. The Broadwater Swamp is approximately eight kilometres downstream of the site, connecting Little Cattai Creek to the Hawkesbury River. The local catchment of which the site is a part is shown has an area of approximately 9980 hectares (ERM, 2006).

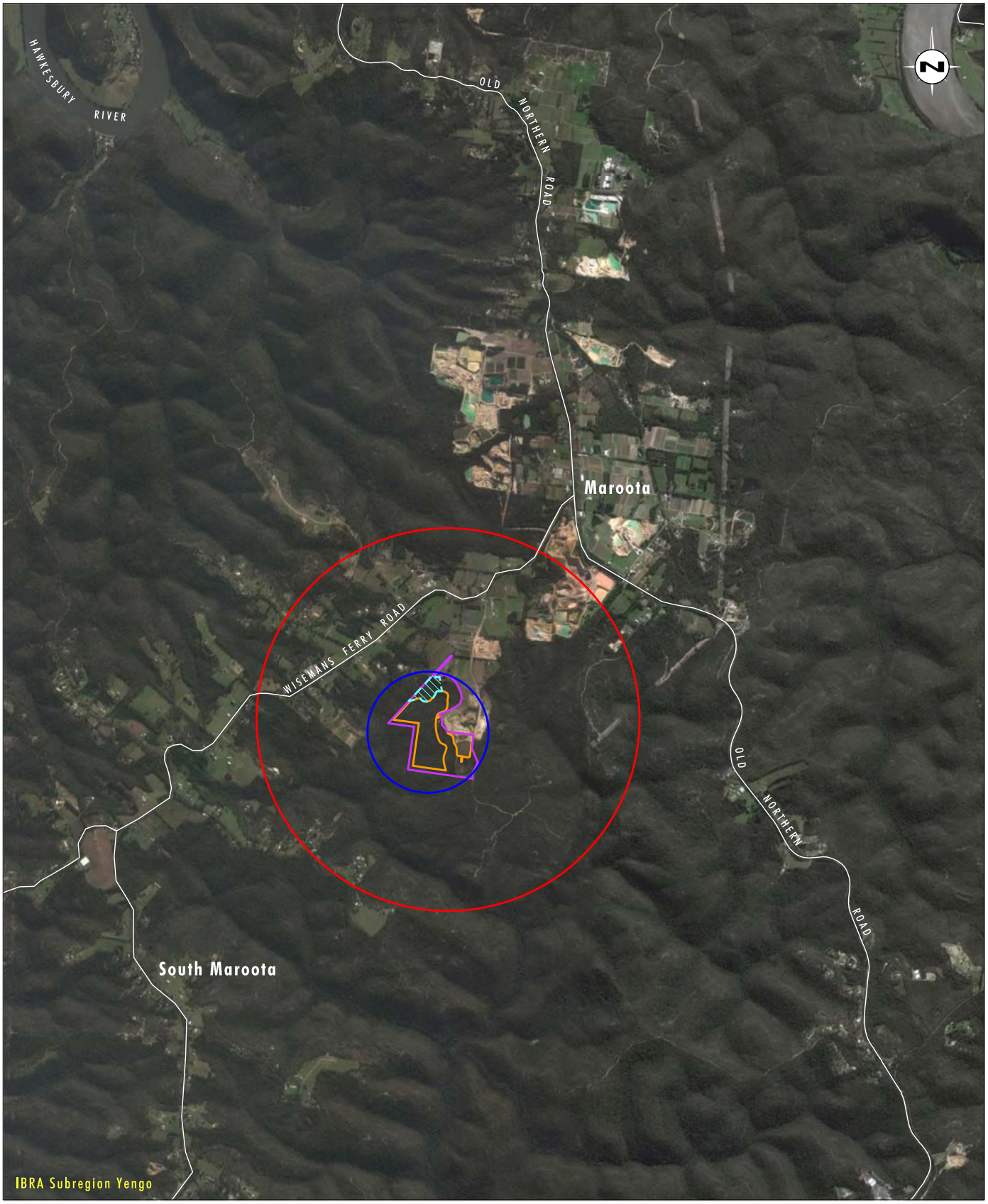


Image Source: Google Earth (2014)
Data Source: IBRA V7 - Australian Government Department of the Environment (2012)

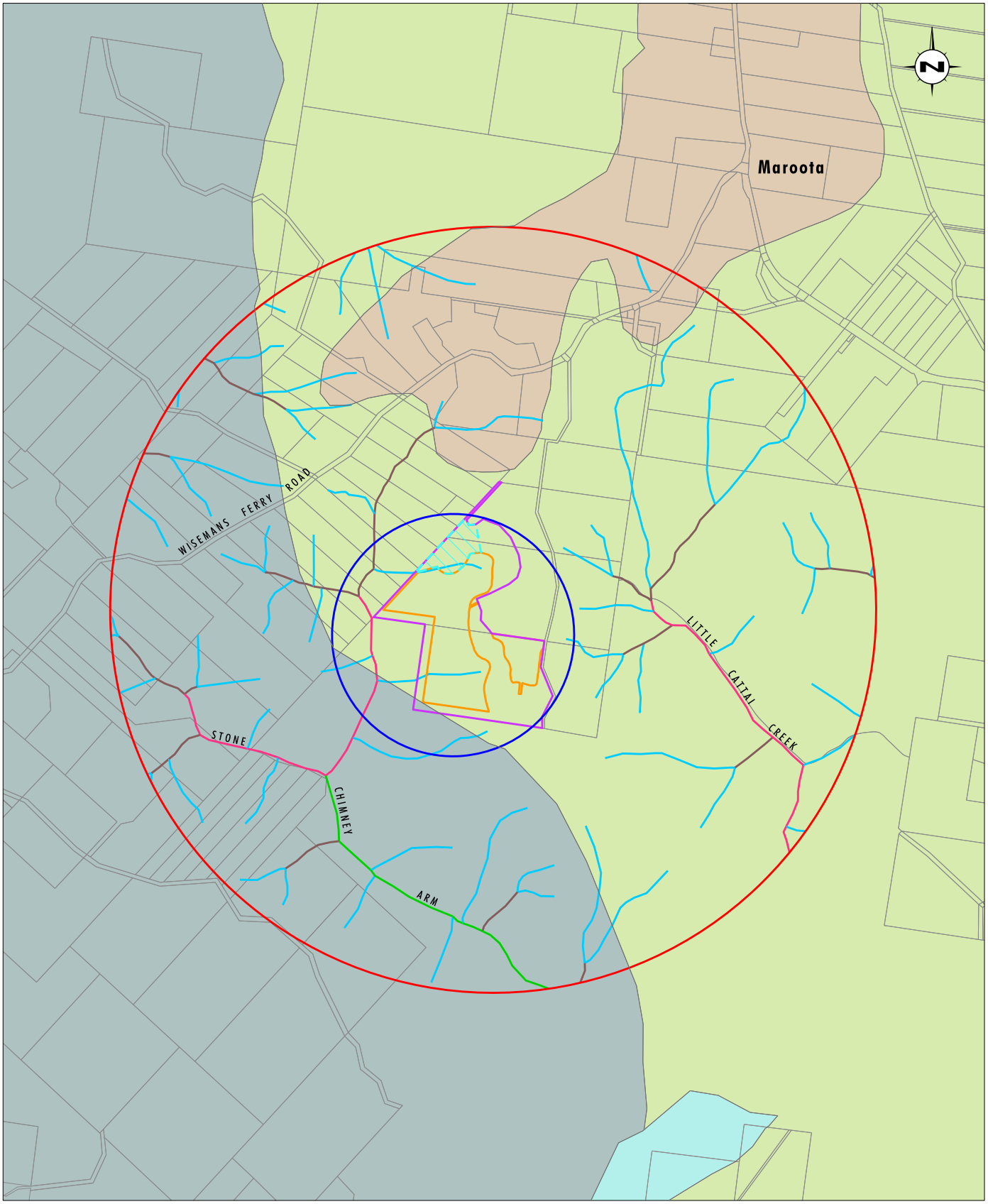
0 0.5 1.0 2.0km
1:50 000

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle

FIGURE 6.2

Haerses Road Offset Site
Location Map - IBRA V7 Regions



Data Source: DECC (2008),LPI (2011)
Note: Site lies within the IBRA Subregion Yengo

0 0.5 1.0 1.25km
1:25 000

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

Mitchell Landscapes:

- Blaxlands Ridge
- Hornsby Plateau
- Maroota Sands
- Sydney Basin Diatremes

FIGURE 6.3

Haerses Road Offset Site
Location Map - Landscape Features

File Name (A4): R04/3479_040.dgn
20160920 11.29

6.2.4 Key Resources, Policies and Documents

The following key resources, policies and documents were used to prepare the Biodiversity Assessment Report for the Haerses Road Offset Site:

- Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects (OEH September 2014)
- BioBanking Assessment Methodology 2008 (DECC July 2008)
- BioBanking Assessment Methodology 2014 (OEH September 2014)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities –Working Draft (DEC 2004)
- BioBanking Credit Calculator (Major Project Assessment Type) Version 4.1, accessed in April 2016
- Vegetation Information System (VIS) Classification Database (OEH 2015), accessed in August 2015
- OEH Atlas of NSW Wildlife database and mapping tool (OEH 2015), accessed in March 2016
- Department of the Environment (DoE) Protected Matters Database (DoE 2015), accessed in March 2016.

6.3 Methods – Haerses Road Offset Site

The threatened species and ecological communities known or likely to occur within the Haerses Road Offset Site were identified by a systematic approach comprising appropriate database searches, a review of recent literature, and targeted field surveys.

6.3.1 Database Searches

Database searches were undertaken to develop a list of Threatened Ecological Communities (TECs) and threatened flora and fauna species that have previously been recorded, or are predicted to occur within 10 kilometres of the boundary of the Haerses Road Offset Site. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring threatened and migratory species and endangered populations. Relevant documents included:

- EPBC Protected Matters Search Tool (30/03/16)
- NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (30/03/16).

As the Haerses Road Offset Site adjoins the northern boundary of the Development Site, assessed under the FBA process and reported above, the same database searches were used for the Haerses Road Offset Site assessment.

Marine species such as albatrosses, petrels, turtles and whales were excluded from the database search results due to an absence of marine habitats in the Haerses Road Offset Site.

A preliminary assessment using the BioBanking Credit Calculator was undertaken, which provided a list of species credit species that might require survey and the suitable survey periods for each species. The results of the database searches, literature review and preliminary assessment using the BioBanking Credit

Calculator were used to design the survey requirements for species credit species to ensure that adequate surveys were undertaken.

The Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC 2004) was considered when undertaking the threatened species surveys in the Development Site.

6.3.2 Systematic Quadrat Surveys

Systematic vegetation quadrats were undertaken within the Modification Area, which encompasses the Haerses Road Offset Site, across two field surveys, the first in November 2014 and the second in December 2015. Detailed information on the timing of these two surveys is provided below in **Section 2.8**.

Systematic vegetation quadrat sites were selected by considering a vast array of attributes that were likely to influence or determine the type of vegetation communities present in the Modification Area. This stratification was done intuitively, based on existing topographic, soil, vegetation and geological mapping. Other factors considered included the spatial coverage of sites across the Modification Area, as well as the topographic position and aspect. Field surveys were undertaken prior to Umwelt being aware of the location of the Haerses Road Offset Site, which resulted in the field survey effort being spread across the Modification Area rather than specifically within the Haerses Road Offset Site.

Each vegetation quadrat comprised 20 metres by 20 metres (400 m^2); a standard size used widely for systematic flora surveys throughout NSW and is recognised by OEH and the Royal Botanic Gardens Sydney. Each quadrat was searched between 45 to 60 minutes for all vascular flora species present. Two ecologists conducted surveys at each quadrat sampled. The highest effort was spent examining the groundcover vegetation, as this stratum supported the majority of species at most sites. Furthermore, effort was also made to search the canopy and trunks of trees for mistletoes, vines and epiphytes.

Information on the structural characteristics of the vegetation in each quadrat was also recorded, and included the height range, canopy cover of each stratum and the dominant species in each stratum. Any species observed outside the quadrat but within the vegetation community being sampled were recorded. Such species were noted as being present but were not assigned cover-abundance values. Flora species cover-abundance data were recorded on a proforma.

6.3.2.1 Plot/Transect Selection and Stratification of the Development Site

Designing an appropriate survey requires consideration of both survey methods and effort. Reference was made to the VIS Classification Database to identify Plant Community Types (PCTs), as well as reviews of other regional and local vegetation mapping and reporting (refer to **Section 7.2.1**) when designing the field survey. The Development Site PCTs were further stratified into Vegetation Zones (condition states) following the initial field survey of the site to determine the appropriate number of transect/plots required in accordance with the FBA methodology (OEH 2014) as outlined in **Table 6.3**. Broad condition states include vegetation in 'Moderate/Good' condition.

Table 6.3 Minimum Number of Plots/Transects Required per Zone Area (OEH 2014)

Vegetation Zone Area (ha)	Minimum Number of Plot/Transect
0-4	1 transect/plot per 2 ha (or part thereof) or 1 transect/plot if vegetation is in low condition
>4-20	3 transects/plots or 2 transects/plots if vegetation is in low condition
>20-50	4 transects/plots or 3 transects/plots if vegetation is in low condition
>50-100	5 transects/plots or 3 transects/plots if vegetation is in low condition
>100-250	6 transects/plots or 4 transects/plots if vegetation is in low condition
>250-1000	7 transects/plots or 5 transects/plots if vegetation is in low condition (More transects/plots may be needed if the condition of the vegetation is variable across the zone)
>1000	8 transects/plots or 5 transects/plots if vegetation is in low condition or in a homogenous landscape in the Western Division (More transects/plots may be needed if the condition of the vegetation is variable across the zone)

Table 6.4 below outlines the adequacy of the plot-based flora survey with respect to the BioBanking Methodology (OEH 2014) pertinent to the Haerses Road Offset Site. Vegetation Zones were identified within the Modification Area prior to Umwelt being aware of the location of the Haerses Road Offset Site, which resulted in the field survey effort being spread across the Modification Area rather than specifically within the Haerses Road Offset Site.

Table 6.4 Adequacy of Vegetation Survey in the Haerses Road Offset Site

Vegetation Zone	BVT and Condition Class	Area in the Haerses Road Offset Site (ha[1])	No. Plots and Transects Sampled (No. Required in parentheses)		
			Plot	Transect	Rapid Sampling
1	HN560_Moderate/Good	0.93^	1 (1)	1 (1)	1
2	HN566_Moderate/Good	0.78^	3 (1)	3 (1)	1
3	HN582_Moderate/Good	1.52^	3 (1)	3 (1)	4
4	HN586_Moderate/Good	0.36^	1 (1)	1 (1)	4
Total		**3.59**	**8 (4)**	**8 (4)**	**10***

[1] All areas are approximate areas despite being shown at two decimal places. Areas are approximate as vegetation type boundaries are based on a combination of field survey and desktop assessment. Additionally, precise boundaries between communities can be difficult or impossible to determine in the field due to the overlap of species in common occurring among vegetation types.

^ These vegetation zones also occur in the wider Modification Area and were sampled during the two field surveys undertaken for this assessment prior to the allocation of the Haerses Road Offset Site. Consequently, all eight plots/transects were completed within the Modification Area but not exclusively within the Haerses Road Offset Site.

* Three additional Rapid Sampling points were completed but occurred in cleared land and therefore is not identified in this table.

6.3.2.2 Plot/Transect Data Collected

At each plot/transect data was recorded according to Appendix 2 of the BioBanking Assessment Methodology (BBAM) and Credit Calculator Operational Manual (DECC 2014). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. The location of the 8 plots/transects undertaken within the Modification Area. Of the 8 plots/transects completed within the Modification Area only one occurs in the Haerses Road Offset Site as shown in **Figure 6.4**.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

Species within the plot were also assigned a cover-abundance value to reflect their relative cover and abundance in the plot. Species located outside the plot (recorded to assist in vegetation community identifications and mapping) were marked as present but were not assigned a cover-abundance value. A modified Braun-Blanquet 6-point scale was used to estimate cover-abundances of all plant species within each quadrat (Braun-Blanquet 1927), with selected modifications sourced from Poore (1955) and Austin *et al*. (2000). **Table 6.5** shows the cover-abundance categories used. Voucher specimens were collected of species that could not be identified in the field for later identification. The following specimens were sent to NSW Royal Botanic Gardens and formally identified:

- crimson bottlebrush (*Callistemon citrinus*)
- *Darwinia biflora*
- *Darwinia fascicularis*
- *Grevillea parviflora* supbsp. *supplicans*
- *Hibbertia superans*
- peach blossom tea-tree (*Leptospermum squarrosum*) and
- *Tetratheca glandulosa*.

Table 6.5 Modified Bran-Blanquet Crown Cover-Abundance Scale

Class	Cover-abundance^	Notes
1	Few individuals (less than 5% cover)	Herbs, sedges and grasses: <5 individuals Shrubs and small trees: <5 individuals
2	Many individuals (less than 5% cover)	Herbs, sedges and grasses: 5 or more individuals Shrubs and small trees: 5 or more individuals Medium-large overhanging tree
3	5 – less than 20% cover	Applies to all species.
4	20 – less than 50% cover	
5	50 – less than 75% cover	
6	75 – 100% cover	

Note: at the time of survey, the updated BioBanking and FBA Methodology (OEH 2014) had not been released including the new requirements for abundance ratings and therefore the modified Braun-Blanquet 6-point scale was used for Cover-Abundance measures. Modified Braun-Blanquet scale (Poore 1955; Austin *et al*, 2000).

At each standard flora quadrat, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover, and
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other), and
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

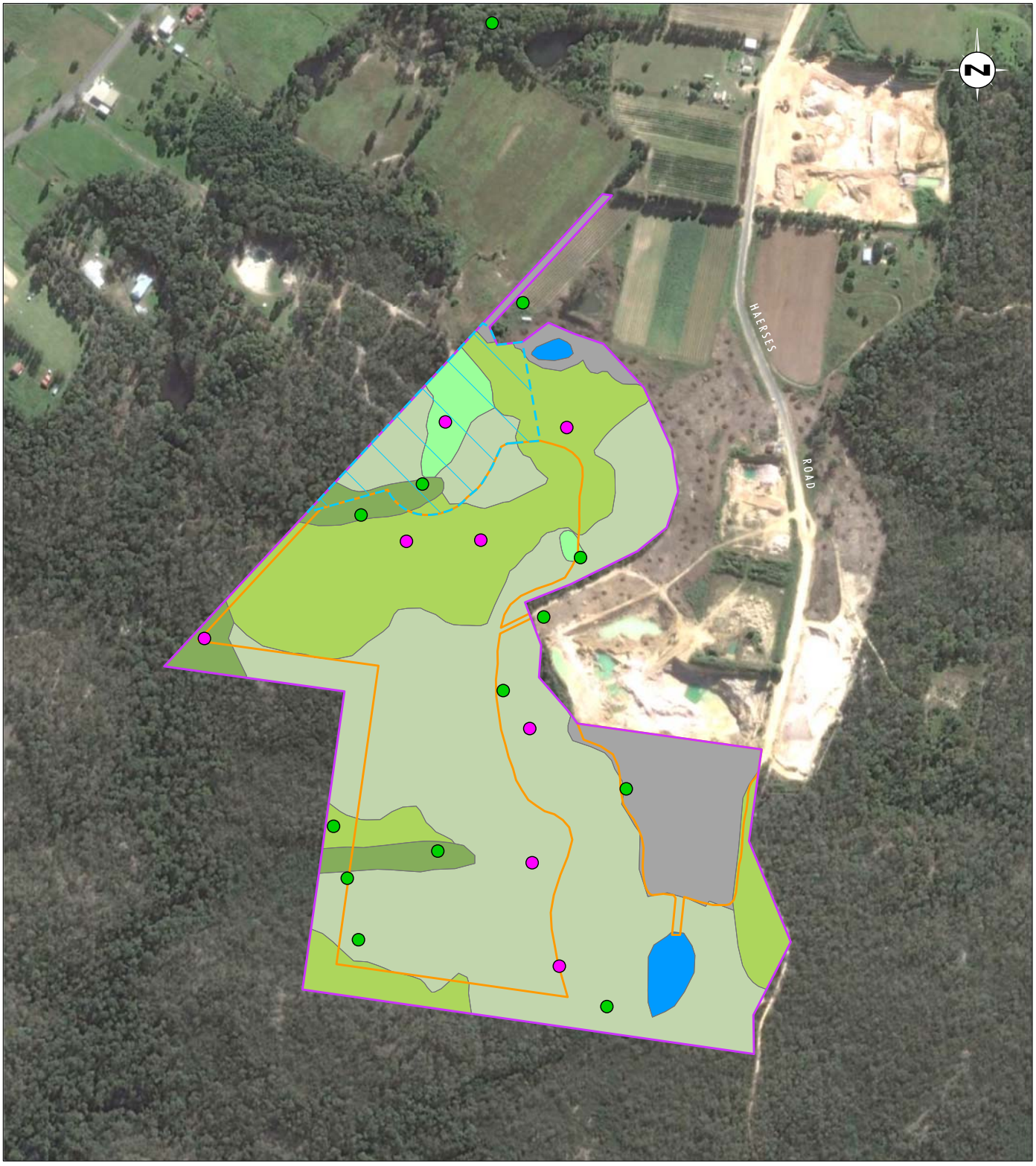


Image Source: Google Earth (2014)

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Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition
- Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition
- Cleared
- Dam
- Flora Plot/Transects
- Semi-quantitative Rapid Sampling Plot

FIGURE 6.4

Flora Survey Locations

6.3.3 Semi-quantitative Rapid Sampling

A total of 13 semi quantitative rapid assessments plots were completed in the Modification Area to collect information about the vegetation, of which only one occurs within the Haerses Road Offset Site. Assessment areas were not fixed area-based, but were generally confined to an area similar to that of a 10 x 10 metre quadrat. Rapid assessments were used to document the characteristics of vegetation over large areas.

