Metromix Pty Ltd
ABN: 39 002 886 839

Teralba Quarry Extensions

Flora Assessment

Prepared by

Idyll Spaces Environmental Consultants

October 2011

Specialist Consultant Studies Compendium
Volume 1, Part 4

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Flora Assessment

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October 2011

The information presented in this report is, in the opinion of the author, a true and accurate record based on an objective study undertaken in response to a brief provided by the client. While every attempt has been made to ensure the accuracy and objectivity of the report, the variability of the natural environment and the paucity of comparative research data may require that professional judgement be applied in reaching conclusions. Any opinions expressed in the report are the professional opinions of the author. They are not intended to advocate any specific proposal or position.

Except where noted in 'Limitations' this report meets DECCW survey guidelines. Survey data will be forwarded to Wildlife Atlas of NSW.

G.N. Elks B.Sc (Botany), M.Litt (Ecology), MECA October 2011

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EXECUTIVE SUMMARY

The Project would extend the existing Teralba Quarry to include further land area to both the north and south of the existing operational quarry areas in order to maintain the extraction rate of the Teralba Conglomerate resources and extend the life of the quarry.

The Study Area for the Project is located to the west of the village of Teralba approx. 7km north of Toronto. It includes the proposed quarry and a large area of surrounding vegetation and occupies a series of ridgelines falling via moderate to steep slopes to intervening gully lines. It is bisected east to west by Rhondda Road and adjoins a private coal haul road and the Newtech Pistol Club.

Large parts of the Project Site have been cleared for quarrying and associated processing. The underlying Newcastle Coal Measures have been mined for coal and are affected by mine subsidence. The vegetation of the Study Area (the Project Site, plus a small area of electricity transmission line to the north of the Project Site) has a history of major disturbances such as clearing or heavy logging, and fire.

Intensive flora survey of the Study Area has been undertaken by Greg Elks of Idyll Spaces (see **Appendix** 3) and Anne Marie Clements, Tony Rodd and others of Anne Clements & Associates over a 14 year period to September 2011. Surveys involved both systematic survey and survey targeting threatened flora. The data was used to map and describe two forest vegetation communities occupying the Study Area. They are Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland, and Blue Gum - White Stringybark Shrubby Tall Open Forest. A non-forest community includes all areas where tree cover is absent as a result of clearing.

The Director-General's requirements list nine threatened flora species and two threatened ecological communities. Six threatened flora species have been recorded within 5km of the Project Site.

One species, the shrub *Tetratheca juncea*, occurs in Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland in parts of the Study Area including within the Project Site. Two other species, the shrubs *Callistemon linearifolius* and *Grevillea parviflora subsp. parviflora*, were assessed as potential occurrences in this community but were not detected in the Study Area.

The rainforest tree *Syzygium paniculatum* occurred in Blue Gum dominated shrubby open forest near the south eastern corner of the Study Area and has potential for occurrence in the Blue Gum - White Stringybark Shrubby Tall Open Forest in the northeast of the Study Area.

No other threatened flora species were assessed as likely to occur in the Study Area.

The vegetation communities of the Study Area do not meet floristic, edaphic and/or locational requirements of any threatened ecological community. No species characteristic of endangered populations were detected in the Study Area. No groundwater dependent ecosystems were detected in the Study Area.

Proposed actions to avoid, minimise and mitigate impacts on threatened flora and native vegetation include:

- avoiding sub-populations of *T. juncea* to retain 64% of clumps in the Study Area;
- relocation of power lines to utilise existing cleared areas wherever possible, and elsewhere adjacent to the haul road so as to minimise the area of clearing required;
- addressing the 13 Biodiversity Offset Principles for proposed offsets;
- progressive rehabilitation of forest habitat in final quarry landforms and of *T. juncea* habitat in disused powerline easements, and
- risk assessment for quarry product export, rehabilitation and revegetation operations and employment of appropriate measures as outlined by NSW Department of Industry and Investment (2011).

It is proposed that those parts of the Project Site not required for the quarry and associated access and infrastructure including 147ha of retained vegetation 118ha of which would be set aside as a biodiversity offset would be legally protected and managed as a biodiversity offset to the clearing of 28.7ha of native vegetation for the quarry extensions and associated infrastructure. Those parts of the Project Site not required for future industrial development would be rehabilitated to native vegetation.

Approximately 7ha of previously cleared land in the southeast of the Project Site has been rehabilitated to forest since 1992. The threatened flora species *Tetratheca juncea* has subsequently established in the rehabilitation area.

It is proposed that topsoil and vegetation extracted from the immediate area of the existing *T. juncea* sub-populations within the Project Site would be relocated to appropriate rehabilitation areas to facilitate re-establishment of *T. juncea*. All machinery required for the operation would be cleaned of all soil and seed residues immediately beforehand to minimise potential problems from soil-borne seeds and diseases.

Weed control in the quarry operational areas and the rehabilitation areas has been regularly undertaken for at least 15 years. It is anticipated that bush regeneration activities associated with weed control will be required in rehabilitation areas and in the more severely Lantana infested areas of the Blue Gum – White Stringybark community in the medium to long term. Ongoing weed control would be addressed in a Vegetation Management Plan for the Project Site.

Recommended intervals between fires would be included as a consideration in the Vegetation Management Plan.

Impacts on *Tetratheca juncea* are assessed as not likely to be significant because of

- the proposed retention of about two-thirds of the known clumps in the Project Site together with large contiguous areas of potential habitat;
- rehabilitation of habitat;
- habitat would not be isolated or fragmented;
- the importance of the habitat to be removed is not critical to the long-term survival of the species in the locality;

- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Project Site;
- the Project is consistent with the actions listed in the Priority Action Statement ;
- the Project constitutes or is part of key threatening processes already operating at the Project Site, but the Proponent would apply measures that would avoid or reduce the impacts of those key threatening processes.

Impacts on *Callistemon linearifolius & Grevillea parviflora* subsp. *parviflora* are assessed as not likely to be significant because:

- neither species have been detected in the Project Sire despite targeted searches at appropriate times;
- the proposal retains large contiguous areas of potential habitat;
- potential habitat would be rehabilitated;
- potential habitat would not be isolated or fragmented;
- the importance of the habitat to be removed is not likely to be of significance to the long-term survival of the species in the locality;
- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Project Site;
- the Project is consistent with the actions listed in the Priority Action Statement ;
- the Project constitutes or is part of key threatening processes already operating in the Project Site but the proposal would apply measures that would avoid or reduce the impacts of those key threatening processes.

Impacts on *Syzygium paniculatum* are assessed as not likely to be significant because:

- the proposal retains all areas of potential habitat;
- potential habitat would be rehabilitated;
- potential habitat would not be isolated or fragmented;
- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Project Site;
- the Project is consistent with the actions listed in the Priority Action Statement ;
- the Project constitutes or is part of key threatening processes already operating in the Project Site but the Proponent would apply measures that would avoid or reduce the impacts of those key threatening processes.

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1. INTRODUCTION

1.1 DEFINITIONS

Subject Site – the area that would be directly or indirectly affected by the proposal – assumed to be the clearing envelope.

Project Site – the area for which project approval is sought, located within the study area.

The Study Area - all vegetation potentially impacted by the proposal, including that proposed as biodiversity offset.

The locality is defined for this study as being within 6km of the Study Area centroid, or (approximately) 5km of the Study Area.

1.2 BACKGROUND

This study was prepared by G.N Elks of Idyll Spaces Environmental Consultants. It was commissioned by R. W. Corkery & Co Pty Ltd on behalf of Metromix Pty Ltd, the operators of the Teralba Quarry.

1.3 THE PROJECT

The Project would extend an existing quarry to include further land area to both the north and south of the existing operational quarry areas. This would maintain the extraction rate of the Teralba Conglomerate resources at 1 million tpa and extend the life of the quarry for an additional 30 years.

1.4 AIMS AND OBJECTIVES

The aim of the report is to present the flora assessment of the Study Area and address the Director-General's Requirements and provide expert advice to assist the determining authority in making a decision on the project approval.

The objectives are to:

- Review existing studies of the Study Area and threatened flora species, population and ecological community records in the locality.
- Refine previous mapping of vegetation communities of the Study Area.
- Determine whether any threatened flora species, threatened ecological communities, threatened populations or their habitat, or critical habitat listed by the TSC Act or the EPBC Act occur within the Study Area.
- Identify the potential impacts of the proposed quarry extensions and appropriate measures to avoid, minimise and mitigate those impacts.
- Assess the likely impacts of the proposal on threatened flora species, threatened ecological communities, threatened populations or critical habitat.

1.5 LOCATION

The Project Site is located to the west of the village of Teralba approx. 7km north of Toronto and 6km to the south of Edgeworth in the Parish of Teralba, in the County of Northumberland (**Figure 1**).

Figure 1
Locality Plan

It falls within the Sydney Basin bioregion, the Wyong sub-region of the Hunter-Central Rivers CMA region, and the Lake Macquarie Local Government Area (LGA).

1.6 LANDFORM

The Study Area occupies undulating terrain consisting of a series of ridgelines to about 90m AHD falling via moderate to steep slopes to intervening gully lines at about 40m AHD. It is surrounded by flatter land at lower elevations including substantially modified landscapes associated with open cut collieries to the north, south and west **(Figure 1** and **Figure 2**).