Rapid vegetation assessment points were located within distinct vegetation community units (rather than within ecotones) to allow data collection for each community without confounding effects from adjacent communities. Dominant, common and some uncommon plant taxa were recorded within each rapid vegetation assessment points, along with cover abundance scores as per **Table 6.5**. The vegetation structure at each rapid vegetation assessment point was documented, including each stratum's height, percent foliage cover and dominant species. Rapid assessment plots were later transferred into a geographical information system (GIS) to aid vegetation community mapping and description. **Figure 6.4** shows the location of the 13 rapid assessment plots completed across the Modification Area.

6.3.4 Plant Identification and Nomenclature Standards

All vascular plants recorded or collected within plots and quadrats were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Jacobs *et al.* (2008). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2015), the online plants name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name. Where the identity of a specimen was unknown or uncertain, it was lodged with the National Herbarium of New South Wales at the Royal Botanic Gardens Sydney.

6.3.5 Targeted Threatened Ecological Community Investigations

Vegetation communities identified in the Haerses Road Offset Site were compared to TECs listed under the Commonwealth EPBC Act and NSW TSC Act and an assessment of similarity with the NSW Scientific Committee Final Determinations and the Commonwealth Threatened Species Scientific Committee Listing and Conservation Advice.

Six TECs were identified as potentially occurring in the Haerses Road Offset Site. The six listed communities are:

- Coastal Upland Swamps in the Sydney Basin Bioregion
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Shale/Sandstone Transition Forest
- Subtropical and Temperate Coastal Saltmarsh
- Turpentine-Ironbark Forest in the Sydney Basin Bioregion and
- Western Sydney Dry Rainforest and Moist Woodland on Shale.

6.3.6 Targeted *Darwinia biflora* Survey

The initial field survey determined that it was impractical to count and mark each individual plant of *Darwinia biflora* in the Modification Area given the potential for large numbers. Instead, the numbers of *D. biflora* were counted within standard 10 x 10 metre or 20 x 20 metre plots (depending on density) during the initial survey in November 2014. This species was recorded in the Sandstone Heath (Heath/Woodland Complex) and Sandstone Ridgetop Woodland.

Further survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, none of the stratified plots targeting *Darwinia biflora* were completed within the area that has now been identified as the Haerses Road Offset Site.

Due to the sporadic nature in which the species occurs in the Modification Area, the impacts to *D. biflora* was assessed by area of habitat rather than the number of individuals. Typically, impacts to flora species should be assessed based on the number of individuals as indicated in Section 10.4.4.2 of the FBA methodology (OEH, 2014). However in the case of sporadically occurring plant species like *D. biflora* it is permitted to assessed the impacts by area of habitat. The NSW Guide to Surveying Threatened Plants (OEH, 2016b) states that impacts to a threatened species can be assessed as area of habitat as long as the surveyor considers the history of land use and/or disturbance and previous surveys of the species at the site. The survey effort undertaken by Umwelt in the Modification Area identified that the population of *D. biflora* could not be accurately measured due to the sporadic nature in which it occurs.

6.3.7 Flora Survey Timing and Effort

The vegetation of the Modification Area was surveyed in two events. The first during spring, from 25 to 27 November 2014 and the second in summer, from 14 to 17 December 2015. All surveys were completed by two Ecologists. A total of 14 person-days, six initially and eight later, were completed to sample the vegetation communities and flora species within the Modification Area.

The following survey effort was completed across the Modification Area and Haerses Road Offset Site (refer to **Figure 6.4**):

- Eight 400 m^2 flora plots, one of which occurs in Haerses Road Offset Site
- Thirteen semi-qualitative rapid assessment plots, one of which occurs in Haerses Road Offset Site.

6.3.8 Fauna Survey Timing and Effort

Fauna surveys across the Modification Area were undertaken from 25 to 27 November, 2014 as well as on 16 December, 2015. Fauna survey effort was designed in consideration of the following survey guidelines:

- Department of Environment, Water, Heritage and the Arts (DEWHA) (2010a). Survey Guidelines for Australia's Threatened Birds

- DEWHA (2010b). Survey Guidelines for Australia's Threatened Frogs
- DEWHA (2011a). Survey Guidelines for Australia's Threatened Reptiles
- DEWHA (2011b). Survey Guidelines for Australia's Threatened Mammals.

6.3.9 Trapping and Remote Surveys

Terrestrial Hair Funnels

Terrestrial Faunatech hair funnels were baited with a rolled oats and peanut butter mixture. All terrestrial hair funnels were positioned amongst habitat features such as logs, fallen bark, rocks and ground cover. Three lines of 20 hair funnels were left in position from 25 November 2014 to 23 December 2014 (refer to **Figure 6.5**). All hair samples collected were identified by Barbara Triggs (a recognised expert in the field of hair and scat identification).

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, no hair funnels were located within the area that has now been identified as the Haerses Road Offset Site.

Remote Cameras

During November and December 2014, remote camera surveys were conducted to target terrestrial mammal species at 10 locations across the Modification Area. At each site, a Bushnell Trophy Cam HD remote camera was mounted approximately 1 metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey. Cameras were set to take three photos in quick succession when movement was detected. Remote cameras were set at each site for 28 days resulting in a total of 280 camera day/nights of survey. The locations of the remote cameras are displayed on **Figure 6.5**.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, only one remote camera was located within the area that has now been identified as the Haerses Road Offset Site.

Micro-bat Echolocation Recordings

Echolocation calls emitted by micro-bats were detected using an Anabat II Bat Detector. Echolocation calls were recorded using an Anabat CF storage ZCAIM or an Anabat SD2 unit. The combination of detector and recording device is hereafter collectively referred to as the 'Anabat echolocation recorder'. The Anabat echolocation recorders were positioned at an approximate 30 degree angle and 1 metre above the ground in waterproof housing. While micro-bat activity is likely to be reduced during rain, calls were still able to be collected during dry parts of the night (particularly nights with brief thunderstorms).

Anabat echolocation recorders were positioned within the vicinity of potential micro-bat flyways. The recorders were automated and programmed to start recording one hour before dusk and to stop recording one hour after sunrise the following morning. Recordings were collected over two to four nights at each Anabat echolocation recording location.

All micro-bat species were identified by Anna McConville of Echo Ecology Pty Limited (a recognised expert in the identification of micro-bat calls). The location of Anabat surveys are shown on **Figure 6.5**. Micro-bat echolocation recordings were undertaken at three locations.

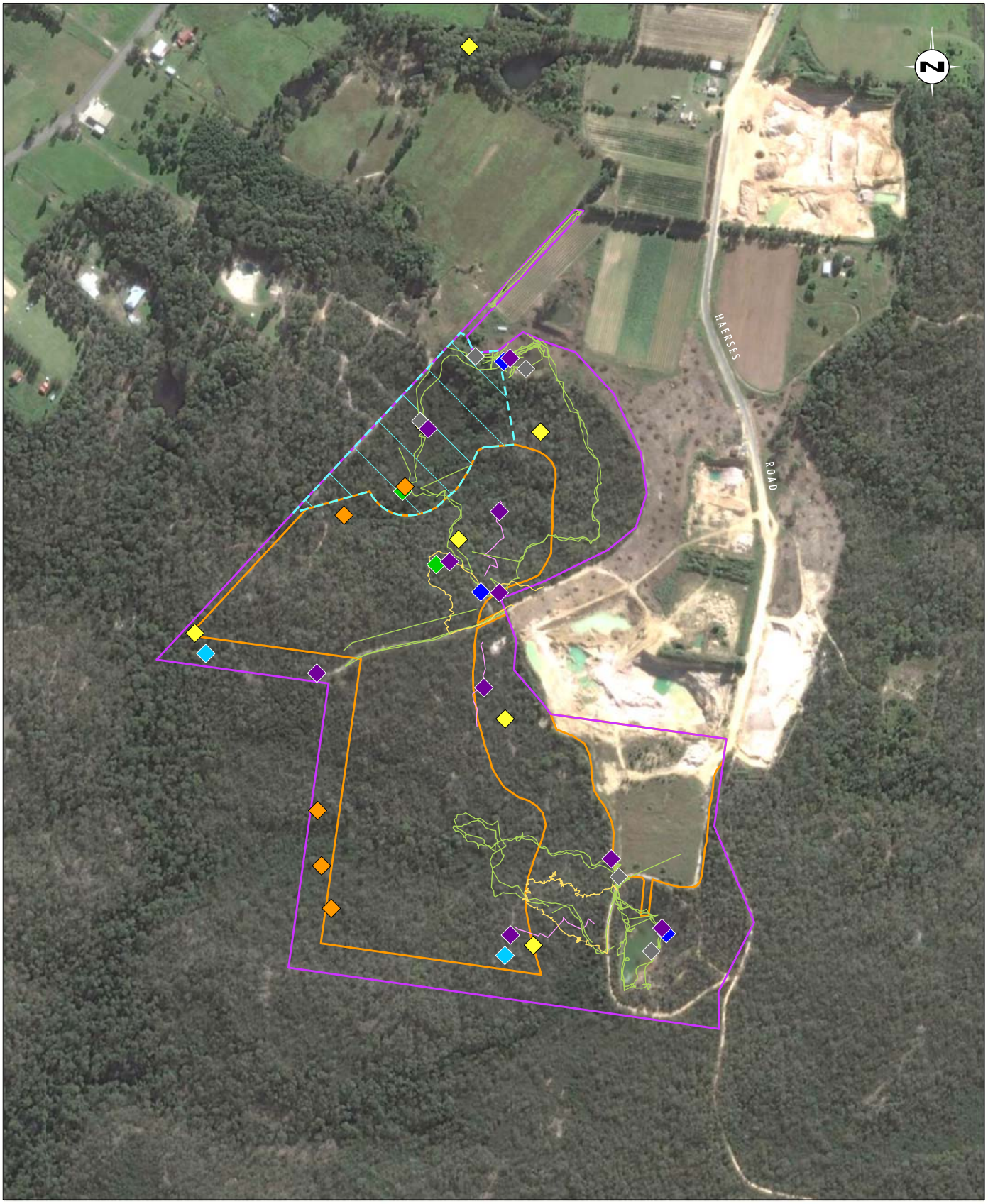

Image Source: Google Earth (2014)

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1:7500

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Dural woodland snail search
- Spotlighting Search
- Terrestrial Hair Funnel Line
- Anabat
- Bird Search
- Habitat Assessments and SAT Test
- Nocturnal Call Playback
- Remote Camera
- Reptile Search
- SAT Test

FIGURE 6.5

Fauna Survey Locations

File Name (A4): R04/3479_042.dgn
20160920 11.37

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, no Anabat units were located within the area that has now been identified as the Haerses Road Offset Site. One unit was however located on the north eastern boundary.

6.3.10 Area-based searches

Spotlighting Searches

Spotlighting searches were undertaken both on foot and from a moving vehicle (refer to **Figure 6.5**). Walking spotlighting searches were undertaken by two observers for a period of one hour (total of two person hours) on each occasion. Vehicle spotlighting searches were undertaken by the passenger(s) from a slow moving vehicle along vehicle tracks between trapping sites. Both walking and vehicle spotlighting searches were conducted using 30 watt Lightforce spotlights.

Reptile and Amphibian Searches

Diurnal searches targeting the Broad-headed snake, *Hoplocephalus bungaroides*, and Rosenberg's goanna, *Varanus rosenbergi*, were undertaken during the warmest parts of the day. Diurnal searches were undertaken by a single person for half an hour on two separate days (refer to **Figure 6.5**). Nocturnal searches targeted the red-crowned toadlet, *Pseudophryne australis*, and giant burrowing frog, *Heleioporus australiacus*. Nocturnal reptile and amphibian searches were undertaken by two people for one hour on two occasions using Petzl headlamps and/or 30 watt Lightforce spotlights. Diurnal and nocturnal searches were undertaken by two ecologists for a period of at least 30 minutes during each search.

Habitat features investigated during reptile and amphibian searches included water bodies, emergent vegetation, wet soak areas, logs, rocks, loose bark on tree trunks, exposed bedrock, leaf litter, and open grassland areas. Amphibians not identifiable from their calls were captured for visual identification. All amphibians were handled according to the hygiene protocol for the control of disease in frogs (Wellington and Haering 2001). Non-venomous snake species and small lizards were captured for identification where necessary.

Bird Searches

Bird searches were undertaken at the trap and hair funnel sites (refer to **Figure 6.5**) at various times of the day, primarily during early to mid morning and mid to late afternoon. Bird searches were undertaken for one person hour (by one or two observers) at two locations. Opportunistic observations were recorded during all other aspects of the field surveys, particularly while checking traps and when travelling between survey sites. Bird species were identified by characteristic calls and by observation using 10 x 24 binoculars.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, only one bird survey was located within the area that has now been identified as the Haerses Road Offset Site.

Dural Woodland Snail Searches

Targeted spotlighting searches for the Dural woodland snail (*Pommerhelix duralensis*) were completed on 16 December 2016 by two observers. These searches were completed on foot at two separate locations within the Development Site (refer to **Figure 6.5**) for a period of 40 and 70 minutes (total of 1.3 and 2.3 person hours). Walking spotlighting searches were conducted using Petzl headlamps and/or 30 watt Lightforce spotlights. Photographs and specimen measurements of the recorded Dural woodland snail were sent to the Australian Museum for identification.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, no Dural woodland snail searches were located within the area that has now been identified as the Haerses Road Offset Site.

Signs of Presence Searches

Searches for indirect evidence of animal presence were conducted opportunistically during all survey activities, particularly during habitat searches and reptile and amphibian searches. Due to the opportunistic nature of signs of presence surveys, the level of survey effort was not recorded. Evidence of presence included scats, feathers, nests, burrows, bones, tufts of hair and scratch marks on trees. All hair, scat and bone samples were identified by Barbara Triggs.

Habitat Assessments

Seven habitat assessments were undertaken across the range of habitat types present in the Modification Area (refer to **Figure 6.5**). The assessment targeted potential habitat and resources for fauna species, particularly threatened fauna species.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, only one habitat assessment was located within the area that has now been identified as the Haerses Road Offset Site.

Records of a number of habitat features were made at each site, including:

- Evidence of disturbance such as fire, weeds, feral animals, dumping, erosion and logging
- Presence of stumps and stags
- Presence of fallen timber/logs
- Presence of dieback and/or insect attack
- Mistletoe presence
- Presence of perch sites, fallen and loose bark
- Vegetation strata and composition
- Tree size class (trunk diameter), and age (old growth, mature, regenerating, saplings)
- Presence of other specific feed tree species (such as for cockatoos and honeyeaters) and
- Collection of detailed hollow data, including tree species and height, hollow size, orientation, position, and height of hollow).

Habitat features such as tree hollows and fallen logs were inspected for any evidence of fauna occupation such as scratches on the trunks of trees, chewed entrances to hollows, scratching or diggings near logs and scats at the base of trees or near logs.

Nocturnal Call Playback

Nocturnal call playback sessions were undertaken at five sites within the first 4 hours after dusk. Calls were broadcast using a 10 watt directional loud hailer. Call playback sessions commenced and ended with a quiet listening period of approximately two minutes. Each species' call was played for a minimum of four minutes followed by a listening period of two minutes before the beginning of the next species' call. Mammal calls were played before bird calls to prevent the calls of predators (such as owls) decreasing the likelihood of prey species (such as gliders) responding to call playback. Call playback sessions included the calls of the following species:

- Giant burrowing frog (*Heleioporus australiacus*)
- Red-crowned toadlet (*Pseudophryne australis*)
- Squirrel glider (*Petaurus norfolcensis*)
- Koala (*Phascolarctos cinereus*)
- Masked owl (*Tyto novaehollandiae*)
- Sooty owl (*Tyto tenebricosa*)
- Barking owl (*Ninnox connivens*) and
- Powerful owl (*Ninnox strenua*).

Fauna Survey Effort Summary

Table 6.6 summarises the trapping and remote camera survey effort undertaken across the Modification Area during spring 2014.

Table 6.6 Summary of Fauna Trapping and Remote Survey Effort

Trapping Method	Number of trap nights – Spring 2014
Terrestrial hair funnel	1680
Anabat echolocation (entire nights)	6
Remote cameras	280

Note: One trap night equals one trap/camera/detector set for one night.

Table 6.7 summarises the area search effort undertaken across the Modification Area during spring 2014.

Table 6.7 Summary of Fauna Area Search Effort

Survey Method	Spring 2014	Summer 2015
Bird surveys (person hours)	2	-
Koala SAT	12	-
Diurnal reptile and amphibian surveys (person hours)	1	-
Nocturnal reptile and amphibian surveys (person hours)	4	-
Walking spotlight	4	-
Dural woodland snail spotlight (person hours)	-	7.2
Driving spotlight	Undertaken opportunistically, kilometres not recorded	-
Nocturnal call playback	5	-

6.4 Threatened Species

6.4.1 Species-credit Flora Surveys

Species-credit flora surveys were undertaken over 7 days and 2 survey periods:

- 25 to 27 November 2014 and
- 14 to 17 December 2015.

The November 2014 field survey was undertaken at a time which was suitable for detection of most targeted species. An additional targeted species survey was undertaken in December 2015 to focus primarily on threatened flora species as the earlier survey was combined with fauna survey efforts. It should be noted that all threatened flora species are species-credit species under the BioBanking Assessment Methodology (OEH 2014).

A preliminary list of species-credit flora species with potential to occur in the Haerses Road Offset Site was generated during the literature review, completion of database searches and preliminary assessment using the BioBanking Credit Calculator. The preliminary list of potentially occurring species credit species was reviewed to remove species that are not known to occur in the local area or species for which there was a lack of suitable habitat in the Haerses Road Offset Site. **Table 6.8** identifies the species-credit flora species that were identified through the BioBanking Credit Calculator, we have amended the table to identify those species that have potential to occur in the Development Site and required targeted and seasonal surveys, as well as those that do not.

Table 6.8 Species-credit Flora Species Requiring Targeted Survey

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Potential to Occur					
Acacia gordonii	*Acacia gordonii*	E	E	All Year	BBCC
Ancistrachne maidenii	*Ancistrachne maidenii*	V	-	December – February	BBCC
Asterolasia elegans	*Asterolasia elegans*	E	E	All Year	BBCC
brown Pomaderris	*Pomaderris brunnea*	E	V	All Year	BBCC
Bynoes wattle	*Acacia bynoeana*	E	V	September – March	BBCC
clandulla geebung	P*ersoonia marginata*	V	V	All Year	BBCC
Darwinia biflora	*Darwinia biflora*	V	V	September – February	BBCC
Darwinia fascicularis subsp. *oligantha* population, Baulkham Hills and Hornsby Local Government Areas	*Darwinia fascicularis* subsp. *oligantha* - endangered population	EP	-	All year	BBCC
Darwinia peduncularis	*Darwinia peduncularis*	V	-	All Year	BBCC
Grevillea parviflora subsp*. supplicans*	*Grevillea parviflora* subsp*. supplicans*	E	-	All year	BBCC
hairy geebung	*Persoonia hirsuta*	E	E	December – May	BBCC
Hibbertia superans	*Hibbertia superans*	E	-	July – December	BBCC
Kunzea rupestris	*Kunzea rupestris*	V	V	All Year	BBCC

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E	-	All Year	BBCC
Micromyrtus blakelyi	*Micromyrtus blakelyi*	V	V	All Year	BBCC
Olearia cordata	*Olearia cordata*	V	V	All Year	BBCC
Pimelea curviflora subsp. *curviflora*	*Pimelea curviflora* subsp. *curviflora*	V	V	All Year	BBCC
spreading guinea flower	*Hibbertia procumbens*	E	-	December - March	BBCC
Tetratheca glandulosa	*Tetratheca glandulosa*	V	-	July – November	BBCC
Zieria involucrata	*Zieria involucrata*	E	-	All Year	BBCC
Unlikely to Occur					
downy wattle	*Acacia pubescens*	V	V	All Year	BBCC
Epacris purpurascens subsp. *purpurascens*	*Epacris purpurascens* subsp. *purpurascens*	V	-	All Year	BBCC
Eucalyptus sp. Cattai	*Eucalyptus* sp. Cattai	CE	-	All Year	BBCC
groves paperbark	*Melaleuca groveana*	V	-	All Year	BBCC
Gyrostemon thesioides	*Gyrostemon thesioides*	E	-	All Year	BBCC
Hibbertia puberula	*Hibbertia puberula*	E	-	September – February	BBCC
Leptospermum deanei	*Leptospermum deanei*	V	V	All Year	BBCC
netted bottle brush	*Callistemon linearifolius*	V	-	September – March	BBCC
Pultenaea parviflora	*Pultenaea parviflora*	E	V	All Year	BBCC

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
singleton mint bush	*Prostanthera cineolifera*	V	V	All Year	BBCC
Velleia perfoliata	*Velleia perfoliata*	V	V	September - November	BBCC

^ Months that surveys are required according to the Threatened Species Profile Database for the Hawkesbury Nepean CMA.

Throughout flora surveys of the Haerses Road Offset Site, targeted searches were carried out for threatened flora species that are known to occur in the vicinity of the Haerses Road Offset Site or were considered likely to occur based on the species' known distribution and the presence of suitable habitat. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot and transect surveys.

Further survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, none of the stratified plots targeting *Darwinia biflora* were completed within the area that has now been identified as the Haerses Road Offset Site.

The seasonal requirements of all species-credit flora species with potential to occur within the Haerses Road Offset Site were met between the combination of the November 2014 and December 2015 survey periods.

6.4.2 Species-credit Fauna Surveys

Species-credit fauna surveys were undertaken over 6 days and two survey periods:

- 25 to 27 November 2014
- 14 to 17 December 2015.

A preliminary list of species-credit fauna species with potential to occur in the Haerses Road Offset Site was generated during the literature review, completion of database searches and preliminary assessment using the BioBanking Credit Calculator (BBCC). The preliminary list of potentially occurring species-credit fauna species was reviewed to remove species that are not known to occur in the local area or species for which there was a lack of suitable habitat in the Haerses Road Offset Site. **Table 6.9** identifies the species-credit fauna species that were identified through the BioBanking Credit Calculator, we have amended the table to identify those species that have potential to occur in the Haerses Road Offset Site and required targeted and seasonal surveys, as well as those that do not.