1.7 CLIMATE

The closest Bureau of Meteorology meteorological station is Newcastle Nobbys Signal Station Number 061055 located 18 km to the northeast, which has operated since 1862 (Bureau of Meteorology website: www.bom.gov.au/climate accessed 10 March 2011).

The mean annual maximum temperature is 22°C and mean annual minimum temperature is 14°C. The mean annual rainfall is 1135 mm with the mean maximum of 120mm in March and the mean minimum of 57mm in November.

1.8 GEOLOGY

The geology of the Study Area is mapped at 1:250 000 scale (Rose *et al*. 1966) (**Figure 3)** as Newcastle Coal Measures (map unit Pn). The Newcastle Coal Measures are described as "Conglomerate, sandstone, tuff, shale, coal" and are of Permian geological age.

The Narrabeen Group (map unit Rnc) of Triassic age adjoins at the central southern boundary of the Study Area and Quaternary deposits (Qa) extend in an arc across low-lying lands well to the east, north, and west of the Study Area.

1.9 SOIL LANDSCAPES

The soil landscape of the Study Area is mapped at 1:100 000 scale (**Figure 4**) (Matthei 1995). The proposed northern quarry extension includes the Gateshead soil landscape (map unit ga) along the ridge, Stockrington soil landscape variant (map unit sna) on the lower slopes and a small area of Doyalson (map unit do) in the west.

The Southern Extension includes the Killingworth soil landscape (map unit ki) on the ridgeline and upper slopes and Gateshead (map unit ga) on the lower slopes.

The Gateshead soil landscape is described (Matthei 1995) as

> Landscape - *undulating to rolling rises on Permian conglomerate, shale and sandstone in the Awaba Hills. Local relief to 100m. Slopes 5 – 15%. Elevation to 130m. Predominantly cleared woodland and open-forest.*
>
> Soils - *moderately deep (100 – 200 cm), moderately well to imperfectly drained yellow Podzolic Soils and yellow Soloths on conglomerate crests and sideslopes, with some shallow (<50 cm), rapidly drained Lithosols. Moderately deep to deep (100 – 400 cm), well to imperfectly drained Red Podzolic Soils, red Soloths and some Yellow soloths on shale parent material.*
>
> Limitations - *water erosion hazard, Mine Subsidence District, localised steep slopes and shallow soils, high run-on and seasonal waterlogging on lower slopes, acid soils of low fertility.*