Table 6.9 Species-credit Fauna Species Requiring Targeted Survey

Common Name	Scientific Name	TSC Status	EPBC Status	Required Survey Period^	Source
Potential to Occur					
brush-tailed phascogale	*Phascogale tapoatafa*	V	-	All Year	
eastern pygmy-possum	*Cercartetus nanus*	V	-	Not specified	BBCC
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	EP	-	All Year	BBCC
giant burrowing frog	*Heleioporus australiacus*	V	V	September - May	BBCC
koala	*Phascolarctos cinereus*	V	V	All Year	BBCC
red-crowned toadlet	*Pseudophryne australis*	V	-	All Year	BBCC
regent honeyeater	*Anthochaera phrygia*	E	CE	All Year	BBCC
Rosenbergs Goanna	*Varanus rosenbergi*	V	-	November – February	BBCC
squirrel glider	*Petaurus norfolcensis*	V	-	All Year	BBCC
Unlikely to Occur					
giant barred frog	*Mixophyes iteratus*	E	E	October – April	BBCC

^ Months that surveys are required according to the Threatened Species Profile Database for the Hawkesbury Nepean CMA.

Targeted surveys were undertaken for the species listed in **Table 6.9** that included a range of survey techniques including targeted searches, hair funnel trapping, call playback, anabat echolocation, spotlighting and remote detection camera surveys. Throughout surveys of the Modification Area, opportunistic surveys for these species were undertaken in suitable habitat along numerous walking meandering transects. The seasonal requirements of all species-credit flora species with potential to occur within the Modification Area were met between the combination of the November 2014 and December 2015 survey periods. The details of these surveys are discussed in the sections below and specific survey locations are shown on **Figure 6.5.**

6.4.2.1 Regent Honeyeater Surveys

Diurnal bird surveys, each of one person-hour, were undertaken in two locations within the Haerses Road Offset Site in November 2014. Bird surveys were undertaken at various times of the day, primarily in early to mid morning and mid to late afternoon. Each survey consisted of a slow walking transect within a Haerses Road Offset Site. The bird surveys targeted areas of flowering eucalypt woodlands containing other nectarivorous species such as lorikeets and honeyeaters.

Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10 x. Opportunistic observations were recorded during all other aspects of the field survey.

6.4.2.2 Eastern Pygmy Possum and Squirrel Glider Surveys

Eastern pygmy possum and squirrel glider were targeted by conducting spotlighting and remote camera surveys. Additionally, nocturnal call playback surveys were undertaken for squirrel glider.

Nocturnal spotlighting surveys, each of two person-hours repeated over two nights, were undertaken in three locations within the Modification Area, of which one occurs within the Haerses Road Offset Site. Spotlighting was conducted on foot using 30 watt Lightforce hand-held spotlights and head torches. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk. In addition, spotlighting was undertaken from a slow-moving vehicle along vehicle tracks and while travelling between trapping locations at night.

Bushnell Trophy Cam HDs (remote cameras) were mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey to increase the likelihood of detecting the eastern pygmy possum. The cameras were set to take three photos in quick succession when movement was detected. The remote cameras were programmed to record movement on an ongoing basis until removed from the site. The cameras were installed for 28 nights in 10 locations, totalling 280 nights of remote camera survey. Of the ten cameras used within the Modification Area, one was located within the Haerses Road Offset Site.

Nocturnal call-playback sessions targeting squirrel glider were undertaken at four locations within the Modification Area, one of which occurs within the Haerses Road Offset Site. An additional location was surveyed immediately north of the Development Site for context. Call-playback sessions commenced with a quiet listening period of approximately five minutes. The squirrel glider call was played on a 15 watt directional loud hailer for a minimum of 4 minutes followed by a listening period of 2 minutes.

6.4.2.3 Koala Surveys

Koalas were targeted by conducting nocturnal call playback and walking and driving spotlighting surveys.

Nocturnal spotlighting surveys, each of one person-hour repeated over two nights, were undertaken in three locations within the Modification Area, of which one occurs in the Haerses Road Offset Site. Walking spotlighting searches were conducted by two observers for a period of one hour (total of two person hours)

on each occasion. Vehicle spotlighting searches were undertaken by the passenger(s) from a slow moving vehicle along vehicle tracks between trapping sites. Both walking and vehicle spotlighting searches used a 30 watt Lightforce hand-held spotlight and head torch for detecting fauna. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk.

Nocturnal call-playback sessions targeting koala were undertaken at four locations within the Modification Area of which one occurs in the Haerses Road Offset Site. An additional location was surveyed immediately north of the Development Site for context. Call-playback sessions commenced with a quiet listening period of approximately five minutes. The koala call was played on a 15 watt directional loud hailer for a minimum of 4 minutes followed by a listening period of 2 minutes.

Searches for signs of the presence of koalas were undertaken at 12 locations across the Modification Area in using the Spot Assessment Technique (SAT). Searches were conducted on and around the base of 10 – 30 trees at every survey site. The searches focussed on signs of presence including scats at the base of trees and characteristic scratches on tree trunks.

6.4.2.4 Amphibian Surveys

The BioBanking Calculator predicted the occurrence of red-crowned toadlet (*Pseudophryne australis*) and giant burrowing frog (*Heleioporus australiacus*) due to the geographic habitat feature of land within 100 metres of a waterbody and land within 40 metres of woodland within the Hawkesbury/Nepean catchment area, respectively. Despite these habitat features being present at the site in the form of woodland and two dams, no permanent streams with substantial fringing vegetation occur in the Development Site.

Despite this, diurnal herpetological searches were undertaken in 2 locations across the Modification Area. During the search likely micro-habitats were examined including around waterbodies, beneath rocks and logs, in tree bark and in ground litter. Each survey consisted of approximately one person hour of survey, totalling 1 hour of diurnal herpetological surveys. At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, no herpetological search was completed within the area that has now been identified as the Haerses Road Offset Site.

Nocturnal spotlighting surveys, each of two person-hours repeated over two nights, were also undertaken in three locations within the Referral Area, of which was located within Haerses Road Offset Site. Spotlighting was conducted on foot using 30 watt Lightforce hand-held spotlights and head torch. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk and targeted relevant habitat features such as water bodies, emergent vegetation, wet soak areas and riparian zones.

6.4.2.5 Micro-bat Habitat Surveys

The presence of threatened micro-bat species was also surveyed using Anabat SD1 recorders at two locations within the Referral Area of which one occurs on the north eastern boundary of the Haerses Road Offset Site. At each site, the Anabat was positioned at an approximate 30 degree angle one metre above the ground in waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over waterbodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Anna McConville of Echo Ecology Pty Limited (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three levels of confidence:

- confident
- probable, and
- possible.

7.0 Results - Haerses Road Offset Site

7.1 Landscape Value

7.1.1 Landscape Features

The outer assessment circle contains some prominent landscape features including sections of 4th order streams, Stone Chimney Arm Creek and Little Cattai Creek. The outer assessment circle also covers multiple Mitchell landscapes and an extensive area of native vegetation predominantly in the east, south and west of the circle. These landscape features are shown in **Figures 6.2** and **6.3**.

Landscape features that were considered in the connectivity value scores for the Haerses Road Offset Site are outlined in **Table 7.1** below.

Table 7.1 Landscape Features in the Haerses Road Offset Site

Landscape Features	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Yengo – Hawkesbury/Nepean
Mitchell Landscape	Hornsby Plateau
Rivers, Streams, Estuaries	1st order streams from Stone Chimney Arm Creek
Wetlands	None identified
Native Vegetation	43.67 hectares in the inner assessment circle 726.69 hectares in the outer assessment circle
State or Regional Biodiversity Links	None identified

7.1.2 Landscape Value Scores

7.1.2.1 Percent Native Vegetation Cover

Table 7.2 details the percent native vegetation cover before and after the BioBanking Offset Agreement in the Haerses Road Offset Site and the native vegetation per cent class entered into the BioBanking Calculator as per Table 9 of Appendix 4 of the FBA (OEH 2014).

Table 7.2 Native Vegetation Cover in Assessment Circles

Assessment Circle	Before BioBanking Offset Agreement			After BioBanking Offset Agreement		
	Area of Native Vegetation (ha)	Native Vegetation Cover (%)	Native Vegetation Percent Class	Area of Native Vegetation (ha)	Native Vegetation Cover (%)	Native Vegetation Percent Class
Outer (1,000 ha)	726.69	72.66	71-75	726.69	72.66	71-75
Inner (100 ha)	43.67	43.67	41-45	43.67	43.67	41-45

7.1.2.2 Connectivity Value

No state or regional significant biodiversity links were identified within a plan approved by the Chief Executive of OEH in the Yengo – Hawkesbury/Nepean. Although a number of first order streams of tributaries of Stone Chimney Arm Creek run through the Haerses Road Offset Site, these are not defined as state or regional significant biodiversity links under the FBA (OEH 2014) (refer to **Figure 7.1**).

Connecting links using moderate to good condition native vegetation were found on the site to occur in all woodland communities in the Haerses Road Offset Site. The entire Haerses Road Offset Site comprises remnant native vegetation and thus the current narrowest point of these links is estimated to be approximately greater than 500 metres wide (refer to **Figure 7.1**). This link will remain with the BioBanking Offset Agreement in place. Therefore it is considered that the connectivity width class after the BioBanking Offset Agreement is finalised on Haerses Road Offset Site would be greater than 500 metres wide (refer to **Table 7.3**).

Woody PCTs within the outer assessment circle were assumed to be in good condition for overstorey foliage cover and midstorey foliage cover. This assumption was based on the location of the Haerses Road Offset Site, abundance of adjacent remnant vegetation and quality of the vegetation within the Haerses Road Offset Site. The overstorey per cent foliage cover in the woody vegetation in the outer assessment circle was assumed, on the whole, to be within benchmark. The midstorey per cent foliage cover in the woody vegetation in the outer assessment circle was assumed, on the whole, to be within benchmark. These are likely to remain the same after the BioBanking Offset Agreement.

Details of the connectivity value scores entered into the BioBanking Credit Calculator are shown in **Table 7.3** below.

Table 7.3 Connectivity Value Scores

Attribute	Before BioBanking Offset Agreement	After BioBanking Offset Agreement
Connectivity Width Class	>500m	>500m
Connectivity Overstorey Condition	PFC at benchmark	PFC at benchmark
Connectivity Midstorey Condition	PFC at benchmark	PFC at benchmark

7.1.2.3 Patch Size

Table 7.4 below details the parameters that determined the Patch Size score as per Table 15 of Appendix 4 of the FBA (OEH 2014).

Table 7.4 Patch Size Score Parameters

Mitchell Landscape	Hornsby Plateau
Percent Native Vegetation Cleared	14%
Patch Size Class	1001 hectares
Patch Size Score	**12**

7.1.2.4 Landscape Value Score

The landscape value score for the Haerses Road Offset Site is **12.0**.

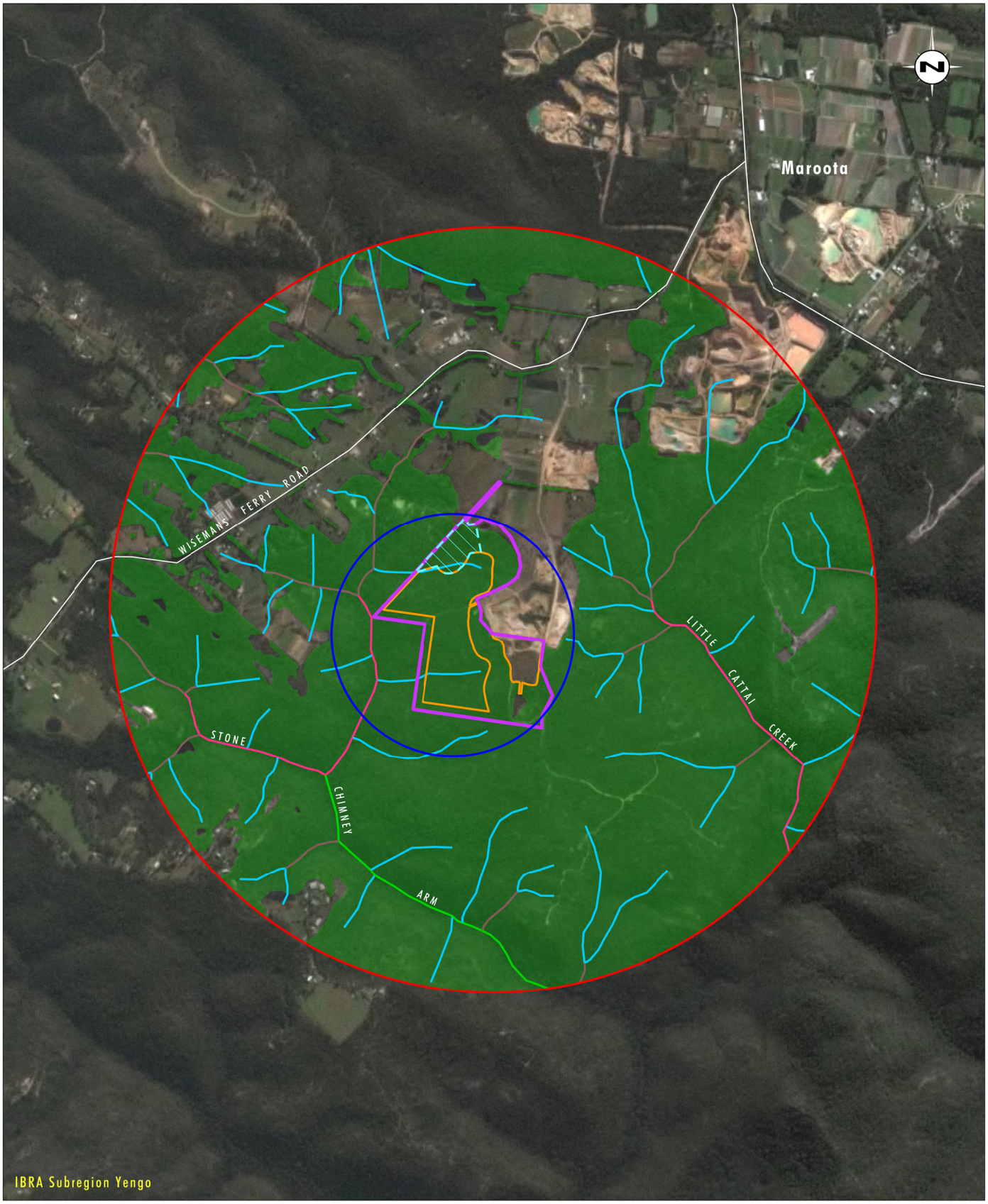

Image Source: Google Earth (2014)
Data Source: LPI (2011)

0 0.5 1.0 1.25km
1:25 000

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- 1000 Ha Assessment Circle
- 100 Ha Assessment Circle
- Native Vegetation
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

FIGURE 7.1

Haerses Road Offset Site Connectivity Value

File Name (A4): R04/3479_043.dgn
20160920 11.40

7.2 Native Vegetation within the Haerses Road Offset Site

7.2.1 Biometric Vegetation Types and Vegetation Zones

Surveys of the Haerses Road Offset Site identified four Biometric Vegetation Types (BVTs) (excluding cleared areas and dams) being:

- HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion
- HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
- HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion and
- HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion.

These BVTs were aligned with types described as part of the NSW Biometric vegetation types database (OEH 2014b), the Sydney Basin Vegetation Inventory (Tozer *et al.* 2010) and the Baulkham Hills Vegetation Mapping. The BVTs were then categorised into four vegetation condition zones (refer to **Figure 7.2**). The composition of these vegetation zones are outlined in **Tables 7.5** to **7.8** below.

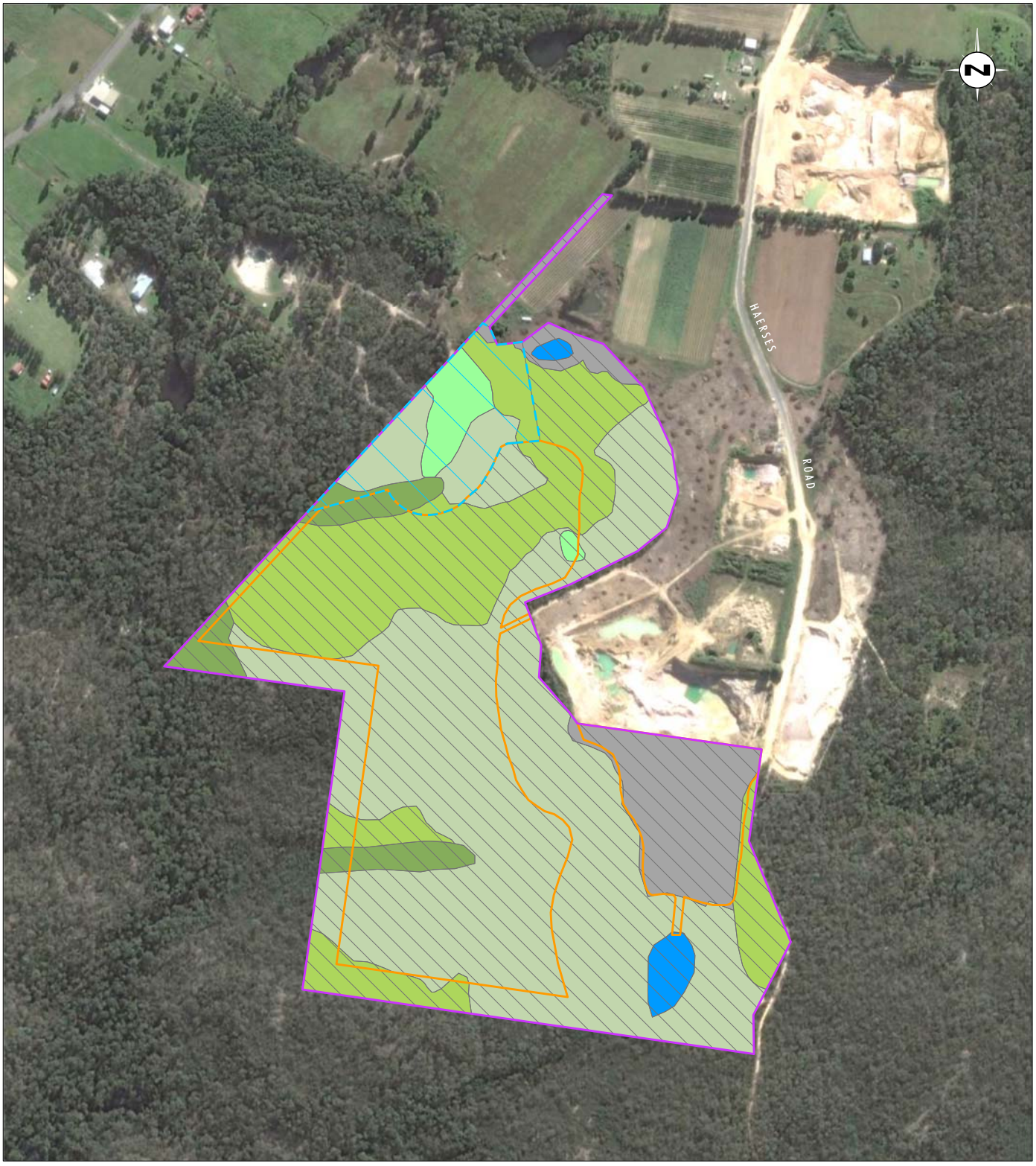

Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Area Mapped Outside Haerses Road Onsite Offset Site
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition
- Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition
- Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition
- Cleared
- Dam

FIGURE 7.2

Vegetation Zones in Haerses Road Offset Site

Table 7.5 Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN560
PCT ID	978
Vegetation Formation	Freshwater Wetlands
Vegetation Class	Coastal Heath Swamps
Hectares in Modification Area	1.03
Hectares in Haerses Road Offset Site	0.93
Tozer *et al.* (2010) Equivalent	FrW p129: Coastal Upland Swamp
AES Environmental Consultancy (2001) Equivalent	
Plots/Transects Undertaken	One (P04)
Floristic Description	This vegetation zone occurs at two locations where ground water seeps to the surface. This vegetation zone is characterised by a mid-dense shrub layer dominated by dwarf apple (*Angophora hispida*), prickly tea-tree (*Leptospermum juniperinum*), heath-leaved banksia (*Banksia ericifolia*), fern-leaved banksia (*Banksia oblongifolia*), *Leucopogon esquamatus*, crimson bottlebrush (*Callistemon citrinus*) and heath myrtle (*Baeckea imbricata*). The dense ground layer is dominated by zig-zag bog rush (*Schoenus brevifolius*), *Ptilothrix deusta*, *Leptocarpus tenax*, spreading rope-rush (*Empodisma minus*), *Drosera spatulata* and pouched coral fern (*Gleichenia dicarpa*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	*Coastal Upland Swamp in the Sydney Basin Bioregion EEC*
EPBC Status	*Coastal Upland Swamps in the Sydney Basin Bioregion EEC*

Feature	Description
Photo	

Table 7.6 Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN566
PCT ID	1083
Vegetation Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
Hectares in Modification Area	11.46
Hectares in Haerses Road Offset Site	0.78
Tozer *et al.* (2010) Equivalent	DSF p131 Coastal Sandstone Ridgetop Woodland
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Ridgetop Woodland
Plots/Transects Undertaken	Three (SR1, P01 and P06)

Feature	Description
Floristic Description	This vegetation zone supports a sparse canopy dominated by yellow bloodwood (*Corymbia* eximia), red bloodwood (*Corymbia gummifera*), narrow-leaved stringybark (*Eucalyptus sparsifolia*) and grey gum (*Eucalyptus punctata*). A dense shrub layer is present and comprises flakey-barked tea-tree (*Leptospermum trinervium*), mountain devil (*Lambertia formosa*), needlebush (*Hakea sericea*), heath-leaved banksia (*Banksia ericifolia*), *Darwinia biflora* and conesticks (*Petrophile pulchella*). The ground layer generally comprises lesser flannel flower (*Actinotus minor*), wiry panic (*Entolasia stricta*), *Lepyrodia scariosa*, *Austrostipa pubescens* and oat speargrass (*Anisopogon avenaceus*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.
Photo	

Table 7.7 Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN582
PCT ID	1134
Vegetation Formation	Heathlands
Vegetation Class	Sydney Coastal Heaths
Hectares in Modification Area	24.49
Hectares in Haerses Road Offset Site	1.52

Feature	Description
Tozer *et al.* (2010) Equivalent	Coastal Sandstone Plateau Heath
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Heath
Plots/Transects Undertaken	Three (SH1, P02 and P03)
Floristic Description	This vegetation zone is dominated by a dense cover of shrubs, with emergent eucalyptus scattered throughout and forming an open woodland community in some areas. Emergent eucalypts include scribbly gum (*Eucalyptus haemastoma*), red bloodwood (*Corymbia gummifera*) and scaly bark (*Eucalyptus squamosa*). Common shrubs include flakey-barked tea-tree (*Leptospermum trinervium*), dwarf apple (*Angophora hispida*), heath-leaved banksia (*Banksia ericifolia*), mountain devil (*Lambertia formosa*), *Darwinia biflora*, grey spider flower (*Grevillea buxifolia*) and conesticks (*Petrophile pulchella*). The ground layer generally comprises grasstree (*Xanthorrhoea* sp.), lesser flannel flower (*Actinotus minor*), heath bog-rush (*Schoenus ericetorum*), wiry panic (*Entolasia stricta*) and *Ptilothrix deusta*. Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.
Photo	

Table 7.8 Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition

Feature	Description
Name	Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion
Condition	Moderate to Good
BVT ID	HN586
PCT ID	1181
Vegetation Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
Hectares in Modification Area	1.91
Hectares in Haerses Road Offset Site	0.36
Tozer *et al.* (2010) Equivalent	DSF p142 Coastal Sandstone Gully Forest
AES Environmental Consultancy (2001) Equivalent	Sydney Sandstone Gully Forest
Plots/Transects Undertaken	One (P05)
Floristic Description	This vegetation zone supports a sparse to mid-dense canopy dominated by smooth-barked apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), grey gum (*Eucalyptus punctata*), yellow bloodwood (*Corymbia eximia*), and old-man banksia (*Banksia serrata*), with occurrences of red bloodwood (*Corymbia gummifera*), turpentine (*Syncarpia glomulifera* subsp. *glomulifera*) and red mahogany (*Eucalyptus resinifera* subsp. *resinifera*). A mid-dense shrub layer is present and comprises flakey-barked tea tree (*Leptospermum trinervium*), white wattle (*Acacia linifolia*), tantoon (*Leptospermum polygalifolium*), heath-leaved banksia (*Banksia ericifolia*), spiny bossiaea (*Bossiaea obcordata*), hairpin banksia (*Banksia minor*), and *Dillwynia retorta*. The ground layer generally comprises lesser flannel flower (*Actinotus minor*), spiny-headed mat-rush (*Lomandra longifolia*), wiry panic (*Entolasia stricta*), *Lepyrodia scariosa*, *Gahnia* sp. And common bracken (*Pteridium esculentum*). Flora species recorded in this zone are included in **Appendix A**.
TSC Status	None.
EPBC Status	None.