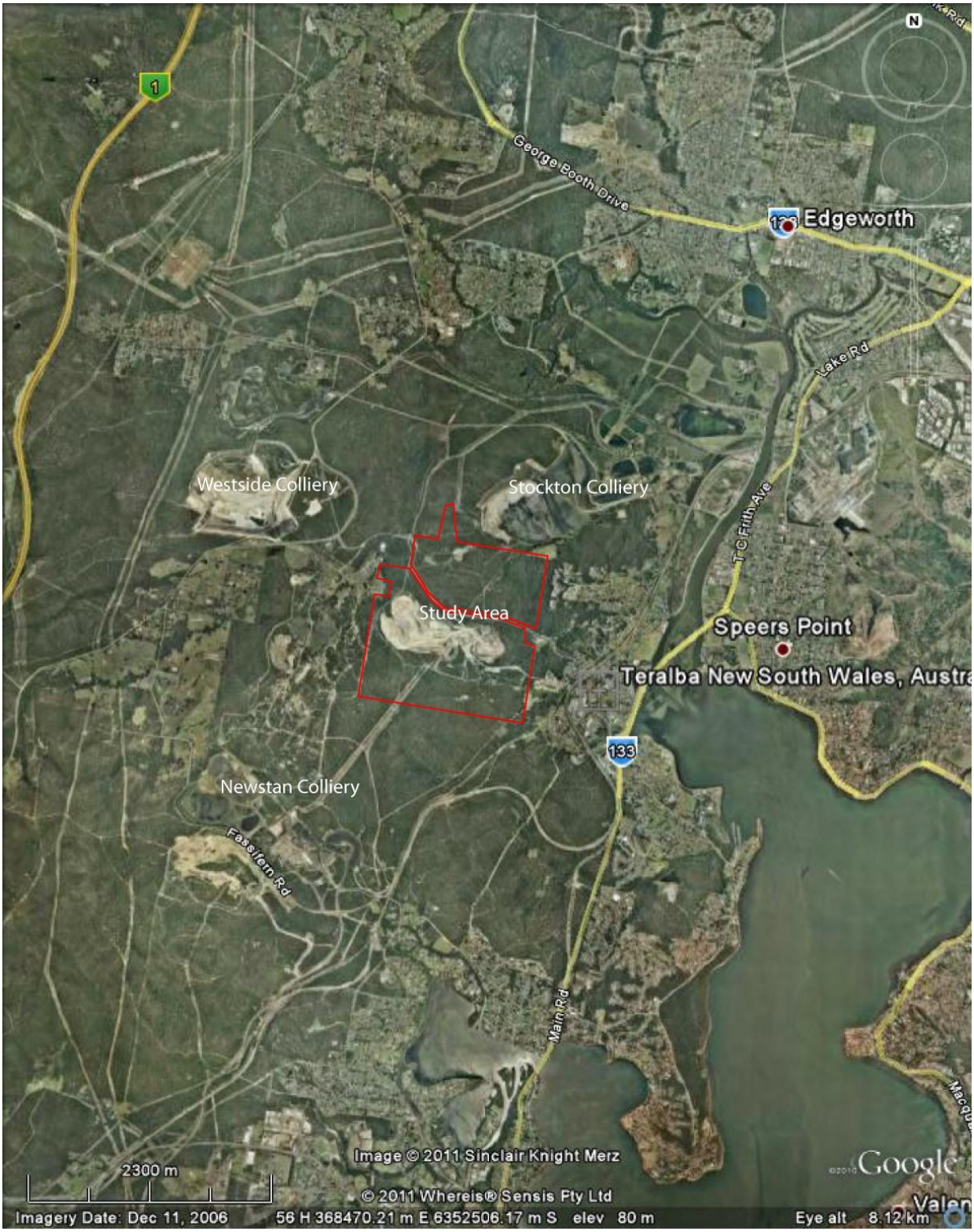


Figure 2
Google 2006 Aerial Photo of Study Area locality

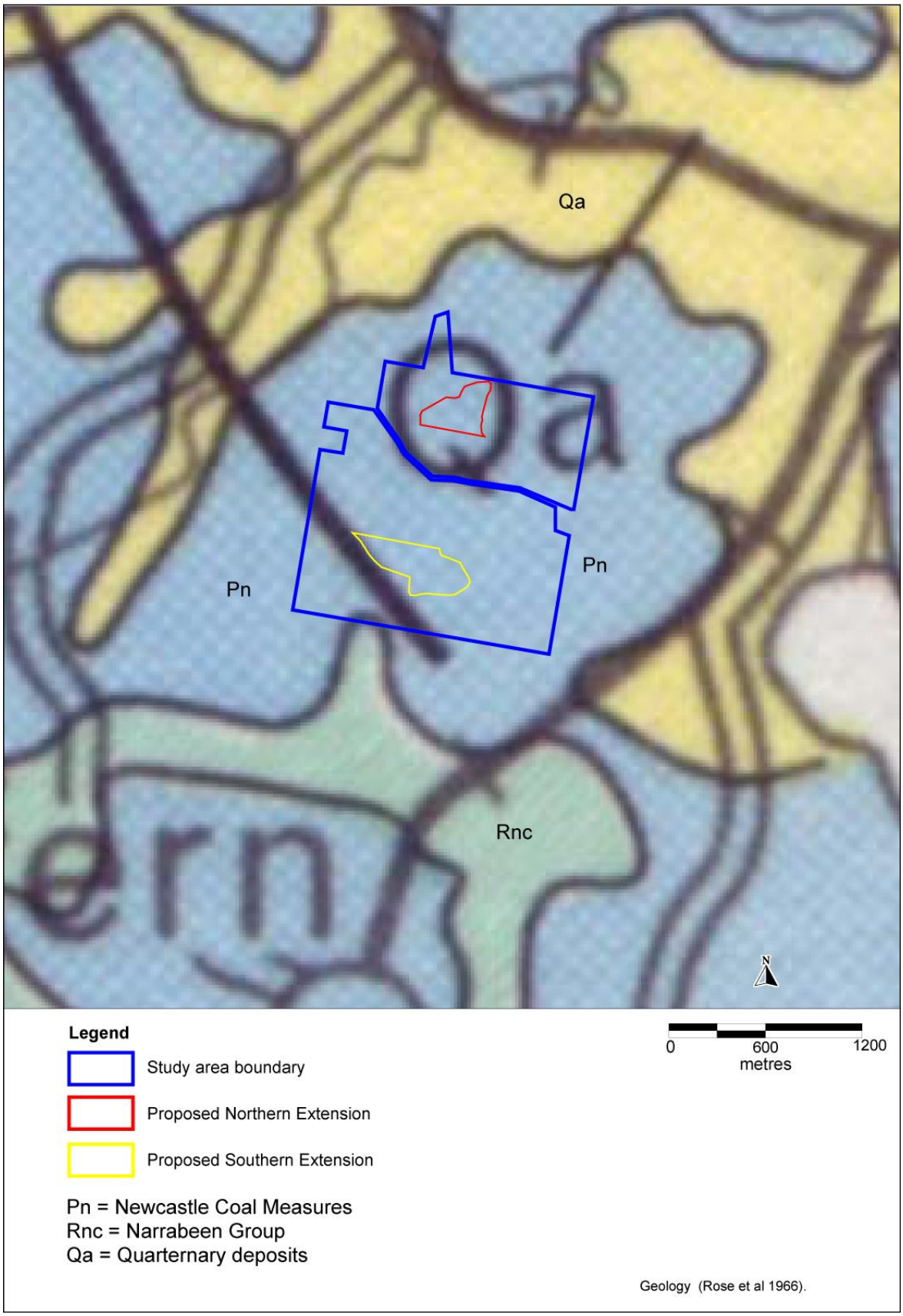


Figure 3
Geology of the Study Area

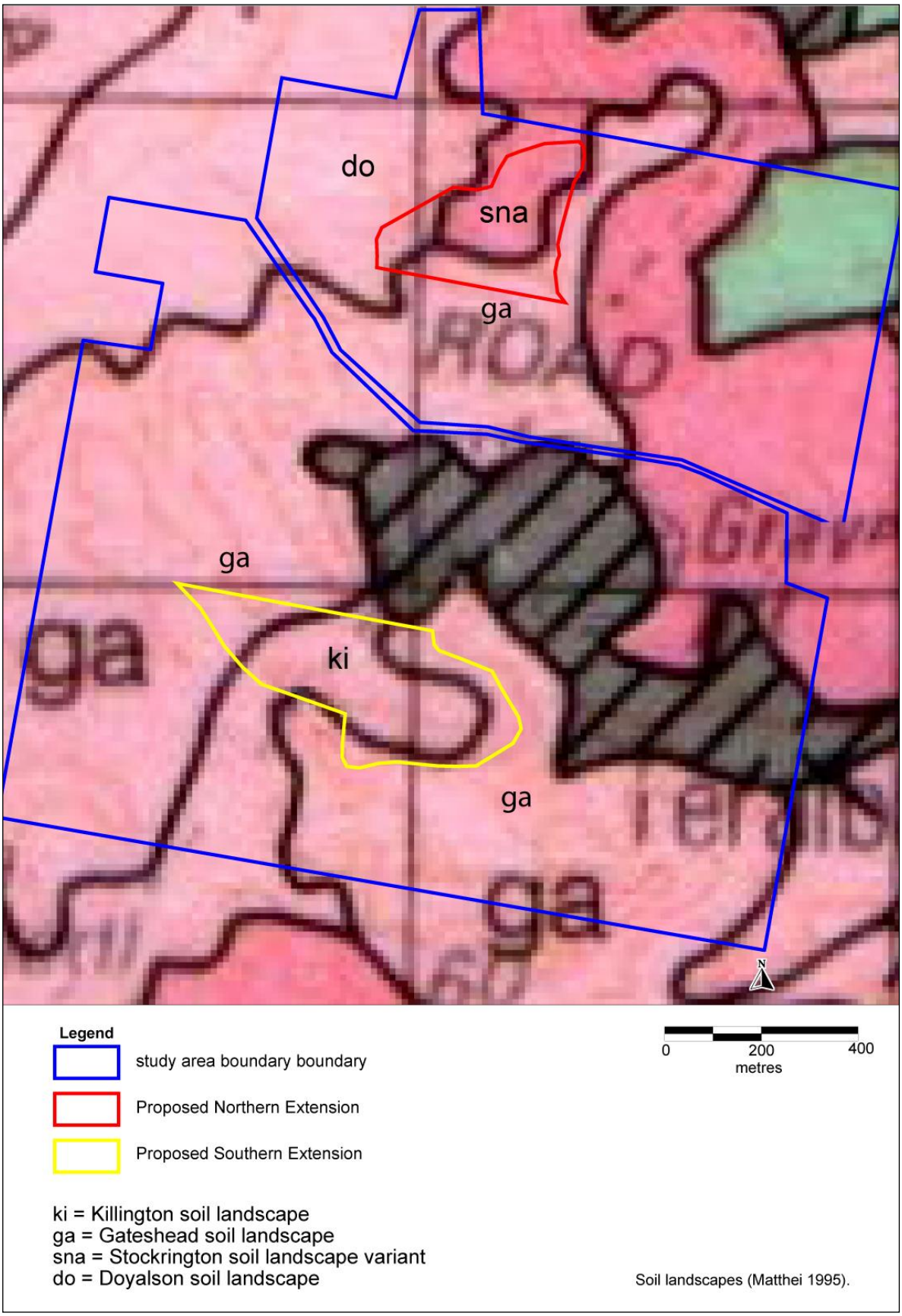


Figure 4
Soil Landscapes of the Study Area

The Stockrington variant is described (Matthei 1995) as

> Landscape – *steep rises on conglomerates of the Newcastle Coal Measures. Adamstown subgroup. Steep slopes have gradients of 25 - > 40% and benches have 15 – 20% slopes. Elevation to 160 m, local relief is up to 180m. Uncleared tall open-forest.*
>
> Soils - *moderately deep to deep (70 - >300 cm), rapidly drained Earthy Loams and Friable Loams on upper slopes with deep (>200 cm), well drained Red Podzolic Soils, red Soloths, Brown Soloths and Yellow Soloths on midslopes and benches.*
>
> Limitations - *steep slopes, mass movement hazard, water erosion hazard, foundation hazard.*

The Killingworth soil landscape is described (Matthei 1995) as

> Landscape - *undulating to rolling hills and low hills on the Newcastle Coal Measures of the Awaba Hills region. Elevation 50 – 160 m, local relief 30 – 100 m, slopes are 3 – 20%. Predominantly uncleared tall open-forest.*
>
> Soils - *shallow (<60 cm) to moderately deep (<150 cm), well to imperfectly drained Yellow Podzolic Soils, yellow soloths, Gleyed Podzolic Soils and Gleyed Soloths on crests and hillslopes, with shallow (<60 cm), well drained Structured Loams, Bleached Loams and Lithosols on some crests.*
>
> Limitations - *High water erosion Hazard, Mine Subsidence District, Foundation hazard (localised), shallow soils (localised), seasonal waterlogging (localised), sodic/dispersible soils of low wet strength, very strongly acid soils of low fertility.*

The Doyalson soil landscape is described (Matthei 1995) as

> Landscape - *gently undulating rises on Munmorah conglomerate. slope gradient <10%; local relief to 30m. broad crests and ridges and long, gently inclined slopes. predominantly cleared eucalypt open-forest.*
>
> Soils – *moderately deep (50 – 150 cm) Yellow Earths, Yellow Podzolic Soils and Soloths occur on sandstones and conglomerates; moderately deep (50 – 150 cm) Yellow Podzolic Soils, Soloths and some red Podzolic soils occur on fine grained siltstones and claystones; moderately deep to deep (100 - > 150 cm) yellow Leached Earths , Grey Earths, Soloths and Gleyed Podzolic Soils occur along drainage lines.*
>
> Limitations – *high erosion hazard, foundation hazard (localised), high run-on (localised), Mine Subsidence District, seasonal waterlogging (localised), hard setting, stony, strongly acid soils of low fertility.*

1.10 VEGETATION COMMUNITIES

Regional scale vegetation mapping was undertaken by NPWS (2003). The mapping identified 55 vegetation communities in the Gosford, Wyong, Lake Macquarie, Newcastle, Port Stephens, Maitland and Cessnock Local Government Areas.

Maps produced were the result of computer modelling of vegetation distribution in relation to 43 environmental variables and consequently there are errors and inaccuracies.

Four vegetation map units are mapped for the Study Area (**Figure 5**). Two of these communities, Coastal Foothills Spotted Gum – Ironbark Forest and Coastal Plains Smoothbarked Apple Woodland, are mapped as occupying most of the Study Area. Smaller areas are mapped as Alluvial Tall Moist Forest and Coastal Plains Scribbly Gum Woodland.

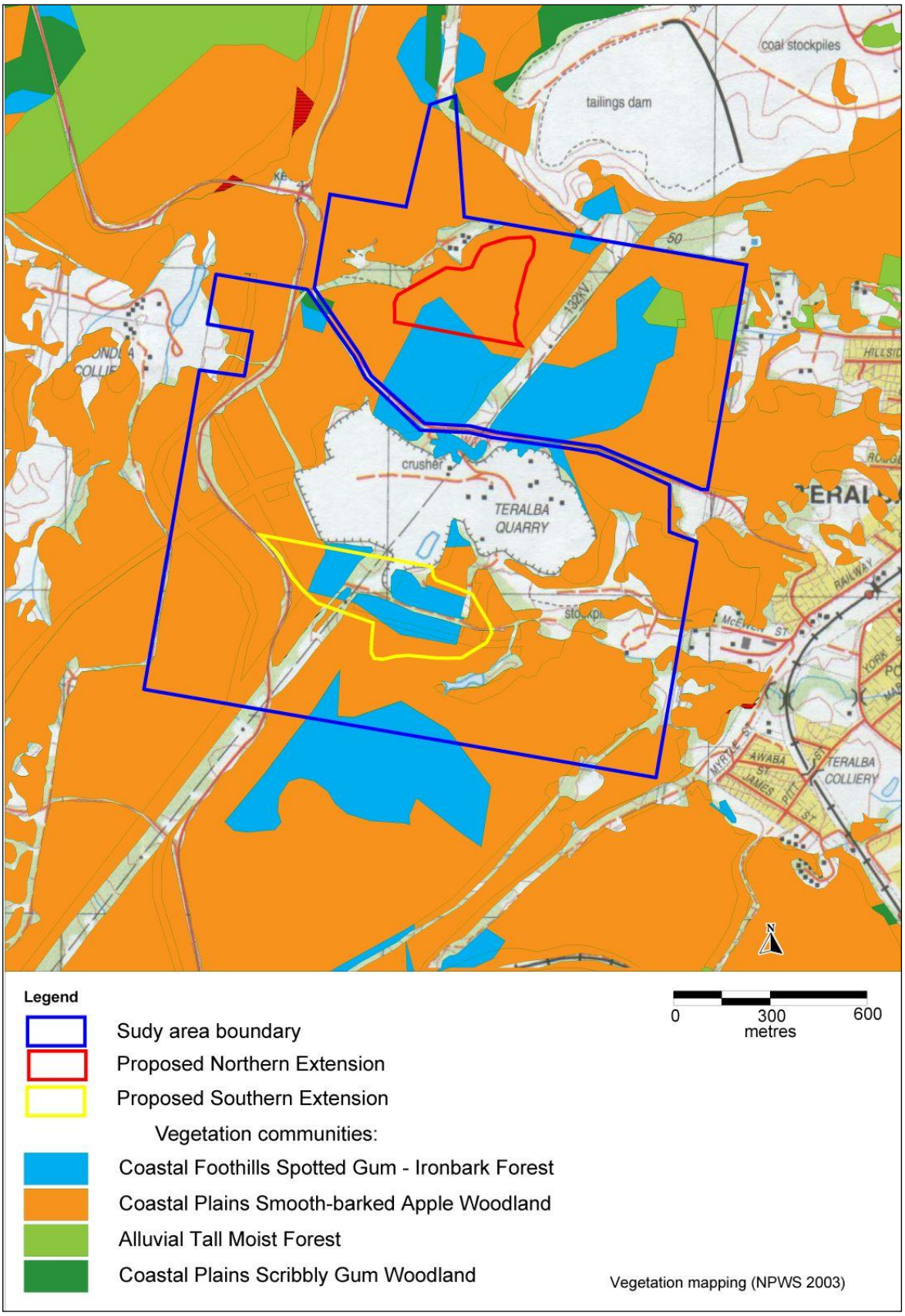


Figure 5
NPWS (2003) Vegetation mapping of the Study Area

Subsequently, LMCC updated vegetation mapping for parts of the Lake Macquarie LGA. Council's Working draft Composite Vegetation Community Map 2010 (Bell and Driscoll 2009) indicates five native vegetation communities exist on the project Site. These communities are:

MU30f − Freemans Peppermint Apple−Bloodwood Forest.

MU30h − Sugarloaf Lowlands Bloodwood Forest.

MU15 − Coastal Spotted Gum Ironbark Forest.

MU17o − Lower Hunter Spotted Gum Ironbark Forest.

MU5 Alluvial Tall Moist Forest.

This mapping in the Project Site is reviewed in Section 4.2.2 of this report.

1.11 LAND USE AND DISTURBANCE HISTORY

The Project Site is bisected east to west by Rhondda Road and adjoins a private coal haul road in the west. The Newtech Pistol Club adjoins the north-west boundary. Large areas of the Project Site have been cleared for quarrying and associated processing.

The retained bushland is fragmented by power line easement clearings and numerous vehicle tracks. Large old trees and large woody debris are rare, trees in the regrowth growth stage are common and most trees are in the early mature and mature growth stages, indicating that the Project Site has a history of major disturbances such as clearing or heavy logging, and fire.

The Project Site was burnt by a fire on 25 November 2002. The fire was described (in Clements 2008) by the Quarry Operations Manager at the time, as "very fast moving, consuming the litter in the ground layer and heat scorching the upper reaches of the trees".

The Project Site is underlain by coal mine workings. The pithead of Newstan Colliery is located 2.5 km southwest of the quarry, the pithead of the disused Rhondda Colliery is 0.7 km west, the tailings dam of the Stockton Borehole Colliery adjoins to the north, and the pit head of Teralba Colliery is about 1 km east-southeast. The area is part of the Killingworth-Wallsend Mine Subsidence District and is affected by mine subsidence. Subsidence cracks are evident in bushland over much of the Study Area.

2. PROJECT OVERVIEW

2.1 PROJECT LOCALITY

The Project Site is located to the west of the Newcastle suburb of Teralba, approximately 7 km north of Toronto and 6 km south of Edgeworth in the Parish of Teralba, in the County of Northumberland. The locality of the Project Site is illustrated in **Figure 1**.

The Project Site encompasses the freehold land incorporating the full area of the existing Teralba Quarry extraction and processing operations, the proposed southern and northern extensions and a section of Rhondda Road. The Project Site covers an area of approximately 130ha and is located entirely within an area of freehold land Metromix leases from the landowner, Mr A.C. Fowkes.

2.2 PROJECT DESCRIPTION

The Project Site incorporates four extraction areas as follows:

- The existing Southern Extraction Area encompasses all approved extraction and processing operations south of Rhondda Road.
- The existing Mid-Pit Area is located north of Rhondda Road.

Two areas not yet approved and the subject of the project application are referred to as the:

- proposed Southern Extension.
- proposed Northern Extension.

The Project Site excludes two areas (non-project related commercial operations) within the existing Southern Extraction Area, namely:

- The Civilake Operation.
- Downer EDI Operation.

2.2.1 Existing Southern Extraction Area

This area encompasses the area almost but not yet fully extracted and all stockpiling and processing facilities, site offices, crib rooms, workshop and weighbridge associated with the existing quarry. The southern boundary of the existing Southern Extraction Area coincides with the boundary nominated in Development Consent DA 130/42.

The existing Southern Extraction Area will be fully extracted by early 2012. The area remaining for extraction lies within the floor of the extraction area where the remaining 10m to 12m of conglomerate above the underlying coal seam remains to be extracted. The total area of the existing Southern Extraction Area is approximately 40ha.

It is noted that in addition to Metromix's quarry operations conducted on the southern side of Rhondda Road, there are currently two other operations undertaken by other companies within the existing Southern Extraction Area.

The existing Southern Extraction Area also encompasses infrastructure related to the existing quarry operations. This infrastructure includes an access road from the quarry operations to Railway Street, Teralba. This sealed road is used by laden heavy vehicles to exit the Project Site to the east and avoid descending the steep downhill section of Rhondda Road. This road is leased from the owner, Teralba Engineering. Metromix is responsible for maintenance of this road, although it is also used by laden heavy vehicles transporting products for Downer EDI and Civilake.

2.2.2 Existing Mid Pit Extraction Area

The existing Mid Pit Extraction Area covers approximately 7.5ha. Extraction commenced in this area during the third quarter of 2010 to supplement the resources extracted from the existing Southern Extraction Area over the next 2 to 3 years.

2.2.3 Proposed Southern Extension

The proposed Southern Extension covers approximately 16.5ha and is located entirely within Lot 2 DP 224037. This lot is traversed by a number of transmission line easements and a small area is leased to Oceanic Coal for the purposes of a private coal haul road between various coal mines to the north and the Eraring Power Station to the south.

2.2.4 Proposed Northern Extension

The proposed Northern Extension is located entirely within Lot 1 DP 224037, on the northern side of Rhondda Road and comprises an area covering approximately 9.3ha. The Newtech Pistol Club is located beyond the northwestern boundary of the proposed Northern Extension within the land leased by Metromix.

2.2.5 Non-Project related Commercial Operations

Two non-Project-related commercial operations are located in areas within the Project Site that, for the purposes of this document, are not included as components of the Project although their environmental impacts are considered in a cumulative sense. These two commercial operations are undertaken by companies independent of Metromix, who hold agreements with Metromix for their tenure on site. Those operations are:

Downer EDI – The asphalt plant occupies a 3ha area within the existing quarry. The plant operates under a separate development consent issued by Lake Macquarie City Council and in accordance with a Dangerous Goods Licence No. 35/026468. The plant typically produces approximately 70 000 tonnes of bitumen products annually. The aggregate raw materials for the asphalt plant are all supplied by external sources and are stockpiled immediately north of the Metromix stockpile area. A number of the laden product trucks from this plant also use the road leased through Teralba Engineering to allow trucks to exit via Railway Street and avoid laden trucks travelling down Rhondda Road towards Teralba.