Feature	Description
Photo	

7.2.2 Current Site Value

Table 7.9 below details the current site value scores for each of the vegetation zones in the Haerses Road Offset Site. The table displays the change in site value scores that is expected to occur following the BioBanking Offset Agreement being secured on the Haerses Road Offset Site. The raw site condition attribute data for each of the vegetation zones is provided in **Appendix B**.

Table 7.9 Vegetation Zone Site Value Scores

Vegetation Zone No.	Vegetation Zone	Current Site Value Score (out of 100)	Site Value following BioBanking Offset Agreement (out of 100)
1	HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion	56.52	81.88
2	HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion	81.77	87.50
3	HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion	69.10	88.72
4	HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion	63.77	78.74

7.2.3 Threatened Ecological Communities

One TEC, listed under the TSC or EPBC Act, was recorded in the Haerses Road Offset Site being:

- *Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC* under the TSC Act (refer to **Section 7.2.3.1**) and EPBC Act (refer to **Section 7.2.3.2**).

Analysis of consistency to the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act, respectively.

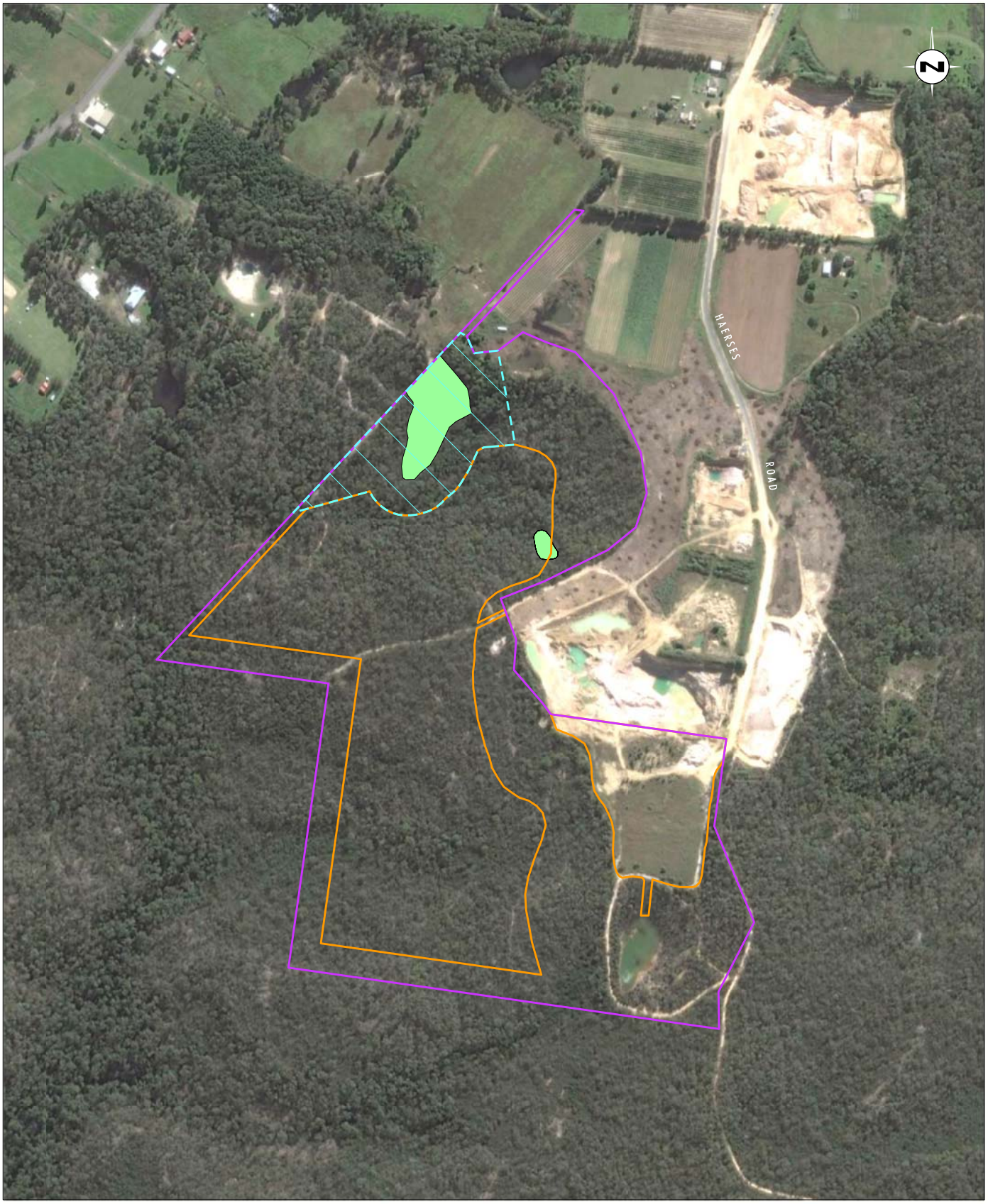

Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition (Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act)

FIGURE 7.3

Threatened Ecological Communities within Haerses Road Offset Site

7.2.3.1 *Coastal Upland Swamp in the Sydney Basin Bioregion* EEC under the TSC Act

Coastal Upland Swamp in the Sydney Basin Bioregion is listed as an endangered ecological community under the TSC Act. The community is known to occur on periodically waterlogged soils on Hawkesbury sandstone plateaus, where the mean annual rainfall generally exceeds 950 millimetres. The community is often associated with acid soils ranging from yellow or grey mineral sandy loams that have a shallow organic horizon to highly organic spongy black peats with pallid subsoils, as described in the Final Determination (NSW Scientific Committee 2012).

The vegetation of this community varies from tall scrub, open heath to sedgelands and is usually dominated by sclerophyll shrubs and/or sedges. This EEC is generally treeless however scattered trees may occur.

The Haerses Road Offset Site supports a total of 0.93 hectares of Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act within HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition). A comprehensive analysis of this vegetation community was undertaken to determine if it conformed to the Final Determination for this community (NSW Scientific Committee 2012).

Constituent Species

The species recorded within Coastal Upland Swamp EEC in the Haerses Road Offset Site comprises an assemblage of species consistent with the Final Determination under the Act (NSW Scientific Committee 2012).

This includes a ground layer dominated by zig-zag bog-rush (*Schoenus brevifolius*) and *leptocarpus tenax* below an upper stratum of peach blossom tea-tree (*Leptospermum squarrosum*) and heath-leaved Banksia (*Banksia ericifolia*).

Assemblage of Species

The NSW Scientific Committee (2012) lists 71 species as characterising the assemblage of species for the *Coastal Upland Swamp* EEC. As part of ecological investigations for the Project, one systematic 20 metre x 20 metre quadrat was sampled in *Coastal Upland Swamp* EEC due to the small area present in the Haerses Road Offset Site.

A total of 21 species were recorded in the Coastal Upland Swamp EEC quadrat, of these 13 (62 per cent) of the species listed in the Final Determination were present within this community.

Particular Area

In relation to the particular area of the *Coastal Upland Swamp* EEC, the NSW Scientific Committee (2012) states that the community occurs within the Sydney Basin Bioregion on Hawkesbury sandstone plateaus.

The Haerses Road Offset Site is located in the Sydney Basin Bioregion on a Hawkesbury sandstone plateau.

Supplementary Descriptors

In relation to supplementary descriptors, the NSW Scientific Committee (2012) includes the following key information pertaining to the *Coastal Upland Swamp* EEC:

- generally has a mean annual rainfall exceeding 950 millimetres

- soils that are acidic and vary from yellow or grey mineral sandy loams with a shallow organic horizon to highly organic spongy black peats with pallid subsoils and

- the vegetation of this community varies from tall scrub, open heath to sedgelands and is usually dominated by sclerophyll shrubs and/or sedges. This EEC is generally treeless however scattered trees may occur.

Of the above supplementary descriptors, the *Coastal Upland Swamp* EEC present in the Haerses Road Offset Site occurs on waterlogged soils and comprise dark brown peaty soils above sands. The mean annual rainfall for the local area is 919 millimetres, but of the last seven years (2009 – 2015) five have exceeded the required mean annual rainfall of 950 millimetres. The vegetation is dominated by multiple shrubs and sedges, and trees are absent.

7.2.3.2 *Coastal Upland Swamps in the Sydney Basin Bioregion* EEC under the EPBC Act

Coastal Upland Swamps in the Sydney Basin Bioregion is listed as an endangered ecological community under the EPBC Act. This community includes a range of vegetation and fauna associated with periodically waterlogged soils on Hawkesbury sandstone plateaus (TSSC 2014). The listing describes a community that includes open graminoid heath, sedgeland and tall scrub.

The Haerses Road Offset Site supports a total of 0.93 hectares of Coastal Upland Swamp(s) in the Sydney Basin Bioregion EEC under the TSC Act and EPBC Act within HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition). A comprehensive analysis of this vegetation community was undertaken to determine if it conformed to the Conservation Advice (including Listing Advice) provided by the Department of the Environment under the EPBC Act (TSSC 2014).

Particular Area

The Coastal Upland Swamps in the Sydney Basin Bioregion EEC under the EPBC Act is endemic to NSW and occurs in the eastern part of the Sydney Basin IBRA bioregion (TSSC 2014).

The Haerses Road Offset Site is within the Sydney Basin Bioregion.

Additional Criteria

The Conservation Advice (including Listing Advice) for the EEC identifies that it occurs primarily on permeable sandstone plateaux in the low relief headwater valleys with abundant seepage moisture (TSSC 2014). Soils are described to vary from yellow or grey sandy loams with a shallow organic horizon to highly organic spongy black peats (TSSC 2014). Additionally, the EEC swamps predominantly occur at elevations between 200 – 450 metres above sea level, but are also known to occur as low as 20 metres and up to 600 metres above sea level.

The swamp vegetation identified at the Haerses Road Offset Site occurs on waterlogged soils and comprise dark brown peaty soils above sands. Specifically, a high degree of seepage moisture was recorded during the field survey. Additionally the development site occurs at approximately 160 metres above sea level.

Vegetative Criteria

A description of the vegetation composition for the EEC is provided in the Conservation Advice (including Listing Advice). It describes a variable mosaic of vegetation that are characterised by soil conditions, size, recent rainfall, fire regimes and disturbance history (TSSC 2014). The EEC is essentially treeless, however trees may be present as scattered individuals or isolated clumps. The advice also provides a list of indicative list of vascular plant species characteristic of the EEC, a list that comprises 73 flora species. However the

advice also notes that the total number of vascular plants within the community is likely to exceed 200 species.

As part of ecological investigations for the Project, one systematic 20 metre x 20 metre quadrat was sampled in *Coastal Upland Swamp* EEC due to the small area present in the Haerses Road Offset Site.

A total of 21 species were recorded in the Coastal Upland Swamp EEC quadrat, of these 13 (18 per cent) of the species listed in the Conservation Advice (including Listing Advice) were present within this community.

HN560 - Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good Condition) within the Haerses Road Offset Site is deemed to meet the criteria discussed above. It therefore conforms with the Coastal Upland Swamps in the Sydney Basin Bioregion endangered ecological community under the EPBC Act.

7.3 Threatened Species within the Haerses Road Offset Site

7.3.1 Ecosystem-credit Species

7.3.1.1 Predicted Species

Table 7.10 below outlines the predicted ecosystem-credit species predicted to occur by the BioBanking Calculator and whether they are considered to occur on site.

Table 7.10 Predicted Ecosystem-credit Species

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	2.2	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 7 km north west of the site from 2014 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
eastern freetail-bat *Mormopterus norfolkensis*	V	-	2.2	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 5 km south east of the site from 2008 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
eastern grass owl *Tyto longimembris*	V	-	1.3	Yes	Species has not been recorded in the Haerses Road Offset Site. There are no known records of this species within 10 km of the Haerses Road Offset Site (OEH 2015).
gang-gang cockatoo *Callocephalon fimbriatum*	V	-	2.0	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 2 km south of the site from 2009 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
glossy black-cockatoo *Calyptorhynchus lathami*	V	-	1.8	Yes	Species was not recorded in the Haerses Road Offset Site but it was recorded nearby along the eastern boundary of the Project Area during the surveys undertaken for this assessment (refer to **Figure 3.4** and **Section 3.3.1.2**). The Haerses Road Offset Site contains foraging habitat for the species.
greater broad-nosed bat *Scoteanax rueppellii*	V	-	2.2	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 5 km south of the site from 2006 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
little eagle *Hieraaetus morphnoides*	V	-	1.4	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 4 km north west of the site from 1994 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
little lorikeet *Glossopsitta pusilla*	V	-	1.8	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 5 km east of the site from 2009 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
New Holland mouse *Pseudomys novaehollandiae*	-	V	2.6	Yes	Species has not been recorded in the Haerses Road Offset Site. There are no known records of this species within 10 km of the Haerses Road Offset Site (OEH 2015).
scarlet robin *Petroica boodang*	V	-	1.3	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 5 km south of the site from 1975 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
spotted-tailed quoll *Dasyurus maculatus*	V	E	2.6	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 6 km north west of the site from 1979 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
square-tailed kite *Lophoictinia isura*	V	-	1.4	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 9 km south west of the site from 2006 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
swift parrot *Lathamus discolor*	E	E	1.3	Yes	Species has not been recorded in the Haerses Road Offset Site. There are no known records of this species within 10 km of the Haerses Road Offset Site (OEH 2015).
varied sittella *Daphoenositta chrysoptera*	V	-	1.3	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 3 km south west of the site from 1996 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	On Site?^	Justification
yellow-bellied glider *Petaurus australis*	V	-	2.3	Yes	Species has not been recorded in the Haerses Road Offset Site. There are several records within approximately 3 km of the site (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.
yellow-bellied sheathtail-bat *Saccolaimus flaviventris*	V	-	2.2	Yes	Species has not been recorded in the Haerses Road Offset Site. The closest record occurs approximately 9 km south west of the site from 2013 (OEH 2015). The Haerses Road Offset Site may contain marginal foraging habitat for the species.

^ As entered into the 'Site Survey Details' tab in the BBCC.

7.3.1.2 Survey Results

Two ecosystem credit species were recorded in the Haerses Road Offset Site during the surveys undertaken for this assessment, these included:

- large-eared pied bat (*Chalinolobus dwyeri*); and
- little bentwing-bat (*Miniopterus australis*).

A discussion on these records is provided below and a full fauna species list from the surveys undertaken by Umwelt in 2014 and 2015 is included in **Appendix C**.

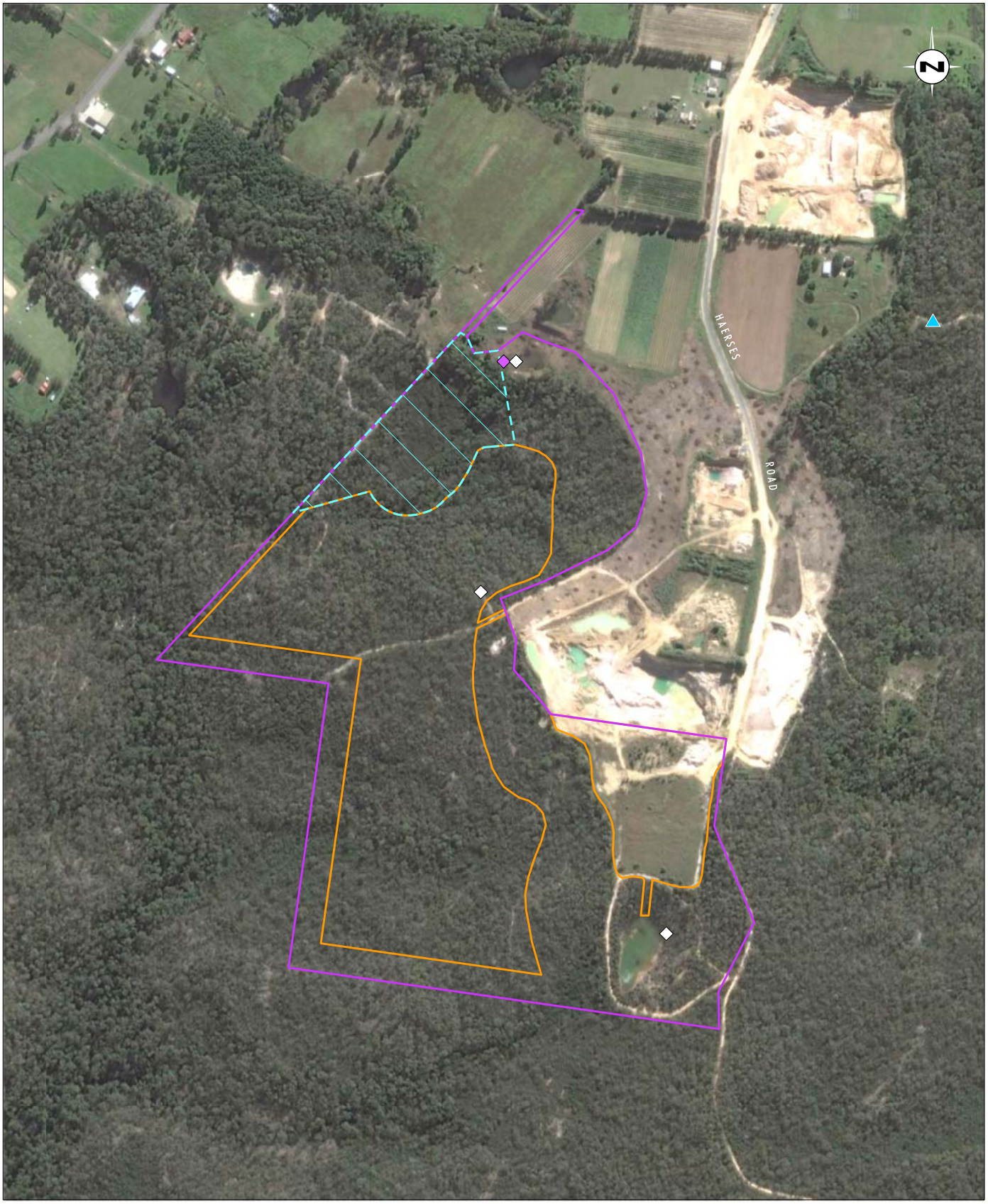

Image Source: Google Earth (2014)

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Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Glossy Black-cockatoo (2 recorded)
- Little Bentwing-Bat
- Large-Eared Pied-Bat

FIGURE 7.4

Ecosystem-credit Species Recorded in Haerses Road Offset Site

Large-eared Pied Bat – *Chalinolobus dwyeri*

The large-eared pied-bat is listed as vulnerable under the TSC Act and EPBC Act. The species is found in areas with extensive cliffs and caves from Rockhampton, Queensland to Bungonia in New South Wales.

Large-eared pied-bat was recorded in the Haerses Road Offset Site. It was recorded through use of bat echolocation recordings using an Anabat II Bat Detector. These recordings were then professionally identified by Anna McConville of Echo Ecology Pty Limited.

The Haerses Road Offset Site does not contain any roosting habitat for the species but is considered to comprise marginal foraging habitat for this species as part of a wider foraging range in the locality.

Little Bentwing-bat – Miniopterus australis

The little bentwing-bat is listed as vulnerable under the TSC Act. The species is occurs along the eastern coast and ranges of Australia, extending from Cape York, Queensland to Wollongong, New South Wales.

This species was recorded in the Haerses Road Offset Site. It was recorded through use of bat echolocation recordings using an Anabat II Bat Detector. These recordings were then professionally identified by Anna McConville of Echo Ecology Pty Limited.

The Haerses Road Offset Site does not contain any roosting habitat for the species but is considered to comprise marginal foraging habitat for this species as part of a wider foraging range in the locality.

7.3.2 Species-credit Species

7.3.2.1 Geographic and Habitat Features

Seven geographic and habitat features (refer to **Table 7.11**) were chosen in the BioBanking Credit Calculator as having broad features that match site habitats at the Haerses Road Offset Site. Other geographic and habitat features were considered as not having broad features that match the Haerses Road Offset Site habitats and were therefore not relevant to the Haerses Road Offset Site and were filtered out of the subsequent steps of the assessment.

Table 7.11 Geographic and Habitat Features in the Haerses Road Offset Site

Geographic/Habitat Feature	Relevant Species-credit Species
Land within 250 metres of termite mounds or rock outcrops	rosenbergs goanna (*Varanus rosenbergi*)
Heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 metres of, ephemeral or intermittent drainage lines	red-crowned toadlet (*Pseudophryne australis*)
Land within 40 metres of heath, woodland or forest	giant burrowing frog (*Heleioporus australiacus*)
Ridgetops	*Hibbertia superans*
Sandstone rock outcrops	*Kunzea rupestris*

Geographic/Habitat Feature	Relevant Species-credit Species
Land within Maroota area of Baulkham Hills and Hornsby LGAs in Yengo CMA subregion	*Darwinia fascicularis* subsp. *oligantha* population, Baulkham Hills and Hornsby Local Government Areas (*Darwinia fascicularis* subsp. *oligantha* - endangered population)
Land below 1000 metres in altitude and within 40 m of rainforest or eucalypt forest with deep leaf litter	giant barred frog (*Mixophyes iterates*)

7.3.2.2 Predicted Species

Table 7.12 below outlines the predicted species-credit species predicted to occur by the BioBanking Credit Calculator (Major Project Assessment Type) and whether they are considered to occur on Haerses Road Offset Site.

Table 7.12 Predicted Species-credit Species

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Acacia gordonii	E	E	2.6	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Ancistrachne maidenii	V	-	2.2	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Asterolasia elegans	E	E	1.8	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
brown Pomaderris *Pomaderris brunnea*	E	V	1.5	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
brush-tailed phascogale *Phascogale tapoatafa*	V	-	2.0	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted remote camera surveys being done for this species.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
bynoes wattle *Acacia bynoeana*	E	V	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
clandulla geebung P*ersoonia marginata*	V	V	1.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Darwinia biflora	V	V	2.0	Yes	A population of this species was recorded throughout the Modification Area during the original survey in 2014. The second field survey in December 2015 was designed to further detail the population of this species within these areas. The surveys suggested the total size of the population could not be determined due to the sporadic habit of the species. For this reason the population of this species within the Development Site and population within the Haerses Road Offset Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.
Darwinia fascicularis subsp. *oligantha* endangered population, Baulkham Hills and Hornsby Local Government Areas	EP	-	1.4	No	A potential specimen of this species was collected during the November 2014 survey. This specimen was sent to the National Herbarium of New South Wales at the Royal Botanic Garden Sydney (RBGS) for formal identification. The RBGS was unable to identify the specimen as being *Darwinia fascicularis* subsp. o*ligantha*, therefore this endangered population was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys. The identification letter from RBGS is attached as **Appendix E**.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Darwinia peduncularis	V	-	1.8	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
deanes paperbark *Melaleuca deanei*	V	V	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
downy wattle *Acacia pubescens*	V	V	1.9	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
eastern pygmy-possum *Cercartetus nanus*	V	-	2.0	Yes	This species was recorded at two locations within the Modification Area. Both locations of this species occur outside the boundary of the Haerses Road Offset Site, but the species was assumed to be present based on the consistency in habitat and proximity of the records to the Haerses Road Offset Site.
Epacris purpurascens subsp. *purpurascens*	V	-	1.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Eucalyptus sp. Cattai	CE	-	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	E	-	2.0	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
giant barred frog *Mixophyes iteratus*	E	E	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
giant burrowing frog *Heleioporus australiacus*	V	V	1.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted call playback and spotlighting surveys being done for this species.
Grevillea parviflora subsp. *supplicans*	E	-	2.6	Yes	This species was recorded within Modification Area, but not specifically in the Haerses Road Offset Site. A total of 219 plants occur within the Modification Area. The species was not to be present in the Haerses Road Offset Site.
groves paperbark *Melaleuca groveana*	V	-	1.4	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Gyrostemon thesioides	E	-	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
hairy geebung *Persoonia hirsuta*	E	E	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Hibbertia puberula	E	-	4.0	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Hibbertia superans	E	-	2.6	No	This species was recorded at one location within the Modification Area. It has been determined that this species does not occur within the Haerses Road Offset Site.
koala *Phascolarctos cinereus*	V	V	2.6	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Kunzea rupestris	V	V	2.6	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Leptospermum deanei	V	V	1.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Leucopogon fletcheri subsp. *fletcheri*	E	-	1.6	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Micromyrtus blakelyi	V	V	2.6	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Dural woodland snail [1] *Pommerhelix duralensis*	-	E	7.7	Yes.	Targeted spotlight surveys undertaken in December 2015 recorded one individual of this species in the Modification Area but not within the Haerses Road Offset Site. The species was assumed to be present based on the consistency in habitat and proximity of the records to the Haerses Road Offset Site.
netted bottle brush *Callistemon linearifolius*	V	-	1.4	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Olearia cordata	V	V	1.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Pimelea curviflora subsp. *curviflora*	V	V	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
Pultenaea parviflora	E	V	1.5	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
red-crowned toadlet *Pseudophryne australis*	V	-	1.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys. That is despite targeted call playback and spotlighting surveys being done for this species.
regent honeyeater *Anthochaera phrygia*	E	CE	7.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
rosenbergs goanna *Varanus rosenbergi*	V	-	3.3	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
singleton mint bush *Prostanthera cineolifera*	V	V	1.4	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
spreading guinea flower *Hibbertia procumbens*	E	-	1.8	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Squirrel Glider *Petaurus norfolcensis*	V	-	2.2	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Tetratheca glandulosa	V	-	1.6	Yes	This species was recorded within the Haerses Road Offset Site and the Modification Area. The population of this species was applied on a habitat basis due to the cryptic nature of this species. For this reason the population of this species within the Development Site and population within the

Species Name	TSC Status	EPBC Status	Threatened Species Offset Multiplier	Impacted by the Modification Project?^	Justification
					Haerses Road Offset Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.
Velleia perfoliata	V	V	1.7	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.
Zieria involucrata	E	-	1.5	No	This species was not recorded within the Haerses Road Offset Site or the larger Modification Area during either of the two extensive field surveys.

^ As entered into the 'Threatened Species Survey Results' tab in the BBCC.

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

7.3.2.3 Survey Results

One species-credit species was recorded in the Haerses Road Offset Site during the surveys undertaken for this assessment (refer to **Figure 7.5**), that being *Tetratheca glandulosa*. An additional three species-credit species were considered to be present within the Haerses Road Offset Site due to the population size within the Development Site, consistency of vegetation and suitable habitat present within the Haerses Road Offset Site. The three species were:

- *Darwinia biflora*
- Eastern pygmy-possum (*Cercartetus nanus*)
- Dural woodland snail (*Pommerhelix duralensis*).

Darwinia biflora

Darwinia biflora is listed as vulnerable under the TSC and EPBC Acts. It is an erect to spreading shrub recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas. It occurs on the edges of weathered shale-capped ridges at the integration with Hawkesbury Sandstone.

A population of this species was recorded throughout the Modification Area during the original survey in 2014. Further survey effort was undertaken for *Darwinia biflora* in the December 2015 survey. This involved a randomised sampling of 10 x 10 metre plots within suitable habitat for the species within the Development Site. The location of plots were randomised using a stratified grid network and between 30 minutes and 60 minutes was spent counting every individual within the plot. The time spent was dependent on how many individuals of the species were present. As the plot locations were randomly stratified, *Darwinia biflora* did not necessarily occur in every plot.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, none of the stratified plots targeting *Darwinia biflora* were completed within the area that has now been identified as the Haerses Road Offset Site.

Eastern pygmy-possum – *Cercartetus nanus*

The eastern pygmy-possum is listed as vulnerable under the TSC Act. The species occurs in south-eastern Australia, from southern Queensland, predominantly along the New South Wales coastline around to eastern South Australia and also Tasmania.

Eastern pygmy-possum was recorded at two locations within the Modification Area during the initial field survey in November 2014. Both records occur outside the Haerses Road Offset Site boundary. The records were made through targeted remote camera surveys. Bushnell Trophy Cam HDs (remote cameras) were mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing oats and honey to increase the likelihood of detecting the eastern pygmy possum. The cameras were set to take three photos in quick succession when movement was detected. The remote cameras were programmed to record movement on an ongoing basis until removed from the site. The cameras were installed for 28 nights in 10 locations, totalling 280 nights of remote camera survey.

Because of the consistency of vegetation and suitable habitat present within the Haerses Road Offset Site the population of this species within the Haerses Road Offset Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.

Dural woodland snail – *Pommerhelix duralensis*

Dural woodland snail is listed as endangered under the EPBC Act. This species is a medium sized snail with dark brown to black semi-translucent, almost spherical shaped shell. It is a shale-influenced habitat specialist that occurs in low densities along the western and north west fringes of the Cumberland IBRA subregion on shale-sandstone transitional landscapes.

Targeted spotlighting searches for the Dural woodland snail (*Pommerhelix duralensis*) were completed on the December 2015 survey. Walking spotlighting searches were conducted at two separate locations within the Modification Area. One specimen of the Dural woodland snail was located within the Modification Area.

At the time of the original survey in November 2014 and additional survey in December 2015 the location and/or extent of the Haerses Road Offset Site was not known. As a result, none of the spotlighting searches targeting Dural woodland snail (*Pommerhelix duralensis*) were completed within the area that has now been identified as the Haerses Road Offset Site. Because of the consistency of vegetation and suitable habitat present within the Haerses Road Offset Site the population of this species within the Haerses Road Offset Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.

Tetratheca glandulosa

Tetratheca glandulosa is listed as vulnerable under the TSC Act. A small, spreading shrub that produces stems often becoming entwined among other plants within the ground stratum. The species is associated with shale-sandstone transition habitat.

Tetratheca glandulosa was recorded at one location within the Haerses Road Offset Site with a total of 11 plants being recorded. The species was also widely recorded throughout the Modification Area. Because of the consistency of vegetation and suitable habitat present within the Haerses Road Offset Site the population of this species within the Haerses Road Offset Site has been calculated based on suitable habitat as is permitted within the FBA 2014 methodology.

7.3.2.4 Species Habitat Polygons

Species habitat polygons have been prepared for all the species recorded and assumed present at the site as per **Table 7.12** above. The species polygons were prepared:

- using satellite imagery dated 2009 (LPI 2014)
- using the unit of measurement identified for those species in the Threatened Species Profile Database
- including the location of the species or areas likely occupied by the species
- containing the specific habitat feature associated with the species at the Haerses Road Offset Site, and
- using GPS to confirm the location of the species polygon on the best available aerial image of the Haerses Road Offset Site.

Species polygons are shown on **Figure 7.5**.

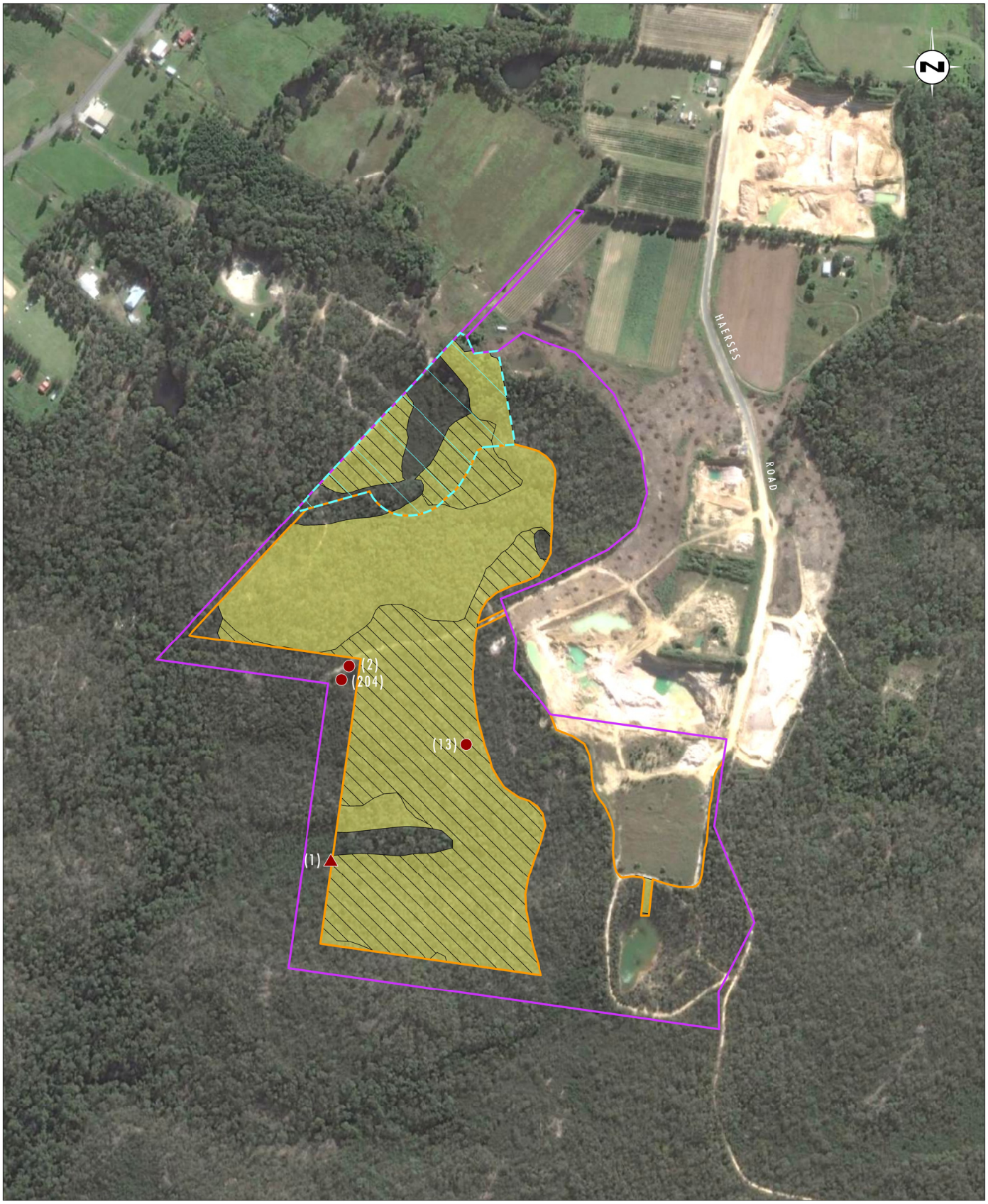


Image Source: Google Earth (2014)

0 100 200 400m
1:7500

Legend

- Development Site
- Modification Area
- Haerses Road Offset Site
- Darwinia biflora, Tetratheca glandulosa and Dural woodland snail
- Eastern pygmy-possum
- *Grevillea parviflora* subsp. *supplicans*
- *Hibbertia superans*

FIGURE 7.5

Species-credit Polygons at Haerses Road Offset Site

File Name (A4): R04/3479_047.dgn
20160920 11.51

7.4 BVTs and Threatened Species Credits

A range of BVTs, ecosystem-credit species and species-credit species were found to occur at the Haerses Road Offset Site as discussed in the sections below.

7.4.1 Ecosystem Credits

Table 7.13 outlines the ecosystem-credit species predicted as being present at the Haerses Road Offset Site.

Table 7.13 Ecosystem-credit species present at Haerses Road Offset Site

Common Name	Species Name	Threatened Species Offset Multiplier
eastern false pipistrelle	*Falsistrellus tasmaniensis*	2.2
eastern freetail-bat	*Mormopterus norfolkensis*	2.2
eastern grass owl	*Tyto longimembris*	1.3
gang-gang cockatoo	*Callocephalon fimbriatum*	2.0
glossy black-cockatoo	*Calyptorhynchus lathami*	1.8
greater broad-nosed bat	*Scoteanax rueppellii*	2.2
little eagle	*Hieraaetus morphnoides*	1.4
little lorikeet	*Glossopsitta pusilla*	1.8
New Holland mouse	*Pseudomys novaehollandiae*	2.6
scarlet robin	*Petroica boodang*	1.3
spotted-tailed quoll	*Dasyurus maculatus*	2.6
square-tailed kite	*Lophoictinia isura*	1.4
swift parrot	*Lathamus discolor*	1.3
varied sittella	*Daphoenositta chrysoptera*	1.3
yellow-bellied glider	*Petaurus australis*	2.3
yellow-bellied sheathtail-bat	*Saccolaimus flaviventris*	2.2

Table 7.14 below outlines the BVTs within the Haerses Road Offset Site and the ecosystem credits generated to offset those credits required by the Modification Project on the Development Site. A full Credit Calculator report is included in **Appendix D**.

Table 7.14 Biometric Vegetation Types Generated within the Haerses Road Offset Site

Biometric Vegetation Type	Vegetation Zone	Area to be Impacted (ha)	Landscape Value Score	Current Site Value Score	Future Site Value Score	Averted Loss in Site Value	Ecosystem Credits Generated
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	1	0.93	12.00	56.52	81.88	9.42	11
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	2	0.78	12.00	81.77	87.50	15.10	6
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	3	1.52	12.00	69.10	88.72	13.02	17
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	4	0.36	12.00	63.77	78.74	12.08	4

7.4.2 Species Credits

Table 7.15 below outlines the species-credit species generated within the Haerses Road Offset Site. A full Credit Calculator report is included in **Appendix D**.

Table 7.15 Species-credit Species Generated within the Haerses Road Offset Site

Common Name	Species Name	Threatened Species Offset Multiplier	Species Credits Generated
Darwinia biflora	*Darwinia biflora*	2.0	14
eastern pygmy-possum	*Cercartetus nanus*	2.0	11
Dural woodland snail [1]	*Pommerhelix duralensis*	7.7	16
Tetratheca glandulosa	*Tetratheca glandulosa*	1.6	14

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

8.0 Offsetting Comparison

8.1 Biodiversity Credit Report

A full Credit Calculator report for the Haerses Road Offset Site is included in **Appendix D**.

Table 8.1 below provides a summary of the ecosystem and species credits that require offsetting as a result of this Modification Project and those that are generated within the Haerses Road Offset Site.

Table 8.1 Ecosystem and Species Credits Required by the Modification Project and those generated at the Haerses Road Offset Site

Name	Credits Required	Credits Generated	Overall Status
Ecosystem Credits			
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	3	11	+8
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	377	6	-371
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	538	17	-521
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	44	4	-40
Total	**962**	**38**	**-924**
Species Credits			
Darwinia biflora	360	14	-346
eastern pygmy-possum (*Cercartetus nanus*)	223	11	-212
Grevillea parviflora subsp. *supplicans*	338	-	-338
Dural woodland snail (*Pommerhelix duralensis*)[1]	1,372	16	-1,356
Tetratheca glandulosa	288	14	-274
Total	**2,581**	**55**	**-2,526**

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

8.2 Additional Offsetting Options

As identified above in **Table 8.1** there are a number of ecosystem and species credit deficits between the number of credits that require offsetting as a result of the Modification Project and those that are generated at the Haerses Road Offset Site. Fulfilling offset requirements, including credit shortfalls will be undertaken using one or a combination of the following offset strategies:

- securing required credits through the open credit market, off site
- offsetting through a land-based offset site secured by a BioBanking Agreement
- if suitable offsets are unavailable, contributing funds to supplementary measures in accordance with relevant conservation or recovery actions relevant to the species, and
- contributing to the Offsets Fund.

The sections below discuss additional offsetting options that are being considered by Dixon Sand.

8.2.1 Porters Road Offset Site

An additional offset site (Porters Road Offset Site) is currently being considered by Dixon Sand that is offsite compared to the location of the Modification Project (**Figure 8.1**). The site is approximately 53 hectares in size and is in the preliminary stages of consideration and subsequently no detailed surveys have been undertaken. A preliminary assessment has been completed on the Porters Road Offset Site by South East Environmental (2016). The assessment was designed around determining suitability of the site for *Darwinia biflora* through the identification of individuals or habitat.

The surveys undertaken by South East Environmental identified six threatened flora species confidently within the site, including *Darwinia biflora*. The additional five species are listed below:

- Bynoe's wattle (*Acacia bynoeana*)
- *Epacris purpurascens* subsp. *purpurascens*
- *Hibbertia superans*
- *Lasiopetalum joyceae*
- *Tetratheca glandulosa*.

The preliminary field survey also confirmed the presence of three vegetation communities that had been identified through regional mapping by Tozer *et al*. (2003) (**Figure 8.2)**.

The results of the preliminary assessment were entered into the BioBanking Credit Calculator to provide insight as to the suitability of Porters Road Offset Site for the Modification Project. **Table 8.2** below provides the preliminary credit summary of Porters Road Offset Site, and an updated potential overall credit summary. As no detailed surveys have been completed on the Porters Road Offset Site, there is currently no transect/plot data for the site. For the purposes of entering data in to the BioBanking Credit Calculator, data was extrapolated (duplicated) from the plot/transect undertaken in the same vegetation type in the Modification Area.