Civilake Pugmill – Civilake, as part of Lake Macquarie City Council (LMCC), operates a road base pugmill within a 2.1ha area within the existing quarry area. Products from Teralba Quarry and various recycled materials are mixed with a cementitious binder in the pugmill for use in construction products throughout the local government area. The pugmill is also used with the reclamation of asphalt. The pugmill operates under a separate development consent issued by LMCC and the plant is operated in accordance with Environment Protection Licence 13015 for Recovery of General Waste and Waste Storage. Civilake recycles concrete and asphalt through the pugmill, bringing in specialised crushing plant for this purpose, when required. This is a wet process that will not be included in the impact assessment.

These two operations operate completely independently to the Metromix Quarry and as such, the operation of these plants, their environmental impact and any impact mitigation employed at these plants is not addressed in this document, except in the assessment of cumulative impacts for the entire Project Site.

3. METHODS

3.1 OVERVIEW

The most critical pieces of legislation for the purposes of threatened species assessment in NSW are the *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The TSC Act provides for the protection of all threatened plants and animals native to NSW and their habitats (including endangered populations and ecological communities, and their habitats). The consent authority requires an Assessment of Significance (as required by Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*), which addresses the factors that must be considered by decision makers to assess whether a proposal is likely to have a significant effect on threatened biodiversity. These mechanisms are contained in s5A of the EP&A Act and s94 of the TSC Act.

The methods required for the adequate survey and assessment of impacts on biodiversity are specified in policies and guidelines including Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979, Threatened Biodiversity Survey and Assessment Guidelines and Assessment of Significance Guidelines issued by the NSW Department of Conservation, and the NSW Groundwater Dependant Ecosystem Policy issued by the NSW Department of Land and Water Conservation.

The EPBC Act mandates assessment of actions that are likely to have a significant impact on a matter of national environmental significance, which include nationally listed threatened species and ecological communities. Where there is a bilateral agreement in place the action may be assessed by the NSW government using the processes accredited under the bilateral agreement.

The Director-General's Requirements issued for the proposed expansion of the Teralba quarry include a consideration of the general requirements of the TSC Act as well as requirements specific to the assessment of impacts of the quarry. Those relevant to flora issues and the part of this report in which they are addressed are outlined in **Table 1**.

Table 1
Director-General's requirements

Page 1 of 2

Director-General's Requirement	Section where addressed
Provide a general baseline flora and fauna survey (including appropriate targeted surveys for threatened species) for the subject site, describing the vegetation communities, habitat types and species assemblages present.	S2.4, App 1 & 2
Undertake surveys at the time of year when the subject species are most likely to be detected	S4.1, Table 4.6
Describe the vegetation communities, habitat types and species assemblages present on the Study Area and subject site.	S3.4, Fig 4.6
Document all known and likely threatened species, populations, ecological communities on the Study Area, including their habitats.	S4.1, Table 4.6
In determining the subject species, populations and/or ecological communities for the site, consider vegetation/habitat types present, records of threatened species or populations in the locality and their known distribution	Table 4.6
Identify potential GDEs within the Study Area	S4.2

Table 1 (Cont'd)
Director-General's requirements

Page 2 of 2

Director-General's Requirement	Section where addressed
Accurate predictions of any vegetation clearing on site and/or removal/damage to habitat, delineated on the basis of vegetation/habitat type.	S6.1
Provide a detailed assessment of the potential impacts of the project on any threatened species, populations, ecological communities or their habitats	S6
Evaluate Impacts on groundwater dependent ecosystems	S4.2
Evaluate Impacts on any local corridor links and wildlife movement	S6.2
Evaluate implications of weed infestation and feral animals	S6.3
Apply Draft Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979 (DEC)	
Apply NSW Groundwater Dependant Ecosystem Policy (DLWC)	S4.2
Apply Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004)	S 1.3, 1.4
Apply Threatened Species Assessment Guidelines – The Assessment of Significance (DECC 2007)	S6.4
Describe the measures to maintain or improve the biodiversity values within the project area in the medium to long term.	S5
Detail the actions that will be taken to avoid or mitigate impacts on threatened species, their habitats, populations and ecological communities; and in instances where impacts cannot be avoided, provide appropriate details on offset/compensatory habitat packages of strategies, habitat enhancement features and proposed management plans	S5
Summarise time invested in each survey technique (e.g. – number of person hours per transect/quadrat, duration of call playback, number of nights traps set, etc…)	App 2
Provide personnel details including name of all surveyor(s), contact phone number and relevant experience, licenses	App 3

3.2 REVIEW OF EXISTING FLORA DATA

3.2.1 Species Listed in Director-General's Requirements (DGRs)

Nine threatened flora species and two threatened ecological communities (TECs) have been nominated by DECCW for the DGRs. The species are *Acacia bynoeana, Agophora inopina, Callistemon linearifolius, Cryptostylis hunteriana, Cynanchum elegans, Grevillea parviflora* subsp*. parviflora, Melaleuca biconvexa, Syzygium paniculatum* and *Tetratheca juncea*.

The TECs are Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions and Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion.

3.2.2 DECCW Wildlife Atlas of NSW

All Wildlife Atlas of NSW flora records for the Lake Macquarie (9231) and Newcastle (9232) 1:100 000 mapsheets were extracted from the DECCW database on 11th April 2011.

All threatened flora ever recorded within approximately 5km (6km of the centroid) of the Study Area were extracted **(Table 4)**, as were all TECs recorded for the Bioregion, and all threatened populations (TPs) recorded for the Lake Macquarie LGA.

3.2.3 EPBC Act Protected Matters Report

An EPBC Act Protected Matters Report undertaken for the Study Area predicts the occurrence of six threatened flora species or their habitat in the Study Area (http://www.environment.gov.au/epbc/pmst/index.html accessed on 10 March 2011). The report predicts the occurrence of an additional threatened species (*Pterostylis gibbosa*) or its habitat within the Study Area.

3.2.4 Anne Clements & Associates

Dr Anne Clements and Mr Tony Rodd of Anne Clements & Associates have undertaken three flora surveys in the Study Area, in 1995, 2002 and 2008.

Whilst the survey data from the 1995 and 2002 surveys may be somewhat dated from the point of view of short-lived flora, it is nonetheless a useful resource. The 2002 data is valuable because it contains a large number of transect floristic records compatible with the 2008 data, especially from the point of view of overstorey floristics.

The 2008 data consists of comprehensive and systematic standard quadrat data, with 4 quadrats wholly or partly within the Subject Site and a further four quadrats in the adjoining Study Area. The survey methods used in the Survey Methodology & Results compiled by Ann Clements & Associates (2008) surveys of the Study Area are generally in accord with Murray and Bell (2001) survey guidelines (Clements p. 3.10) and DECC survey guidelines (2005).

In this report the 2002 and 2008 survey contributes to the classification of forest vegetation in the Study Area, and the 2008 data forms the basis for the description of extant vegetation.

3.3 STRATIFICATION

3.3.1 Previous Stratification

The vegetation mapping undertaken for The Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS) by NPWS (2003) did not use traditional methods of vegetation mapping but used a computer model of the relationships between vegetation assemblages (or 'ecosystems') and remote data variables derived from field sampling, to predict the occurrence of these vegetation assemblages across the landscape.

The vegetation maps produced were the outcome of predicting vegetation distribution in relation to 43 environmental variables including altitude, aspect, slope, rainfall & topographic variables, soil parent material and vegetation structure. The vegetation mapping produced by NPWS (2003) therefore represents a comprehensive environmental stratification.

That mapping was examined in the light of floristic field survey data acquired by Clements in 2002 and 2008 as part of previous studies of the Teralba Study Area. An overlay of Clements' survey locations on the NPWS mapping **(**Figure 1 of **Appendix 1)** indicates that the survey locations were all located either in Coastal Foothills Spotted Gum Ironbark Forest or Coastal Plains Smooth-barked Apple Woodland communities, or occasionally on the boundary between them.

Anne Clements and Associates data clearly supports the conclusion that all of the vegetation sampled was best classified as Coastal Foothills Spotted Gum Ironbark Forest. At none of the survey locations were *Angophora costata* and *Corymbia gummifera* dominant, or alternatively

Eucalyptus umbra and *E. capitellata*, as described for Coastal Plains Smooth-barked Apple Woodland (NPWS 2003). Except for a single record of *Allocasuarina littoralis* in a managed regeneration area the characteristic understorey species *Allocasuarina littoralis, Banksia spinulosa* and *Acacia myrtifolia* were not recorded either.

Additional field survey undertaken for this report confirmed that Coastal Foothills Spotted Gum Ironbark Forest extended beyond the areas previously surveyed by Clements and with the exception of the Blue Gum – White Stringybark community, occupied the remainder of the forested parts of the Study Area.

Therefore the mapped Coastal Plains Smooth-barked Apple Woodland was included with Coastal Foothills Spotted Gum Ironbark Forest as a single stratum for this study.

3.3.2 Stratification Utilised for this Study

Three further strata were recognised for this study: two areas in the north-east of the Study Area mapped as Alluvial Tall Moist Forest and a small area in the north-west mapped as Scribbly Gum Woodland**,** and a previously cleared area east of the existing quarry that now supports regenerating forest **(Figure 5)**.