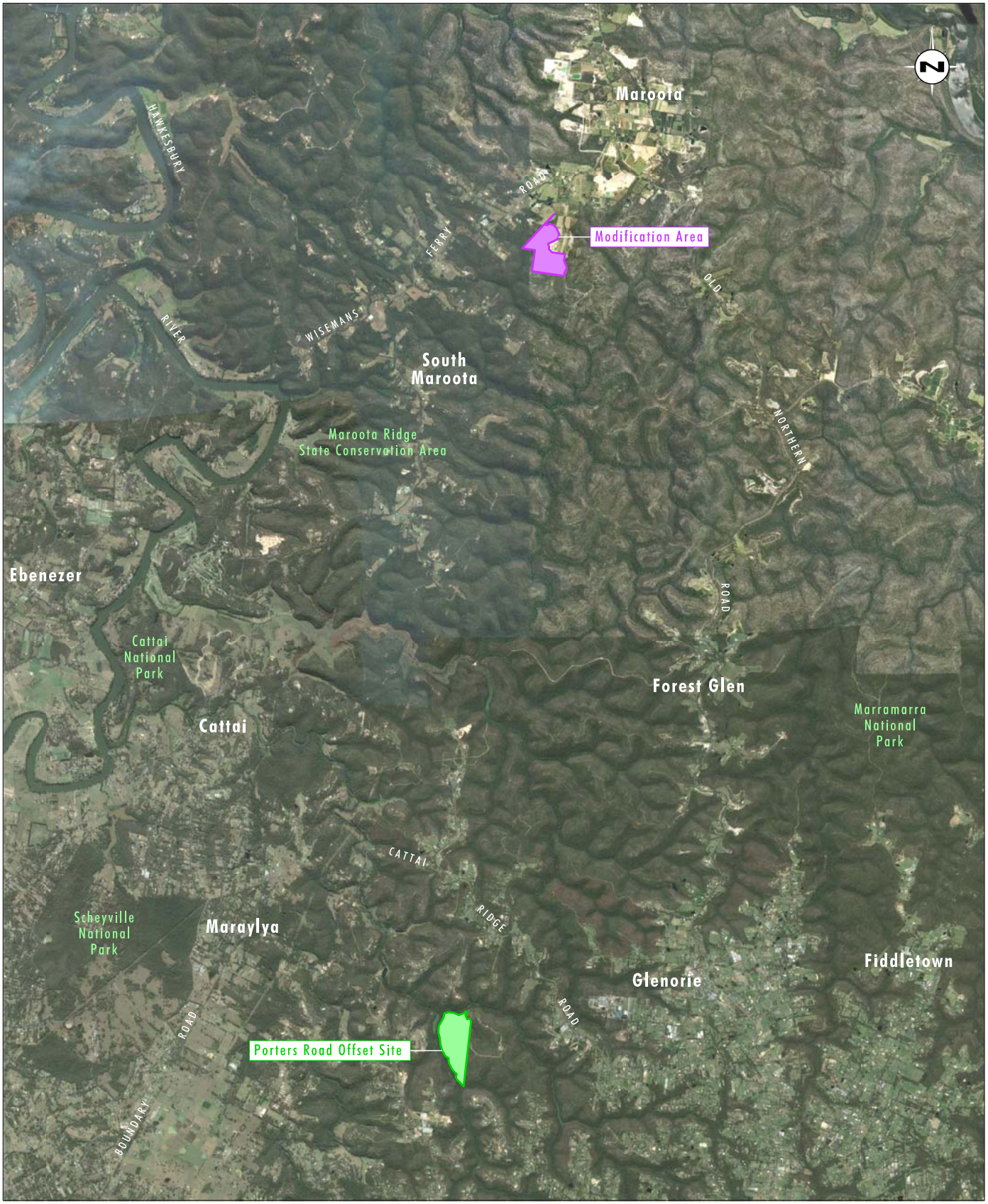


Image Source: Google Earth (2016)

0 1.0 2.5 5.0km
1:100 000

Legend

- Modification Area
- Porters Road Offset Site

FIGURE 8.1

Porters Road Offset Site
Site Location

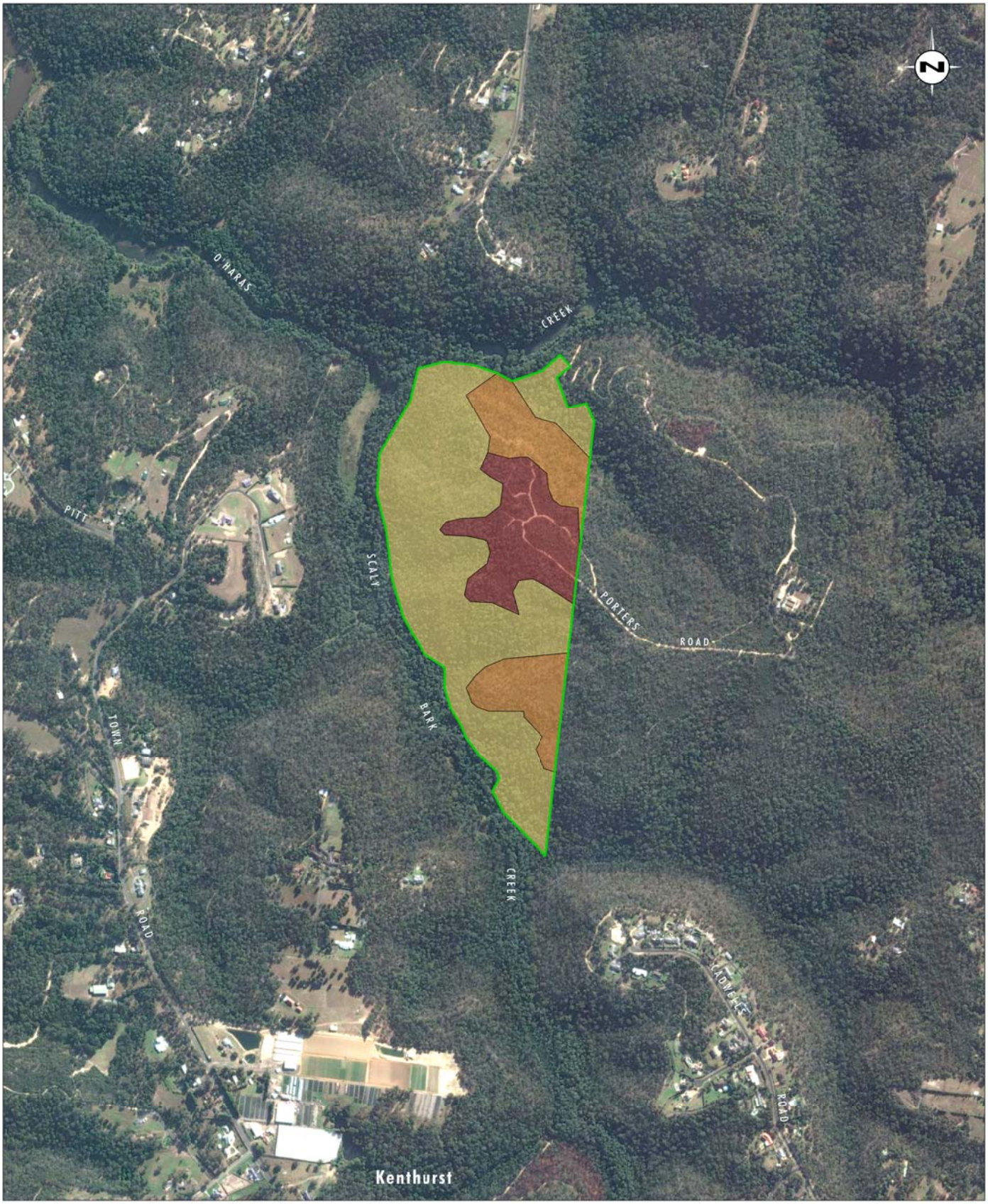


Image Source: Google Earth - DigitalGlobe (July 2016)

0 250 500 750m

1:15 000

Legend

- Porters Road Offset Site
- HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion
- HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion
- HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion

FIGURE 8.2

Vegetation Communites at the Porters Road Offset Site

Table 8.2 Ecosystem and Species Credits Required by the Modification Project, those generated at the Haerses Road Offset Site and those estimated at the Porters Road Offset Site

Name	Credits Required	Haerses Road Offset Site Credits Generated	Porters Road Offset Site Estimated Credits	Overall Status
Ecosystem Credits				
HN560 Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	3	11	0	+8
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	377	6	86	-285
HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good)	538	17	104	-417
HN586 Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion (Moderate/Good)	44	4	327	+287
Total	**962**	**38**	**517**	**-407**
Species Credits Required and Generated				
Darwinia biflora	360	14	142	-204
eastern pygmy-possum (*Cercartetus nanus*)	223	11	0	-212
Grevillea parviflora subsp. *supplicans*	338	0	0	-338
Dural woodland snail (*Pommerhelix duralensis*)[1]	1,372	16	0	-1,356
Tetratheca glandulosa	288	14	142	-132
Total	**2,581**	**55**	**284**	**-2,242**
Species Credits Generated				
Epacris purpurascens subsp. *purpurascens*	0	0	142	+142
Hibbertia superans	0	0	142	+142
Bynoe's wattle (*Acacia bynoeana*)	0	0	142	+142
Lasiopetalum joyceae	0	0	64	+64

[1] This species was not able to be added to the list of threatened species within the BBCC. Instead Mitchells rainforest snail (*Thersites mitchellae*) was entered into the BBCC as it has the same Threatened Species Offset Multiplier as the Dural woodland snail of 7.7.

8.2.2 Biodiversity Credits Register

Dixon Sand may consider purchasing ecosystem and species credits to offset those required as part of the Modification Project and that remain in deficit despite those generated at the Haerses Road Offset Site and those that could be generated at the Porters Road Offset Site. The Biodiversity Credits Register provides a means for developers seeking credits to search and purchase such credits as required. The Biodiversity Credit Register is an online resource that has been established in accordance with the TSC Act 1995.

Umwelt accessed the Biodiversity Credit Register in June 2016 (OEH 2016a). **Table 8.3** below provides a summary of ecosystem credits and **Table 8.4** provides a summary of species credits that are currently listed on the Biodiversity Credit Register for those credits with an overall credit status that is currently in deficit. No additional credits are required for those credits that are in a surplus.

Table 8.3 Ecosystem Credits listed on the Biodiversity Credit Register

Name	Overall Credit Status	IBRA sub-region		Potential Overall Status
		Yengo	Wollemi	
HN566 Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion (Moderate/Good)	-285	105	42	-138

There were no credits for HN582 Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion (Moderate/Good) listed on the Biodiversity Credit Register. Additionally, there are no credits listed for HN580 Sandstone cliff soak moist shrubland of the Sydney Basin Bioregion which was identified in **Section 6.2.1.3** as a suitable offsetting replacement.

Table 8.4 Species Credits listed on the Biodiversity Credit Register

Name	Overall Credit Status	Credits Listed on the Register	Potential Overall Status
Darwinia biflora	-204	7,072	+6,868
eastern pygmy-possum (*Cercartetus nanus*)	-212	0	-212
Grevillea parviflora subsp. *supplicans*	-338	0	-338
Dural woodland snail (*Pommerhelix duralensis*)[1]	-1,356	0	-1,356
Tetratheca glandulosa	-132	882	+750

As previously mentioned, the Dural woodland Snail could not be entered into the BioBanking calculator. A replacement species in Mitchells rainforest snail (*Thersites mitchellae*) was entered in its absence. Additionally, this species could not be searched on the Biodiversity Credits Register for available credits. Further, detailed discussion with regulators will be required to determine an appropriate offset strategy for the impacts of the Modification Project on Dural woodland snail (*Pommerhelix duralensis*).

8.2.3 Credits Wanted Register

The Credits Wanted Register is an online tool for proponents who are seeking biodiversity credits, allowing them to search for ecosystem and species credits which they require but also list those credits with their contact details. This allows people with excess credits to make direct contact with people that are seeking such credits.

With a number of ecosystem and species credits that remain in deficit after considering those generated at two offset sites and those that are available for purchase on the Biodiversity Credits Register, Dixon Sand have listed credits sought after on Credits Wanted Register. Should any person, company or organisation have one or a number of credits required by the Modification Project they will be able to contact Umwelt on behalf of Dixon Sand to discuss the potential selling of credits.

Umwelt listed credits on the Credits Wanted Register on behalf of Dixon Sand on 7 April 2016.

9.0 Conclusion

Dixon Sand is committed to delivering a Biodiversity Offset Strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Modification Project under the NSW *Biodiversity Offsets Policy for Major Projects* (OEH 2014).

As previously mentioned, fulfilling offset requirements under the NSW *Biodiversity Offset Policy for Major Projects* will be undertaken using one or a combination of the following offset strategies:

- On-site in-perpetuity conservation of applicable credits.
- Offsetting through a site secured by a BioBanking Agreement.
- Securing required credits through the open credit market, off site.
- If suitable offsets are unavailable, contributing money to supplementary measures in accordance with relevant conservation or recovery actions will be investigated.
- Contributing to the Offsets Fund.

Dixon Sand will investigate, in consultation with OEH, the application of the Offsets Fund (when available) and the monetary contribution required addition to the proposed offset sites through the use of a BioBanking Agreement.

10.0 References

AES Environmental Consultancy (2001) Natural Asset Mapping for Baulkham Hills Shire Council Plant Communities in Baulkham Hills Shire.

Austin, M, P, Cawsey, E, M, Baker, B, L, Yialeloglou, M, M, Grice, D, J, and Briggs, S, V, (2000) Predicted Vegetation Cover in the Central Lachlan Region. Final report of the Natural Heritage Trust Project AA 1368.97. CSIRO Wildlife and Ecology, Canberra

Braun-Blanquet, J, (1927) *Pflanzensoziologie*. Springer, Vienna.

(DEWHA) Department of Environment, Water, Heritage and the Arts (2010a). Survey Guidelines for Australia's Threatened Birds.

(DEWHA) Department of Environment, Water, Heritage and the Arts (2010b). Survey Guidelines for Australia's Threatened Frogs.

(DEWHA) Department of Environment, Water, Heritage and the Arts (2011a). Survey Guidelines for Australia's Threatened Reptiles.

(DEWHA) Department of Environment, Water, Heritage and the Arts (2011b). Survey Guidelines for Australia's Threatened Mammals.

Department of the Environment (DoE) (2015) Protected Matters Search Tool http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf accessed September 2015.

Environmental Resources Management (ERM) (2006a). Haerses Road Sand Quarry Environmental Monitoring Program (final), Dixon Sand (Penrith) Pty Ltd.

Environmental Resources Management (ERM) (2006b). Haerses Road Sand Quarry Site Water Management Plan, Dixon Sand (Penrith) Pty Ltd.

Harden, G, J, editor, (1992) Flora of New South Wales. Volume 3. Royal Botanic Gardens Sydney & New South Wales University Press, Sydney.

Harden, G, J, editor, (1993) Flora of New South Wales. Volume 4. Royal Botanic Gardens Sydney & New South Wales University Press, Sydney.

Harden, G, J, editor, (2000) Flora of New South Wales. Volume 1. 2nd edition. New South Wales University Press and Royal Botanic Gardens, Sydney.

Harden, G, J, editor, (2002) Flora of New South Wales. Volume 2. Revised edition. Royal Botanic Gardens Sydney & New South Wales University Press, Sydney.

Morgan, G. (2001) Delineation and description of the Eastern Environmental Subregions (provinces) in New South Wales Study. NSW NPWS, Hurstville.

NSW Scientific Committee (2002) Coastal Upland Swamp in the Sydney Basin Bioregion – endangered ecological community final determination, gazetted 09 March 2012.

Office of Environment and Heritage (OEH) (2014) Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects, September 2014

Office of Environment and Heritage (OEH) (2015) BioNet Atlas of NSW Wildlife, accessed September 2015.

OEH (2016a) BioBanking Credit Register http://www.environment.nsw.gov.au/bimsprapp/SearchBiodiversityCredit.aspx?Start=1, accessed June 2016.

OEH (2016b) *NSW Guide to Surveying Threatened Plants*. Office of Environment and Heritage, Sydney NSW 2000.

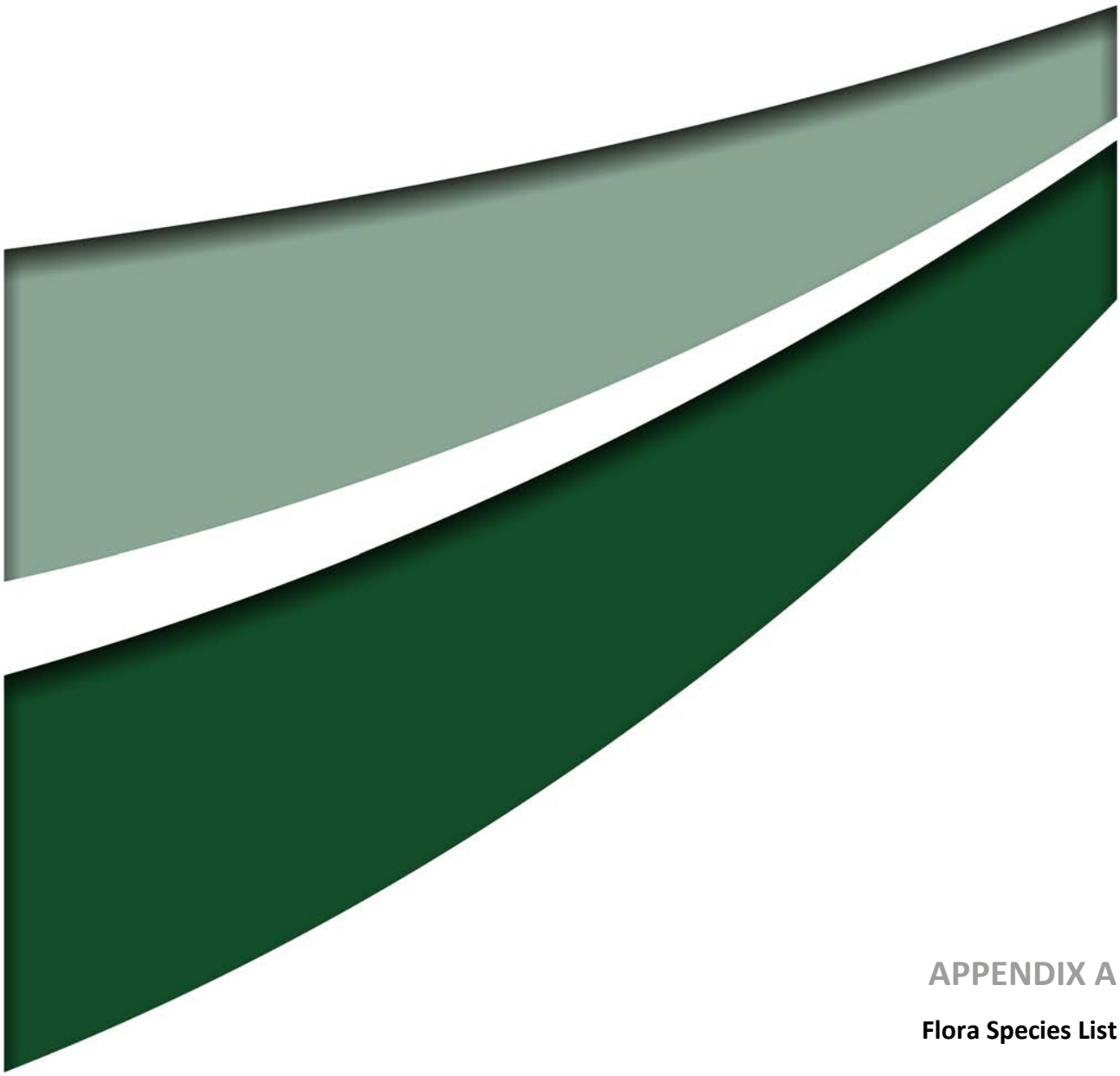
Poore, M. E. D. (1955) The use of phytosociological methods in ecological investigations. I. The Braun-Blanquet system. *Journal of Ecology* 42: 216-224.

South East Environmental (2016) Environmental Assessment Brief for DP 565423 Porters Road Kenshurst. South East Environmental, Moruya, NSW.

Threatened Species Scientific Committee (TSSC) (2014) Coastal Upland Swamps in the Sydney Basin Bioregion Listing Advice, registered 2014.

Tozer, M.G., Turner, K., Keith, D.A., Tindall, D., Pennay, C., Simpson, C., Mackenzie, B., Beukers, P. and Cox, S. (2010) Native Vegetation of Southeast NSW: a revised classification and map for the coast and eastern tablelands, *Cunninghamia* 11(3) 359-406.

Wellington, R, C, and Haering, R, 2001. Hygiene Protocol for the Control of Disease in Frogs. Information Circular Number 6. NSW National Parks and Wildlife Service, Hurstville NSW.



APPENDIX A

Flora Species List

Appendix A - Flora Species List

The following list was developed from surveys of the Modification Site by Umwelt in November 2014 and December 2015. It includes all species of vascular plants observed during these surveys. It is acknowledged that the list may not be completely comprehensive, as not all species are readily detected at any one time of the year. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

sp.	specimens that are identified to genus level only.

The following abbreviations or symbols are used in the list:

asterisk (*)	denotes species non-native species;
subsp.	subspecies;
var.	variety; and
+	denotes species recorded outside the plot/transect but in the same vegetation community.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002) and Wheeler *et al.* (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from PlantNET (Botanic Gardens Trust 2016), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

The score below each species is an estimated cover-abundance score allocated using a modified Braun-Blanquet 6-point scale (Braun-Blanquet 1927), with selected modifications sourced from Poore (1955) and Austin *et al*. (2000). A full definition of this methodology and scoring system is provided in **Section 2.3** of the main report.