3.4 FLORA SURVEY

Intensive flora survey of the Study Area has been undertaken by Greg Elks of Idyll Spaces and Anne Clements & Associates over a sixteen year period extending from January 1995 until September 2011 and involving both systematic survey and survey targeting threatened flora. Survey details are summarised in **Table 2** below.

Table 2
Summary of flora survey, dates, types and locations

Surveyor	Date	Survey Type	Sample	Location
Anne Clements & Associates	Jan, Apr & Jun 1995	systematic	13 x 0.03ha transects	S & W of existing quarry
		targeted	14 x 0.03ha spot locations	S & W of existing quarry
Anne Clements & Associates	September 2002	systematic	25 x 0.03ha transects	across Study Area
		systematic	2 x 0.03ha transects	Rehabilitation area
		targeted	8 x 0.03ha spot locations	across Study Area
Anne Clements & Associates	November 2008	systematic	4 x 0.04ha quadrats	across Study Area
		targeted	parallel search	Proposed N&S extensions
		targeted	0.03ha spot search	around Tetratheca juncea record
G. Elks Idyll Spaces	January 2011	targeted	6 random transects	across Study Area
		targeted	4 extended spot locations	around Tetratheca juncea records
	March 2011	systematic & Biometric	11 nested quadrats	across Study Area
	September 2011	targeted	4 transects	Along existing and proposed electricity easements

The first survey, undertaken by Anne Clements & Associates, sampled areas to the south and west of the current quarry in January, April and June 1995. Another survey undertaken by Anne Clements & Associates in September 2002 sampled vegetation across the Study Area by means of 27 x 0.03ha transects and undertook targeted search at eight spot locations. A further survey by Clements and Associates in November and December 2008 sampled the vegetation in eight 0.04ha quadrats and undertook targeted searches during two months of the peak flowering time for *Tetratheca juncea*.

In January 2011 Greg Elks carried out targeted search of the Study Area for threatened flora, and in March 2011 carried out systematic quadrat survey and also collected Biometric data.

In response to comments on the Teralba flora assessment from OEH & LMCC, in particular the existing and proposed powerline easements, supplementary survey was undertaken in September 2011 for *Tetratheca juncea* and *Grevillea parviflora.*

For assessment of impacts on flora this report only utilises data collected from 2008 onward, as required by the DGRs. However the overstorey floristic data from both 2002 and 2008 was used to refine vegetation community mapping.

3.4.1 Anne Clements & Associates

3.4.1.1 Systematic Flora Survey September 2002

The Project Site was surveyed on 5 and 6 September 2002 by Tony Rodd and Sian Wilkins and on 9 and 10 September 2002 by Dr Anne Clements, Tony Rodd, Sian Wilkins and Emma Gorrod.

Relative frequency was recorded for all species detected in 25 transects. Each transect consisted of three contiguous 10m x 10m quadrats

The Clements' species frequency data is reproduced in Table 1 of **Appendix 1** to this report**.**

3.4.1.2 Systematic flora survey November 2008

On 11 and 12 November 2008 the vegetation in eight 20m x 20m (0.04ha) quadrats was surveyed by Tony Rodd and Peter Juniper of Anne Clements & Associates. Relative frequency was recorded for all species detected. The percentage cover of exposed ground (bare soil and rock) and leaf litter percent and percentage projected foliage cover of the following vegetation strata were estimated for each of the quadrats:

- Native canopy trees
- Native midstorey trees
- Native shrubs
- Native grasses/graminoids
- Native herbs
- All exotic species.

Each 0.04ha quadrat consisted of four contiguous 10m x 10m subquadrats. The maximum height and number of individuals for each species greater than 2m high was recorded in each of the 10m x 10m subquadrats.

The relative frequency of plant species in the quadrats was assessed by recording the presence/absence of each species in each of four 5m x 5m subquadrats nested within each 10m x 10m subquadrat.

The Clements percentage cover data is reproduced in Table 2 of **Appendix 1** to this report.

For a detailed description of Clements' methodology see Survey Methodology & Results compiled by Anne Clements & Associates (2008) report (**Appendix 4**).

3.4.1.3 Targeted Threatened Flora Survey November & December 2008

Targeted searches for *Tetratheca juncea* were undertaken on 15 and 16 November by Tony Rodd and Peter Juniper and on 18 and 19 December 2008 by Anne Clements, Peter Juniper, Jane Rodd, Sue Wright and Anne Jones of Anne Clements & Associates. Two persons searched each transect. Search used parallel transects at 10m to 15m spacings. The parallel search transects covered the whole of the Subject Site as well as other areas including those where *T. juncea* had previously been recorded in September 2002. The rehabilitation areas in the east of the Quarry lease were also searched.

GPS coordinates (datum described in Clements as AMG94 Z56) of the locations were noted using a hand-held GPS and flagging tape was tied around each plant or adjacent vegetation.

3.4.2 Idyll Spaces

3.4.2.1 Systematic Flora Survey March 2011

The Study Area was surveyed on 23, 24 and 25 March 2011 by Greg Elks of Idyll Spaces Environmental Consultants.

Cover-abundance scores were recorded for all species detected by grid search in eleven 0.04ha quadrats more or less randomly located within strata of the Study Area **(**see Table 3 of **Appendix 2)**.

Percentage foliage cover of exotics and cover of native overstorey, midstorey and the grass, shrub and other cover of the ground layer were estimated for a 0.1ha plot enclosing the 0.04ha plot using the methodology outlined in the Biometric operations manual. A plot disturbance and modification record, the number of trees with hollows and the total length of fallen logs were also recorded **(**Table 4 of **Appendix 2).**

Total plot survey time was approximately 12.25 hours (details in Table 8 of **Appendix 2**). Traverses between plots were utilised as informal targeted search for threatened flora.

3.4.2.2 Targeted flora survey January 2011

Targeted searches for flora listed in the DGR's were undertaken along 8 transects on 11th and 12th January 2011 (locations shown superimposed on vegetation community mapping in Figure 2 of **Appendix 2**).

Total transect search time was 8.3 hours, total transect search distance was 1.3km (details in Table 7 of **Appendix 2.**

Clumps of *Tetratheca juncea* identified by Survey Methodology & Results compiled by Anne Clements & Associates (2008) were relocated and counted. A summary table of survey records is included in Table 6 of **Appendix 2**.

3.4.2.3 Targeted flora survey September 2011

In response to comments on the Teralba flora assessment from OEH & LMCC, in particular the existing and proposed powerline easements, supplementary targeted survey was undertaken along 2km of transect over 6 hours on 6 September 2011for *Tetratheca juncea* and *Grevillea parviflora*. Survey examined the area to be impacted and the offset area along cleared transmission easements, where OEH has indicated the species is known to occur elsewhere in the region. *Grevillea parviflora* was not detected by this survey or by previous surveys undertaken by Clements (2002, 2008) during the flowering period. Neither *Tetratheca juncea* nor *Grevillea parviflora* were detected in the powerline easement.

3.5 VEGETATION MAPPING

A review of Anne Clements & Associates data was used as the basis for preliminary modification of LHCCREMS mapping, which was then field checked during the January 2011 field visit. Further refinements were made during the March 2011 field visit.

A review of flora survey data was undertaken to ground truth Council's Working draft Composite Vegetation Community Map 2010 (Bell and Driscoll 2009). This mapping is reviewed in Section 4.2.2 of this report.

A final vegetation map for the Study Area is presented in **Figure 6**.

3.6 SURVEY LIMITATIONS & WEATHER

The 2011 targeted survey for *Grevillea parviflora* subsp. *parviflora* was not within the flowering period for the species. Although this species is recognisable from vegetative characters in the absence of flowers, it has been assumed to be present for the purpose of assessment of impacts. Further survey of the powerline easements, identified as potential habitat by OEH, was undertaken during the flowering period in September 2011.

Weather in the three months preceding the January 2010 survey was warm and moist, with average rainfall. Weather in the 3 months preceding the March 2011 survey was warm and dry with below average rainfall (60-80% of mean). Weather conditions preceding the surveys were unlikely to limit their effectiveness.

4. RESULTS

4.1 THREATENED SPECIES, POPULATIONS AND ECOLOGICAL COMMUNITIES KNOWN OR PREDICTED TO OCCUR IN THE LOCALITY

4.1.1 National

The EPBC Act online database Protected Matters Search Tool predicts that 6 flora species of national significance, or their habitats, may occur within 2km of the Study Area centroid (**Table 3**).