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Filicopsida (Ferns)											
Adiantaceae	*Adiantum aethiopicum*	common maidenhair								3	
Aspleniaceae	*Asplenium flabellifolium*	necklace fern		1				2			
Dennstaedtiaceae	*Pteridium esculentum*	bracken						2			
Gleicheniaceae	*Gleichenia dicarpa*	pouched coral fern					1				
Lindsaeaceae	*Lindsaea microphylla*	lacy wedge fern				2					
Schizaeaceae	*Schizaea bifida*	forked comb fern	1					+			
Schizaeaceae	*Schizaea* spp.			+							
Magnoliopsida (Flowering Plants) - Liliidae (Monocots)											
Anthericaceae	*Caesia parviflora* var. *parviflora*		1	1							
Anthericaceae	*Thysanotus tuberosus*	common fringe-lily		1					1	2	1
Colchicaceae	*Burchardia umbellata*	milkmaids					1	1			
Cyperaceae	*Caustis pentandra*	thick twist rush			1					4	
Cyperaceae	*Caustis recurvata*				1			1			
Cyperaceae	*Cyathochaeta diandra*		1								
Cyperaceae	*Eleocharis sphacelata*	tall spike rush	1								
Cyperaceae	*Gahnia sieberiana*	red-fruit saw-sedge						3			
Cyperaceae	*Lepidosperma gunnii*					2		1	1		
Cyperaceae	*Lepidosperma* spp.				1						
Cyperaceae	*Ptilothrix deusta*					3			3		
Cyperaceae	*Schoenus brevifolius*						3				
Cyperaceae	*Schoenus ericetorum*			1	2			1	1		
Haemodoraceae	*Haemodorum planifolium*					1					
Lomandraceae	*Lomandra cylindrica*			1							
Lomandraceae	*Lomandra glauca*	pale mat-rush				2			2		
Lomandraceae	*Lomandra longifolia*	spiny-headed mat-rush		1				2	2		3

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush							1		
Lomandraceae	*Lomandra obliqua*			3	2				2	2	3
Lomandraceae	*Lomandra* spp.	mat-rush								3	
Orchidaceae	*Cryptostylis erecta*	tartan tongue orchid	1								
Orchidaceae	*Cryptostylis subulata*	large tongue orchid	1			1				2	
Orchidaceae	*Cymbidium suave*	snake orchid	1								
Orchidaceae	*Dipodium punctatum*		1								
Orchidaceae	*Dipodium variegatum*		1								
Orchidaceae	*Prasophyllum flavum*	yellow leek orchid	1								
Orchidaceae	*Thelymitra* spp.		1								
Phormiaceae	*Dianella prunina*			1	1			2			
Poaceae	*Anisopogon avenaceus*	oat speargrass						1			
Poaceae	*Aristida calycina* var. *calycina*									3	
Poaceae	*Austrostipa pubescens*							2			3
Poaceae	*Cynodon dactylon*	common couch	1								
Poaceae	*Entolasia stricta*	wiry panic		2	2	2		3			
Poaceae	**Eragrostis curvula*	African lovegrass	1								
Poaceae	*Paspalidium distans*			+							4
Poaceae	**Paspalum dilatatum*	paspalum	1								
Poaceae	*Themeda australis*	kangaroo grass	1						2		
Restionaceae	*Empodisma minus*						3				
Restionaceae	*Leptocarpus tenax*						3				
Restionaceae	*Lepyrodia scariosa*			2	1	3		3			
Restionaceae	*Lepyrodia* spp.									1	
Smilacaceae	*Smilax glyciphylla*	sweet sarsparilla		1				1			
Xanthorrhoeaceae	*Xanthorrhoea* spp.			2		2			2		

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Magnoliopsida (Flowering Plants) - Magnoliidae (Dicots)											
Apiaceae	*Actinotus helianthi*	flannel flower	1								
Apiaceae	*Actinotus minor*	lesser flannel flower					1	2	2	3	
Apiaceae	*Platysace ericoides*								1		1
Apiaceae	*Platysace linearifolia*			2	2			2		2	
Apiaceae	*Xanthosia pilosa*							1			
Apiaceae	*Xanthosia* spp.			2							
Apiaceae	*Xanthosia tridentata*	rock xanthosia		2							
Araliaceae	*Astrotricha obovata*							+			
Asteraceae	**Hypochaeris radicata*	catsear	1								
Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell	1								
Caryophyllaceae	**Polycarpon tetraphyllum*	four-leaved allseed		1					1		
Casuarinaceae	*Allocasuarina distyla*					1					
Cunoniaceae	*Ceratopetalum gummiferum*	Christmas bush		1				1			
Dilleniaceae	*Hibbertia empetrifolia* subsp. *empetrifolia*			2				1	+		
Dilleniaceae	*Hibbertia fasciculata*					1					
Dilleniaceae	*Hibbertia* spp.									1	
Droseraceae	*Drosera peltata*	a sundew								1	
Droseraceae	*Drosera spatulata*						2				
Elaeocarpaceae	*Elaeocarpus reticulatus*	blueberry ash						1			
Elaeocarpaceae	*Tetratheca glandulosa*			1					1		
Ericaceae	*Epacris microphylla*	coral heath								3	
Ericaceae	*Epacris pulchella*	Wallum heath		2		2		2			
Ericaceae	*Leucopogon attenuatus*	a beard-heath			1	2					
Ericaceae	*Leucopogon ericoides*	pink beard-heath		1							
Ericaceae	*Leucopogon esquamatus*						2				

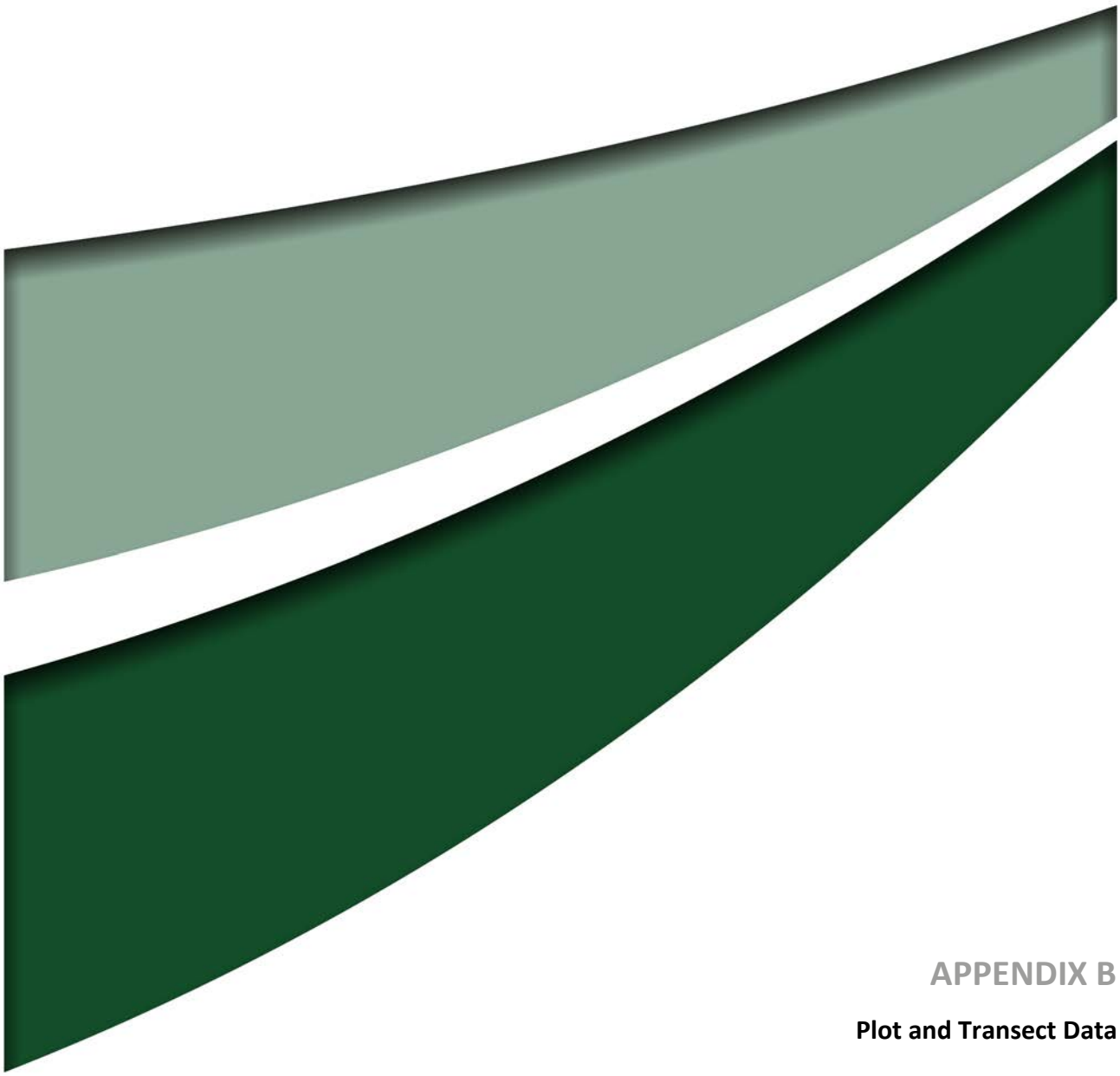
Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Ericaceae	*Leucopogon microphyllus*		1			2					
Ericaceae	*Lissanthe strigosa*	peach heath								3	
Ericaceae	*Melichrus procumbens*	jam tarts							1		
Ericaceae	*Monotoca scoparia*				1			1			
Ericaceae	*Woollsia pungens*		1		1	1					
Euphorbiaceae	*Amperea xiphoclada* var. *xiphoclada*							+			
Fabaceae (Faboideae)	*Aotus ericoides*			2							
Fabaceae (Faboideae)	*Bossiaea ensata*	sword bossiaea			2	2					
Fabaceae (Faboideae)	*Bossiaea heterophylla*	variable bossiaea			2			1			
Fabaceae (Faboideae)	*Bossiaea lenticularis*							3	1		3
Fabaceae (Faboideae)	*Bossiaea obcordata*	spiny bossiaea		3							
Fabaceae (Faboideae)	*Bossiaea scolopendria*							2		2	
Fabaceae (Faboideae)	*Bossiaea* spp.										1
Fabaceae (Faboideae)	*Dillwynia retorta*				1				1	2	
Fabaceae (Faboideae)	*Gompholobium glabratum*	dainty wedge pea			1						
Fabaceae (Faboideae)	*Gompholobium grandiflorum*	large wedge pea						1	1		
Fabaceae (Faboideae)	*Hovea linearis*								1		
Fabaceae (Faboideae)	*Hovea purpurea*				+						
Fabaceae (Faboideae)	*Mirbelia rubiifolia*	heathy mirbelia		2				2			
Fabaceae (Faboideae)	*Phyllota grandiflora*	heath phyllota				2					
Fabaceae (Faboideae)	*Phyllota phylicoides*	heath phyllota			3						
Fabaceae (Faboideae)	*Pultenaea retusa*						1				
Fabaceae (Faboideae)	*Pultenaea* spp.							1	1		
Fabaceae (Faboideae)	*Pultenaea tuberculata*				1						
Fabaceae (Mimosoideae)	*Acacia echinula*	hedgehog wattle				1					
Fabaceae (Mimosoideae)	*Acacia elongata*	swamp wattle					1				

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Fabaceae (Mimosoideae)	*Acacia linearifolia*	narrow-leaved wattle							2		
Fabaceae (Mimosoideae)	*Acacia linifolia*	white wattle		1							3
Fabaceae (Mimosoideae)	*Acacia longifolia*									1	
Fabaceae (Mimosoideae)	*Acacia suaveolens*	sweet wattle		1		2		2	1		1
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	prickly moses						1			
Gentianaceae	**Centaurium* spp.		1								
Goodeniaceae	*Dampiera stricta*			1	1	1	1	1	1		
Goodeniaceae	*Goodenia bellidifolia*					1					
Goodeniaceae	*Goodenia bellidifolia* subsp. *bellidifolia*									2	
Goodeniaceae	*Goodenia* spp.		1								
Goodeniaceae	*Scaevola ramosissima*	purple fan-flower	1					1	1	1	2
Haloragaceae	*Gonocarpus tetragynus*	poverty raspwort							1		1
Lamiaceae	*Hemigenia purpurea*					1					
Lauraceae	*Cassytha glabella*			2	2	2			2	2	1
Lauraceae	*Cassytha pubescens*	downy dodder-laurel						2			1
Loranthaceae	*Amyema* spp.	mistletoe		+							
Myrtaceae	*Angophora costata*	Sydney red gum						3			
Myrtaceae	*Angophora hispida*	dwarf apple		1	1				1	3	
Myrtaceae	*Baeckea diosmifolia*	fringed baeckea	1	2	1			2		1	2
Myrtaceae	*Baeckea imbricata*						1				
Myrtaceae	*Callistemon citrinus*	crimson bottlebrush					2	1			
Myrtaceae	*Callistemon linearis*	narrow-leaved bottlebrush		1							
Myrtaceae	*Calytrix tetragona*	common fringe-myrtle			2						
Myrtaceae	*Corymbia eximia*	yellow bloodwood		3							
Myrtaceae	*Corymbia gummifera*	red bloodwood				+		1	3		3
Myrtaceae	*Darwinia biflora*			3	1	3			1	2	

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Myrtaceae	*Darwinia fascicularis*			+							3
Myrtaceae	*Eucalyptus haemastoma*	broad-leaved scribbly gum								3	
Myrtaceae	*Eucalyptus piperita*	Sydney peppermint						3			
Myrtaceae	*Eucalyptus punctata*	grey gum						3	3		3
Myrtaceae	*Eucalyptus sparsifolia*	narrow-leaved stringybark		3	+				3		3
Myrtaceae	*Eucalyptus squamosa*	scaly bark									3
Myrtaceae	*Kunzea ambigua*	tick bush			2	2					
Myrtaceae	*Leptospermum parvifolium*			3							
Myrtaceae	*Leptospermum polygalifolium*			3		2	2	1		3	
Myrtaceae	*Leptospermum squarrosum*						4			2	
Myrtaceae	*Leptospermum trinervium*	slender tea-tree						3			
Myrtaceae	*Syncarpia glomulifera*	turpentine		2				3			
Olacaceae	*Olax stricta*				1						
Phyllanthaceae	*Phyllanthus hirtellus*	thyme spurge							2		
Pittosporaceae	*Billardiera scandens*	hairy apple berry		2					1		1
Polygalaceae	*Comesperma defoliatum*						+				
Proteaceae	*Banksia aemula*	Wallum banksia	1								
Proteaceae	*Banksia ericifolia*	heath-leaved banksia		2		4				5	
Proteaceae	*Banksia marginata*	silver banksia								3	
Proteaceae	*Banksia oblongifolia*	fern-leaved banksia		1	1	2					
Proteaceae	*Banksia serrata*	old-man banksia	1					3			
Proteaceae	*Banksia spinulosa*	hairpin banksia		2				1	1		
Proteaceae	*Grevillea buxifolia*	grey spider flower	1	2	2				1		1
Proteaceae	*Grevillea mucronulata*			1				1	2		
Proteaceae	*Grevillea parviflora* subsp. *supplicans*		1								
Proteaceae	*Grevillea speciosa*	red spider flower	1		2			1		1	

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Proteaceae	*Grevillea* spp.						1		+		
Proteaceae	*Hakea dactyloides*	finger hakea		2	1	2					
Proteaceae	*Hakea gibbosa*				2	2			2		
Proteaceae	*Hakea sericea*	needlebush		2							
Proteaceae	*Hakea* spp.			1							
Proteaceae	*Isopogon anemonifolius*	broad-leaf drumsticks			1	1				2	
Proteaceae	*Isopogon anethifolius*	narrow-leaf drumsticks									3
Proteaceae	*Lambertia formosa*	mountain devil		2		2		1	2		1
Proteaceae	*Lomatia silaifolia*	crinkle bush						1	1		1
Proteaceae	*Persoonia lanceolata*	lance leaf geebung		1		+					
Proteaceae	*Persoonia levis*	broad-leaved geebung		1	1			1	1		1
Proteaceae	*Petrophile pulchella*	conesticks		3	2	2		1	3		1
Rubiaceae	*Pomax umbellata*	pomax		2							
Rutaceae	*Boronia ledifolia*	Sydney boronia		+	1			1	1		
Rutaceae	*Boronia pinnata*					1		2			
Rutaceae	*Boronia* spp.					1				2	
Rutaceae	*Nematolepis squamea* subsp. *squamea*	satinwood			2						
Rutaceae	*Philotheca salsolifolia*					2					
Santalaceae	*Exocarpos cupressiformis*	cherry ballart									3
Stackhousiaceae	*Stackhousia nuda*						2				
Stackhousiaceae	*Stackhousia viminea*	slender stackhousia								2	
Sterculiaceae	*Lasiopetalum parviflorum*			1							
Stylidiaceae	*Stylidium graminifolium*	grass triggerplant						+			
Thymelaeaceae	*Pimelea glauca*	smooth rice-flower	1								
Thymelaeaceae	*Pimelea linifolia*	slender rice flower			1						
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*							1			

Family	Scientific Name	Common Name	Ops	P01	P02	P03	P04	P05	P06	SH1	SR1
Thymelaeaceae	*Pimelea* spp.					1					
Violaceae	*Hybanthus monopetalus*	slender violet-bush				1				1	
Violaceae	*Viola* spp.										2



APPENDIX B

Plot and Transect Data

Appendix B - Plot and Transect Data

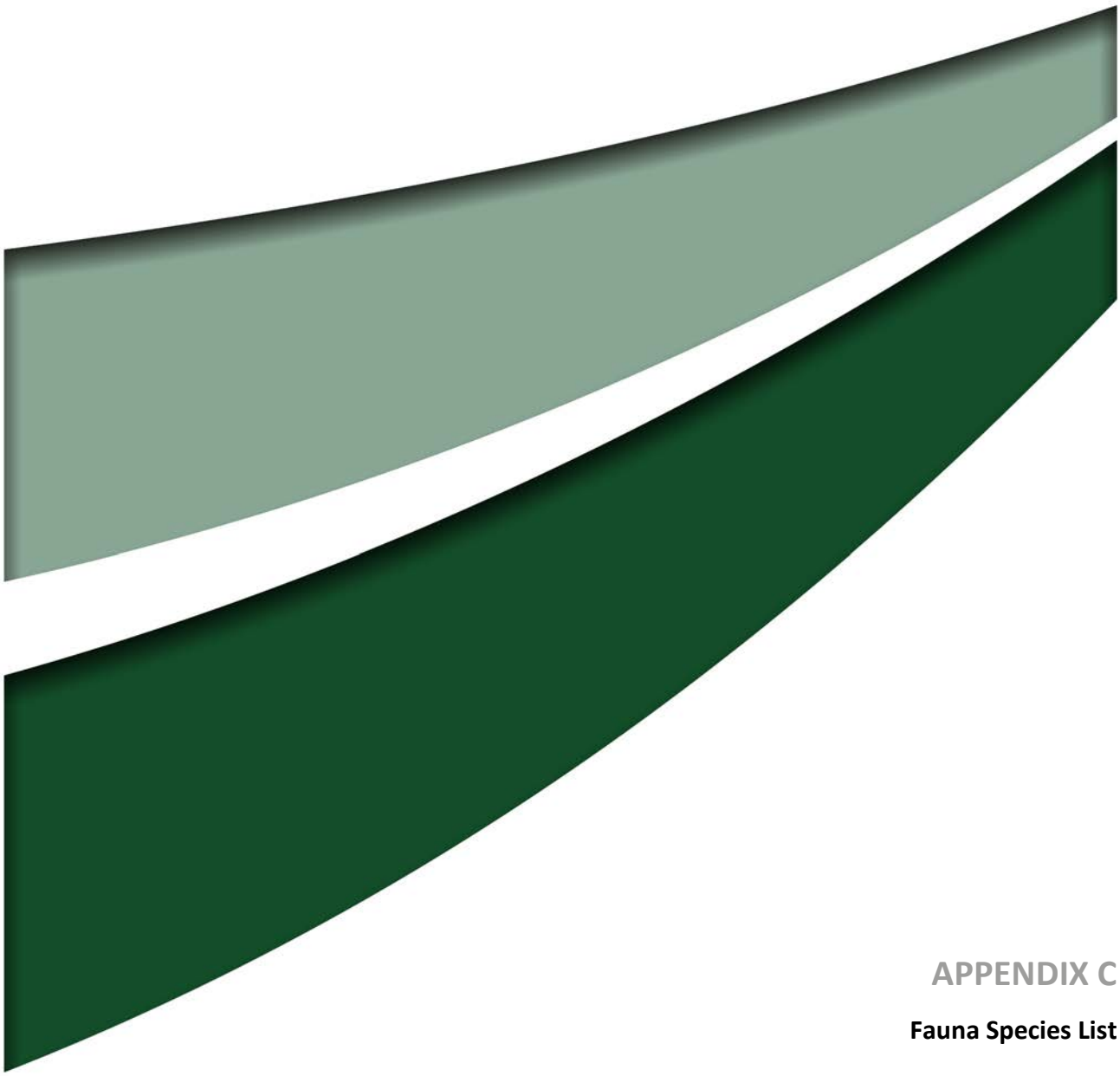
The following plot and transect data was collected from surveys of the Development Site. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the FBA (OEH 2014). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Calculator to assess the site value of each PCT in the Development Site.

The following abbreviations or symbols are used in the list:

NPS	native plant species
NOC	native overstorey cover
NMC	native midstorey cover
NGCG	native ground cover (grasses)
NGCS	native ground cover (shrubs)
NGCO	native ground cover (other)
EPC	exotic plant cover
NTH	number of trees with hollows
OR	overstorey regeneration, and
FL	total length of fallen logs.