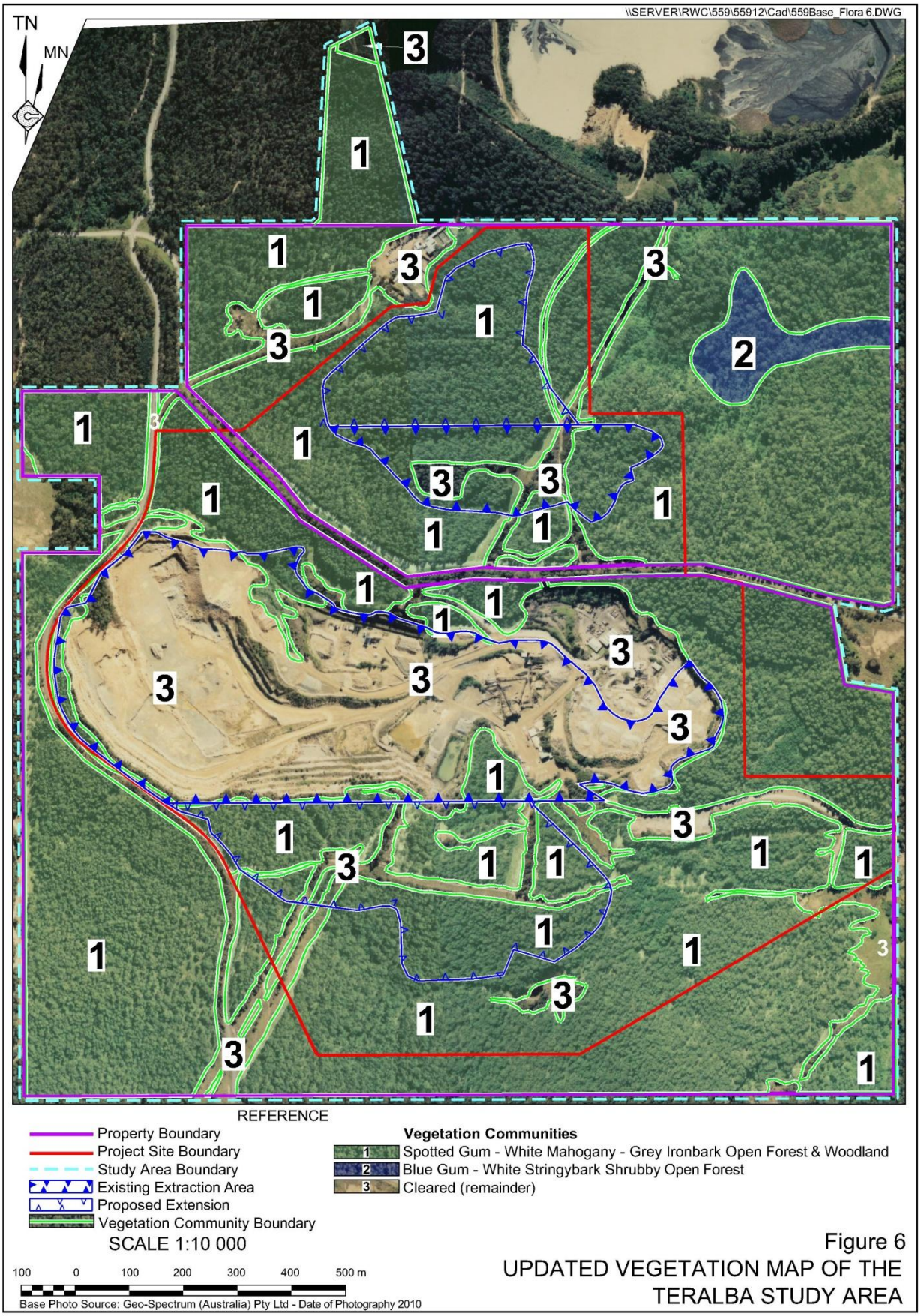


Figure 6
UPDATED VEGETATION MAP OF THE TERALBA STUDY AREA

Table 3
***EPBC Act* listed flora known or predicted to occur within 2km of the Study Area**

Scientific name	**EPBC Act Status**
Cryptostylis hunteriana	Vulnerable
Grevillea parviflora subsp. parviflora	Vulnerable
Melaleuca biconvexa	Vulnerable
Pterostylis gibbosa	Endangered
Syzygium paniculatum	Vulnerable
Tetratheca juncea	Vulnerable

No ecological communities of national significance under the *EPBC Act* are predicted to occur.

4.1.2 New South Wales

The Wildlife Atlas of NSW database (extracted 2 December 2010) contains 4775 flora records within 5km of the Study Area, of which 1145 are threatened flora representing 6 species **(Table 4)**.

Table 4
***TSC Act* listed threatened flora recorded within 5km of the Teralba Study Area**

Scientific name	**TSC Act Status**	**Number of records within 5km**
Angophora inopina	Vulnerable	542
Callistemon linearifolius	Vulnerable	33
Cryptostylis hunteriana	Vulnerable	1
Grevillea parviflora subsp. parviflora	Vulnerable	27
Syzygium paniculatum	Endangered	2
Tetratheca juncea	Vulnerable	540

The Wildlife Atlas of NSW lists five **Endangered Populations** known to occur in the catchment and/or LGA:

- *Leionema lamprophyllum* subsp. *obovatum* population in the Hunter Catchment
- *Cymbidium canaliculatum* population in the Hunter Catchment
- *Acacia pendula* population in the Hunter catchment
- *Eucalyptus parramattensis* C. Hall. subsp. *parramattensis* in Wyong and Lake Macquarie local government areas
- *Eucalyptus camaldulensis* population in the Hunter catchment

The Wildlife Atlas of NSW lists 54 threatened ecological communities known to occur in the Sydney Basin bioregion.

Critically Endangered Communities:

- Cumberland Plain Woodland in the Sydney Basin Bioregion
- Blue Gum High Forest in the Sydney Basin Bioregion
- Kincumber Scribbly Gum Forest in the Sydney Basin Bioregion

Endangered Communities:

- Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion
- Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion
- Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion
- Mount Gibraltar Forest in the Sydney Basin Bioregion
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion
- Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland
- Robertson Rainforest in the Sydney Basin Bioregion
- Southern Highlands Shale Woodlands in the Sydney Basin Bioregion
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions
- Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion
- Moist Shale Woodland in the Sydney Basin Bioregion
- Kurri Sand Swamp Woodland in the Sydney Basin Bioregion
- Sydney Freshwater Wetlands in the Sydney Basin Bioregion
- Milton Ulladulla Subtropical Rainforest in the Sydney Basin Bioregion
- Melaleuca armillaris Tall Shrubland in the Sydney Basin Bioregion
- Grey Box - Grey Gum Wet Sclerophyll Forest in the NSW North Coast Bioregion
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions
- Illawarra Subtropical Rainforest in the Sydney Basin Bioregion
- Shale/Sandstone Transition Forest
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions
- Low woodland with heathland on indurated sand at Norah Head
- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion
- Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion
- Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Agnes Banks Woodland in the Sydney Basin Bioregion
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions
- Western Sydney Dry Rainforest in the Sydney Basin Bioregion
- Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
- Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion
- Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion
- Warkworth Sands Woodland of the Sydney Basin Bioregion
- Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions
- Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Shale gravel Transition Forest in the Sydney Basin Bioregion
- Duffys Forest Ecological Community in the Sydney Basin Bioregion
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Vulnerable Communities:

- Blue Mountains Swamps in the Sydney Basin Bioregion
- Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion
- Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions
- No **Critical Habitat** is listed in NSW.

4.2 PREVIOUS FLORA STUDIES

4.2.1 NPWS (2003)

Vegetation communities mapped for the Study Area by NPWS are presented in **Figure 5** and include:

- Coastal Foothills Spotted Gum – Ironbark Forest (NPWS map unit 15);
- Coastal Plains Smoothbarked Apple Woodland (NPWS map unit 30);
- Alluvial Tall Moist Forest. (NPWS map unit 5) and
- Coastal Plains Scribbly Gum Woodland (map unit 31).

Two of these communities, Coastal Foothills Spotted Gum – Ironbark Forest and Coastal Plains Smoothbarked Apple Woodland, are mapped as occupying most of the Study Area.

Coastal Foothills Spotted Gum – Ironbark Forest is described as:

> *… a moderately tall open forest dominated by* Corymbia maculata *in combination with one or several ironbark species* E. siderophloia, E. paniculata *or* E. fibrosa. *E. acmenoides, E. umbra* and *Syncarpia glomulifera* are common associate trees. *Typically the shrub layer is open with species such as* Persoonia linearis, Polyscias sambucifolia, Breynia oblongifolia *and* Daviesia ulicifolia. *In the northern extent around Lake Macquarie* Pultenaea villosa *and* Podolobium ilicifolium *can become more prevalent. The ground cover is dominated by a number of common grasses including* Imperata cylindrica *var.* major, Entolasia stricta, Themeda australis *and* Microlaena stipoides *var.* stipoides.

Coastal Plains Smoothbarked Apple Woodland is described as:

> *…a dry shrubby forest occurring along the coastal plain south from the Wyong Region to Medowie near Port Stephens in the north.* Angophora costata *and* Corymbia gummifera *consistently occur as dominant canopy species. In some areas* Eucalyptus umbra *and* E. capitellata *will be dominant or codominant. The dry shrubby mid-storey is characterised by the occurrence of* Allocasuarina littoralis, Banksia spinulosa *and* Acacia myrtifolia. *Less commonly found in the mid-story are* Leptospermum polygalifolium, Dodonaea triquetra, Lambertia formosa *and* Dillwynia retorta. *The ground layer is dominated by grasses such as* Entolasia stricta *and* Themeda australis. *Other common species found among the lower stratum are* Lomandra obliqua, Pteridium esculentum, Phyllanthus hirtellus, Imperata cylindrica *var.* major *and* Lepidosperma laterale.