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 1: HN560 – Needlebush – Banksia Wet Heath on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition													
P04	16	5	2	0	5	100	0	0	1	0	312277	6294089	56
Zone 2: HN566 – Red Bloodwood – Scribbly Gum Heathy Woodland on Sandstone Plateaux of the Sydney Basin Bioregion – Moderate to Good Condition													
SR1	31	31.5	8	58	32	4	0	9	1	17	312225	6293930	56
P01	50	17	9.5	26	32	52	0	6	1	114	312439	6294082	56
P06	41	18.5	18	42	18	62	0	8	1	18	312324	6293932	56
Zone 3: HN582 – Scribbly Gum – Hairpin Banksia – Dwarf Apple Heathy Woodland on Hinterland Sandstone Plateaux of the Central Coast, Sydney Basin Bioregion – Moderate to Good Condition													
SH1	28	19	5	12	18	52	0	0	1	90	312393	6293502	56
P02	39	1	15.2	6	40	40	0	4	1	9	312429	6293364	56
P03	40	15	14	32	82	42	0	2	1	8	312389	6293681	56
Zone 4: HN586 – Smooth-barked Apple – Red Bloodwood – Sydney Peppermint Heathy Open Forest on Slopes of Dry Sandstone Gullies of Western and Southern Sydney, Sydney Basin Bioregion – Moderate to Good Condition													
P05	55	12.5	15.5	10	44	68	0	9	1	28	311956	6293801	56
EXTRA 1*	55	12.5	15.5	10	44	68	0	9	1	28	311956	6293801	56
EXTRA 2*	55	12.5	15.5	10	44	68	0	9	1	28	311956	6293801	56
EXTRA 3*	55	12.5	15.5	10	44	68	0	9	1	28	311956	6293801	56

#denotes plot/transect data duplicated for the Porters Road Offset Site.



APPENDIX C

Fauna Species List

Appendix C - Fauna Species List

The following fauna list was developed from surveys of the Development Site by Umwelt.

The following abbreviations or symbols are used in the list:

asterisk (*) Denotes species not indigenous to the project area;

subsp. Subspecies;

MIG Listed migratory species under the EPBC Act;

PV Potential to be a Vulnerable species (Identification method not sufficient to be certain)

V Vulnerable; and

E Endangered.

Birds recorded were identified using descriptions in Pizzey and Knight (2012) and the scientific and common name nomenclature of Birdlife Australia (Birdlife International 2013). Reptiles recorded were identified using keys and descriptions in Cogger (2014) and Wilson & Swan (2008) and the scientific and common name nomenclature of Cogger (2014).

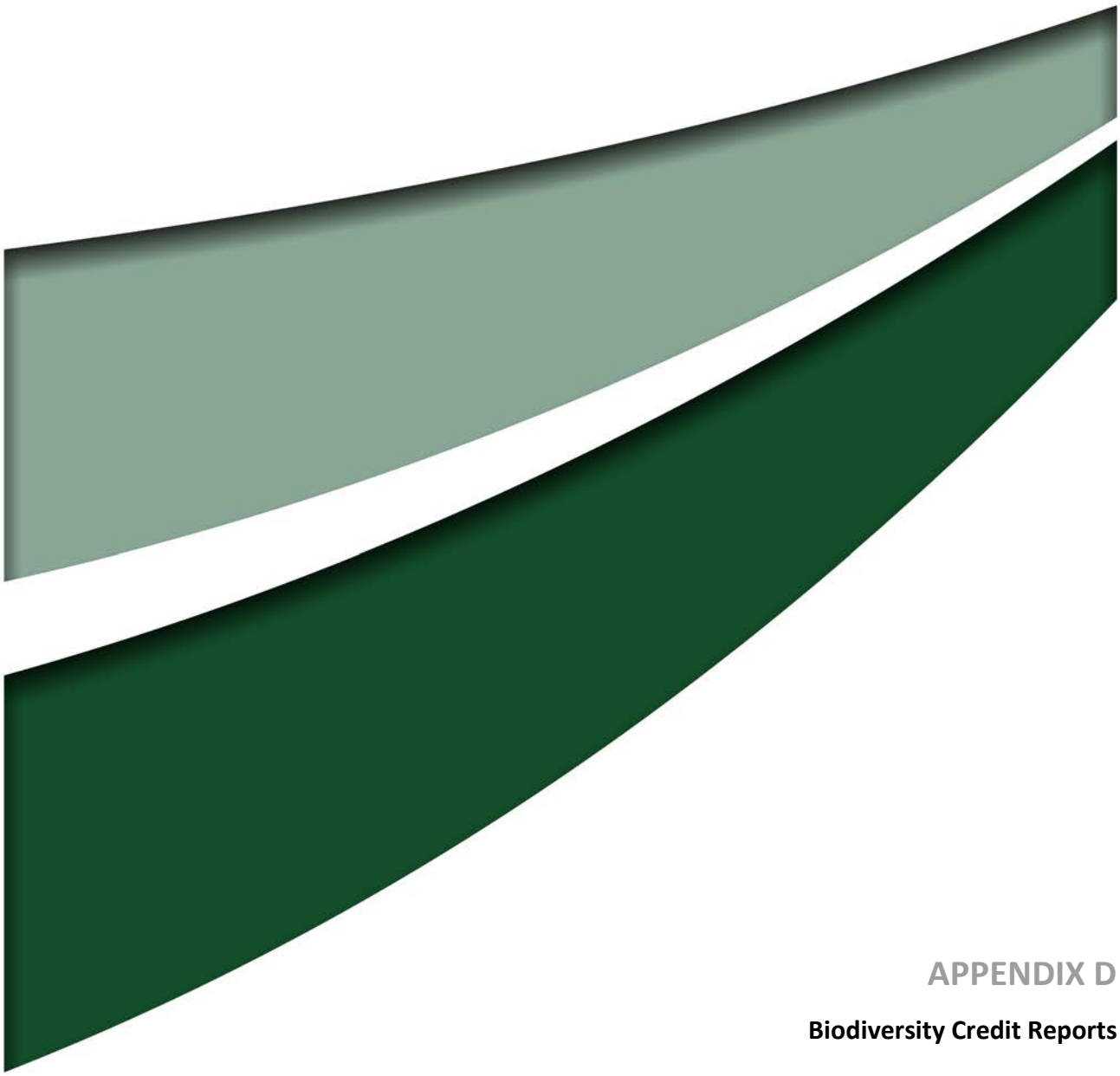
Amphibians recorded were identified using keys and descriptions in Cogger (2014), Robinson (1998), Anstis (2013) and Barker *et al*. (1995) and the scientific and common name nomenclature of Cogger (2014). Mammals recorded were identified using keys and descriptions in Van Dyck & Strahan (2008), and Menkhorst & Knight (2010) and the scientific and common name nomenclature of Van Dyck & Strahan (2008).

Scientific Name	Common Name	TSC Act	EPBC Act	MIGRATORY EPBC
PHYLUM MOLLUSCA				
GASTROPODA				
Myobatrachidae				
Pommerhelix duralensis	Dural woodland snail		**E**	
PHYLLUM CHORDATA				
AMPHIBIA				
Myobatrachidae				
Crinia signifera	common froglet			
Limnodynastes dumerilii	eastern banjo frog			
Limnodynastes peronii	brown-striped frog			
Uperoleia laevigata	smooth toadlet			
Uperoleia sp.	a ground frog			
Hylidae				
Litoria fallax	eastern dwarf tree frog			
Litoria latopalmata	Gunther's tree frog			

Scientific Name	Common Name	TSC Act	EPBC Act	MIGRATORY EPBC
Litoria peronii	Peron's tree frog			
REPTILIA				
Pygopodidae				
Pygopus lepidopodus	common scaly-foot			
Lialis burtonis	Burton's snake-lizard			
Scincidae				
Lygisaurus foliorum	tree-base litter-skink			
Varanidae				
Varanus variaus	lace monitor			
AVES				
Columbidae				
Geopelia humeralis	bar-shouldered dove			
Phaps chalcoptera	common bronzewing			
Alcedinidae				
Dacelo novaeguineae	laughing kookaburra			
Todiramphus sanctus	sacred kingfisher			
Cululidae				
Scythrops novaehollandiae	Channel-billed cuckoo			
Cacatuidae				
Calyptorhynchus lathami	glossy black-cockatoo	**V**		
Calyptorhynchus funereus	yellow-tailed black-cockatoo			
Psittacidae				
Platycercus eximius	eastern rosella			
Tytonidae				
Tyto javanica	eastern barn owl			
Anatidae				
Anas superciliosa	Pacific black duck			
Podicipedidae				
Tachybaptus novaehollandiae	Australasian grebe			
Ardeidae				
Egretta novaehollandiae	white-faced heron			
Accipitridae				
Elanus axillaris	black-shouldered kite			
Charadriidae				
Vanellus miles	masked lapwing			

Scientific Name	Common Name	TSC Act	EPBC Act	MIGRATORY EPBC
Psophodidae				
Psophodes olivaceus	eastern whipbird			
Climacteridae				
Climacteris picumnus	brown treecreeper			
Pardalotidae				
Pardalotus striatus	striated pardalote			
Meliphagidae				
Acanthorhynchus tenuirostris	eastern spinebill			
Lichenostomus penicillatus	white-plumed honeyeater			
Phylidonyris niger	white-cheeked honeyeater			
Acanthizidae				
Acanthiza lineata	striated thornbill			
Smicrornis brevirostris	weebill			
Sericornis frontalis	white-browed scrubwren			
Sericornis sp.	a scrubwren			
Pachycephalidae				
Pachycephala pectoralis	golden whistler			
Corvidae				
Corvus coronoides	Australian raven			
Rhipiduridae				
Rhipidura albiscapa	grey fantail			
Rhipidura leucophrys	willie wagtail			
Maluridae				
Malurus lamberti	variegated fairy-wren			
Malurus cyaneus	superb fairy-wren			
Nectariniidae				
Dicaeum hirundinaceum	mistletoebird			
Estrildidae				
Neochmia temporalis	red-browed finch			
MAMMALIA				
Tachyglossidae				
Tachyglossus aculeatus	short-beaked echidna			
Dasyuridae				
Antechinus sp.	a marsupial mouse			
Actrobatidae				
Acrobates pygmaeus	feathertail glider			

Scientific Name	Common Name	TSC Act	EPBC Act	MIGRATORY EPBC
Burramyidae				
Cercartetus nanus	eastern pygmy-possum			
Macropodidae				
Wallabia bicolor	swamp wallaby			
Petauridae				
Petuarus breviceps	sugar glider			
Phalangeridae				
Trichosurus vulpecula	common brushtail possum			
Peramelidae				
Isoodon sp.	a bandicoot			
Vombatidae				
Vombatus ursinus	common wombat			
Molossidae				
Tadarida australis	white-striped freetail-bat			
Mormopterus sp. 2	eastern freetail-bat			
Vespertilionidae				
Chalinolobus dwyeri	large-eared pied bat	**V**	**V**	
Chalinolobus gouldii	Gould's wattled bat			
Chalinolobus morio	chocolate wattled bat			
Miniopterus australis	little bentwing-bat	**V**		
Vespadelus pumilus	eastern forest bat			
Canidae				
**Canis lupus familiaris*	domestic dog			
**Vulpes vulpes*	red fox			
Leporidae				
**Lepus capensis*	brown hare			
Bovidae				
**Ovis aries*	sheep			
Muridae				
Rattus sp.	a rat			



APPENDIX D

Biodiversity Credit Reports

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 20/05/2016 Time: 10:20:11AM Calculator version: v4.0

Major Project details

Proposal ID:	0020/2016/2563MP
Proposal name:	Hearses Road Quarry
Proposal address:	75 York Street Teralba NSW 2284
Proponent name:	Umwelt
Proponent address:	75 York Street Teralba NSW 2284
Proponent phone:	49505322
Assessor name:	Travis Peake
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	0020

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	0.08	3.00
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	6.67	377.00
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	11.15	538.00
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	0.99	44.00
Total	18.89	962

Credit profiles

1. Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566)

Number of ecosystem credits created	377
IBRA sub-region	Yengo - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HN587) Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion, (HN567) Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586) Spotted Gum - Grey Ironbark open forest in the Pittwater area, Sydney Basin Bioregion, (HN642) Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion, (HN644)	Yengo - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586)

Number of ecosystem credits created	44
IBRA sub-region	Yengo - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586) Smooth-barked Apple - Sydney Peppermint - Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion, (HN587) Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566) Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion, (HN567) Spotted Gum - Grey Ironbark open forest in the Pittwater area, Sydney Basin Bioregion, (HN642) Sydney Peppermint - White Stringybark - Smooth-barked Apple forest on shale outcrops, Sydney Basin Bioregion, (HN644)	Yengo - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion, (HN582)

Number of ecosystem credits created	538
IBRA sub-region	Yengo - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Sandstone cliff soak moist shrubland of the Sydney Basin Bioregion, (HN580) Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion, (HN582)	Yengo - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion, (HN560)

Number of ecosystem credits created	3
IBRA sub-region	Yengo - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion, (HN560) Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion, (HN563) Baeckea linifolia - Grevillea acanthifolia subsp. acanthifolia shrub/sedge swamp on sandstone, Sydney Basin Bioregion, (HN633)	Yengo - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Darwinia biflora	Darwinia biflora	18.00	360
Mitchells Rainforest Snail	Thersites mitchellae	17.82	1,372
Tetratheca glandulosa	Tetratheca glandulosa	18.00	288
Grevillea parviflora subsp. supplicans	Grevillea parviflora subsp. supplicans	13.00	338
Eastern Pygmy-possum	Cercartetus nanus	11.15	223

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 20/05/2016 Time: 10:21:57AM Calculator version: v4.0

Biobank details

Proposal ID:	0020/2016/3573B
Proposal name:	Hearses Road Offset
Proposal address:	75 York Street Teralba NSW 2284
Proponent name:	Umwelt
Proponent address:	75 York Street Teralba NSW 2284
Proponent phone:	49505322
Assessor name:	Travis Peake
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	0020

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	0.93	11.00
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	0.78	6.00
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	1.52	17.00
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	0.36	4.00
Total	3.59	38

Credit profiles

1. Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566)

Number of ecosystem credits created	6
IBRA sub-region	Yengo - Hawkesbury/Nepean

2. Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586)

Number of ecosystem credits created	4
IBRA sub-region	Yengo - Hawkesbury/Nepean

3. Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion, (HN582)

Number of ecosystem credits created	17
IBRA sub-region	Yengo - Hawkesbury/Nepean

4. Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion, (HN560)

Number of ecosystem credits created	11
IBRA sub-region	Yengo - Hawkesbury/Nepean

Species credits summary

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Eastern Pygmy-possum	Cercartetus nanus	1.52	11
Darwinia biflora	Darwinia biflora	2.00	14
Mitchells Rainforest Snail	Thersites mitchellae	2.30	16
Tetratheca glandulosa	Tetratheca glandulosa	2.00	14

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Darwinia biflora	Feral and/or over-abundant native herbivore control
Eastern Pygmy-possum	Fox control
Mitchells Rainforest Snail	Exclude miscellaneous feral species
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Control of feral pigs
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Exclude miscellaneous feral species
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Fox control
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Control of feral pigs
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Exclude commercial apiaries
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Exclude miscellaneous feral species
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Fox control
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Control of feral pigs
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Exclude miscellaneous feral species
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control

Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Fox control
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Control of feral pigs
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Exclude commercial apiaries
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Exclude miscellaneous feral species
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Fox control
Tetratheca glandulosa	Feral and/or over-abundant native herbivore control

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 5/07/2016 Time: 11:34:27AM Calculator version: v4.0

Biobank details

Proposal ID:	0020/2016/3576B
Proposal name:	Porters Road - Dixon Offset
Proposal address:	75 York Street Teralba NSW 2284
Proponent name:	Umwelt
Proponent address:	75 York Street Teralba NSW 2284
Proponent phone:	49505322
Assessor name:	Travis Peake
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	0020

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	10.47	86.00
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	9.34	104.00
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	33.51	327.00
Total	53.32	517

Credit profiles

1. Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (HN566)

Number of ecosystem credits created	86
IBRA sub-region	Yengo - Hawkesbury/Nepean

2. Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (HN586)

Number of ecosystem credits created	327
IBRA sub-region	Yengo - Hawkesbury/Nepean

3. Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion, (HN582)

Number of ecosystem credits created	104
IBRA sub-region	Yengo - Hawkesbury/Nepean

Species credits summary

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Bynoe's Wattle	Acacia bynoeana	20.00	142
Darwinia biflora	Darwinia biflora	20.00	142
Epacris purpurascens subsp. purpurascens	Epacris purpurascens subsp. purpurascens	20.00	142
Hibbertia superans	Hibbertia superans	20.00	142
Tetratheca glandulosa	Tetratheca glandulosa	20.00	142
Lasiopetalum joyceae	Lasiopetalum joyceae	9.00	64

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Darwinia biflora	Feral and/or over-abundant native herbivore control
Epacris purpurascens subsp. purpurascens	Feral and/or over-abundant native herbivore control
Epacris purpurascens subsp. purpurascens	Maintain or re-introduce natural flow regimes
Hibbertia superans	Feral and/or over-abundant native herbivore control
Hibbertia superans	Slashing
Lasiopetalum joyceae	Feral and/or over-abundant native herbivore control
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Control of feral pigs
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Exclude commercial apiaries
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Exclude miscellaneous feral species
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Fox control
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Control of feral pigs
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Exclude miscellaneous feral species
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Scribbly Gum - Hairpin Banksia - Dwarf Apple heathy woodland on hinterland sandstone plateaux of the Central Coast, Sydney Basin Bioregion	Fox control

Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Control of feral pigs
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Exclude commercial apiaries
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Exclude miscellaneous feral species
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	Fox control
Tetratheca glandulosa	Feral and/or over-abundant native herbivore control

APPENDIX E

Royal Botanic Gardens Identification Letter

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Ryan PARSONS
Umwelt Pty Ltd
75 York Street
Teralba, NSW 2284

Enquiry No: 19561
Botanical.Is@rbgsyd.nsw.gov.au
Fax No: (02) 9251 1952
Ph No: (02) 9231 8111
Date: 20 April 2016

Dear Ryan PARSONS,

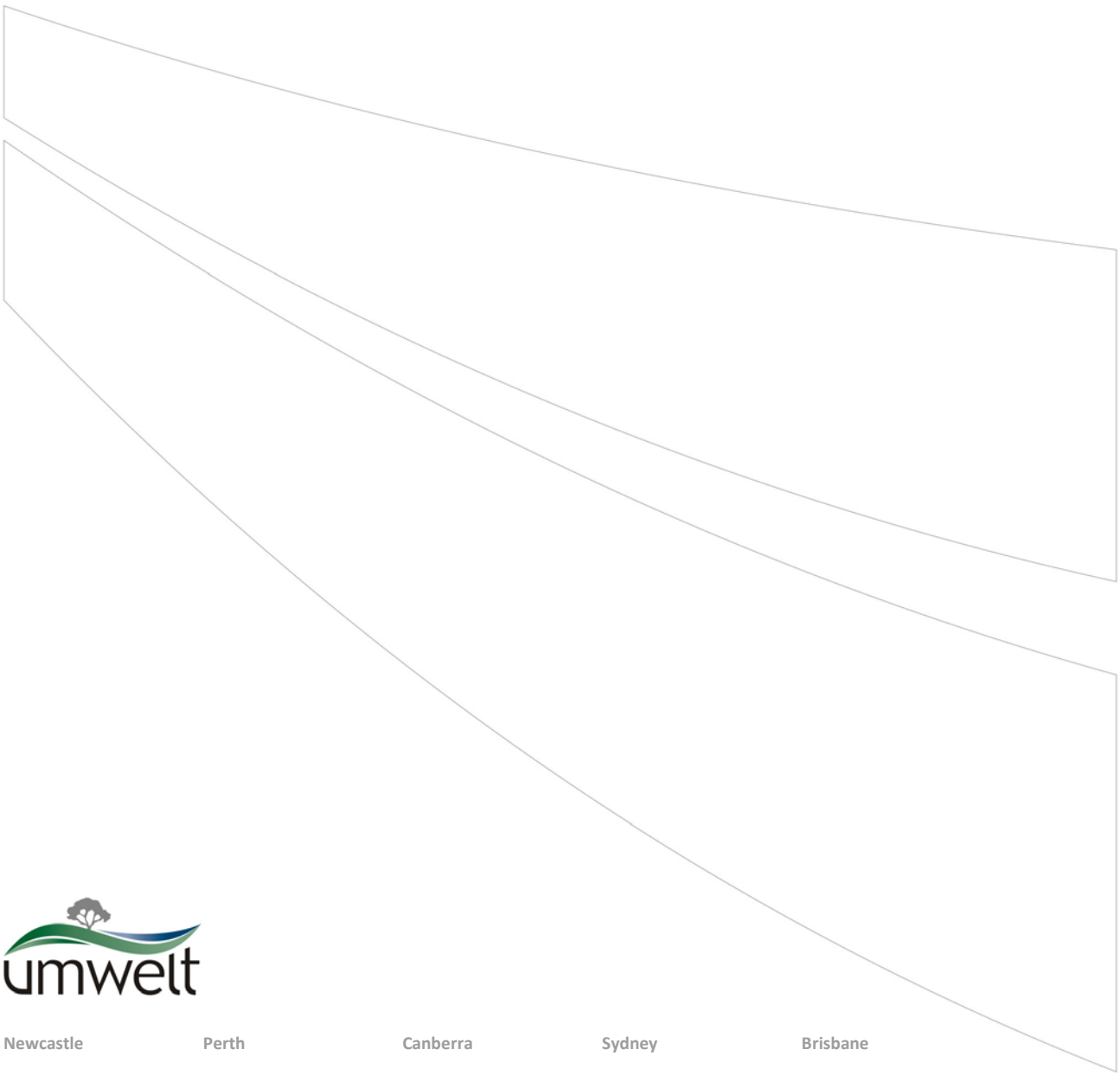
Thank you for your enquiry of 15-Mar-16. We are happy to provide the following information:

Dr Peter Wilson has examined your *Darwinia* collection from the Maroota area near Wisemans Ferry and our own herbarium collections from similar sites. The *Darwinia fascicularis* in the Maroota area have fewer flowers than you would expect for eastern populations of this species and require further study. I am sorry that we are unable to give you a complete report to subspecies at this point in time.
Your specimen has been retained for our herbarium collection and further study. There is no charge for this enquiry.

Thank you for your enquiry.

Yours sincerely

Barbara Wiecek
Identification Botanist
Botanical Information Service



umwelt

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