The two vegetation communities mapped as occupying only small parts of the Study Area are Alluvial Tall Moist Forest and Coastal Plains Scribbly Gum Woodland.

Alluvial Tall Moist Forest is described as

> *…occurring in areas of higher rainfall on deep alluvial soils. The tallest stratum in this community ranges between a sparse eucalypt emergent and a tall open forest. Below this is a moderately dense small tree canopy consisting of rainforest species and* Melaleuca spp*. Understorey vegetation consists largely of mesic small trees, herbs and ferns. The tree stratum is highly varied with combinations of* Eucalyptus saligna, Syncarpia glomulifera, Angophora floribunda, *and* Eucalyptus robusta *most common. The small tree stratum is*

> *typified by* Glochidion ferdinandi, Acmena smithii, Melaleuca styphelioides, Ficus coronata, Melaleuca linariifolia, Callistemon salignus *and* Backhousia myrtifolia. *The shrub layer is floristically variable but commonly includes species* Breynia oblongifolia, Gahnia clarkei *and* Acacia irrorata subsp irrorata*. The understorey in this community also supports a moderately high diversity of climbers and twiners (11 species),the most common being* Geitonoplesium cymosum *and* Dioscorea transversa. *The moderately dense ground layer is comprised of grasses, ferns and herbs such as Adiantum aethiopicum, Pseuderanthemum variabile,* Entolasia marginata, Lomandra longifolia, Oplismenus imbecillis *and* Pratia purpurascens. *Alluvial Tall Moist Forest represents the gradient between well -developed rainforest on alluvium and Swamp Mahogany - Paperbark Swamp Forest.*

Coastal Plains Scribbly Gum Woodland is described as

> *woodland to low open woodland rarely exceeding 15 metres in height. The canopy is clearly dominated by* Eucalyptus haemastoma *in association with* Corymbia gummifera*. In deeper depressions the endangered* Angophora inopina *may be dominant or codominant in the canopy. Where this Map Unit merges with Map Unit 30* Eucalyptus capitellata *and* Angophora costata *occur. The mid-storey is also relatively open. Characteristic species include* Lambertia formosa, Banksia oblongifolia, Leptospermum trinervium, Hakea dactyloides, Persoonia levis *and* Isopogon anemonifolius*. The ground layer is typically dense and has high species diversity. This layer consists of a broad range of grasses, heath shrubs, grass trees and herbs common to infertile soils. Commonly found grasses include* Entolasia stricta, Themeda australis, Anisopogon avenaceus*, as well as the grass tree* Xanthorrhoea latifolia subsp latifolia *and the sedge* Ptilothrix deusta*. Other characteristic species include* Pimelea linifolia, Grevillea sericea, Epacris pulchella, Dampiera stricta *and* Patersonia sericea*.*

4.2.2 City of Lake Macquarie (2010)

Subsequently, LMCC updated vegetation mapping for parts of the Lake Macquarie LGA. Council's Working draft Composite Vegetation Community Map 2010 (Bell and Driscoll 2009) indicates five native vegetation communities exist on the project Site. These communities are:

MU30f − Freemans Peppermint Apple−Bloodwood Forest.

MU30h − Sugarloaf Lowlands Bloodwood Forest.

MU15 − Coastal Spotted Gum Ironbark Forest.

MU17o − Lower Hunter Spotted Gum Ironbark Forest.

MU5 Alluvial Tall Moist Forest.

Except for MU15 this mapping is not generally supported by floristic survey data collected in the Project Site, as detailed below.

In MU30f Peppermint is characteristic in an otherwise Bloodwood-Apple community. Sampled in the study area east of the haul road by Clements & Associates in Transects 5,6,10,19,21 and Quadrat 5. Peppermint *E. piperita* was not recorded. Dominant species recorded in the field were *Corymbia maculata* and either *E. acmenoides, E globoidea or E punctata*. Council's draft mapping of this community east of the haul road is not supported by the data, although west of the haul road there is insufficient data to draw any firm conclusions.

MU 30h is dominated by *Angophora costata, Corymbia gummifera* and *Eucalyptus umbra.* Sampled in the study area east of the haul road by Clements & Associates Transects 6, 12 & 21 and Quadrat 1, and by Idyll Spaces in Quadrat 7 and west of the haul road, Quadrat 6. Council's draft mapping of this community is not well supported by the data. Dominant species recorded in the field were *Corymbia maculata* and *E. acmenoides.* The occurrence of *Angophora costata, Coymbia gummifera, E umbra, E globoidea, E punctata* and *E. paniculata* was patchy and recorded in some survey areas only. *E. capitellata* was observed on elevated areas near the southern part of the haul road during threatened species transects in September 2011, suggesting the occurrence of MU30a in parts of the area mapped as MU30h.

MU15 Coastal Foothills Spotted Gum - Ironbark Forest is dominated by *Corymbia maculata* in combination with one or several ironbark species *E. siderophloia, E. paniculata* or *E.fibrosa*. *E.acmenoides, E. umbra* and *Syncarpia glomulifera* are common associate trees. Council's draft mapping is supported by ample data. Sampled in the study area at 21 transects or quadrats, with *C. maculata* and *E.acmenoides* usually dominant, and *E. paniculata* common. Associated trees include *E. punctata, E. umbra* and *Syncarpia glomulifera*.

MU17o Hinterland Spotted Gum - Red Ironbark Forest is dominated by *Corymbia maculata* and *E. fibrosa* with a prickly shrub understorey including *Melaleuca decora* and *Dillwynia retorta* or, in the case of the listed EEC, *Daviesia ulicifolia, Acacia parvipinnula* and *Melaleuca nodosa.* Sampled in the study area by Anne Clements & Associates Transects 1, 2, 7 & 11, none of which were located in the area adjacent to Rhondda Road, which is the area sampled by Bell & Driscoll 2009 (Figure 4 ibid). Council's draft mapping is not supported by the survey data. Dominant species recorded in the field were *C. maculata, E. acmenoides* and *E. paniculata. E. fibrosa* was not recorded, nor were *Melaleuca decora, Dillwynia retorta, Acacia parvipinnula* or *Melaleuca nodosa*, and *Daviesia ulicifolia* occurred only at low density or was absent.

MU5 Alluvial Tall Moist Forest is typically dominated by *E saligna* and *Syncarpia glomulifera*, with a moist understorey. Sampled in the study area by Idyll Spaces Quadrat 2. Mapped in the study area, but in an adjoining location to that mapped by Council. As mapped by Idyll Spaces the community does not equate with the EEC description because it has no significant swamp forest understorey elements and occurs on south-easterly slopes without alluvial deposits. There is insufficient survey data to comment further on Council's mapping of MU5.

4.2.3 City of Lake Macquarie 2008

A supplementary State of the Environment Report for the 2007-08 financial year found that there was approximately 38 321ha of native vegetation, representing 59.6% of the Lake Macquarie LGA, of which approximately 7 971ha is mapped as Coastal Foothills Spotted Gum-Ironbark Forest and 16 675ha as Coastal Plains Smooth-barked Apple Woodland.

There were 12 threatened plant species listed under the Commonwealth *EPBC Act* 1999, and 13 EECs and 12 threatened plant species listed under the NSW *TSC Act* 1995, known or likely to occur in the LGA

There were 31 regionally significant vegetation communities in the LGA, 12 of which are suitable for nomination under the Commonwealth EPBC Act and potentially of National significance, 22 are equivalent to endangered ecological communities listed under the NSW TSC Act and of State significance, 16 are regionally vulnerable communities, 11 are regionally specialised communities, three are regionally at risk communities; and four are regionally significant habitat.

The Coastal Foothills Spotted Gum-Ironbark Forest and Coastal Plains Smooth-barked Apple Woodland communities mapped on the Study Area by NPWS (2003) are identified as regionally significant habitat.

4.2.4 Anne Clements & Associates

The following conclusions were drawn in Survey Methodology & Results compiled by Anne Clements & Associates (2008).

A total of 162 species (144 native and 18 exotic) were recorded in eight 20m x 20m quadrats (Quadrats 1 to 8) in November 2008 (see Figure 1 of **Appendix 2**).

A total of 258 species (50 exotic, 208 native) were recorded from 27 transects (T1 to T25, R1 and R2) and eight spot locations (A to F, RA and RB) in September 2002. Two of these transects (R1 and R2) and two spot locations (RA and RB) were located in the in the rehabilitation areas.

The recorded vegetation appears to best fit the map unit profile for Coastal Foothills Spotted Gum-Ironbark Forest.

This community has been identified as Regionally Significant Habitat by City of Lake Macquarie (2008).

The canopy vegetation had not changed significantly from 2002 to 2008, despite the fire in 2002.

No vegetation communities of National or State conservation significance were recorded.

One species of National and State conservation significance was recorded, namely *Tetratheca juncea,* listed as Vulnerable under the Commonwealth EPBC Act and the NSW TSC Act. Five sub-populations of *Tetratheca juncea* were identified in the Southern Extension toward the western end of the area and on the south-facing slope. Two previously located populations in the south-east of the Southern Extension, recorded in 2002, were not relocated in the 2008 targeted search. The 2008 targeted search identified a total of 124 clumps; populations varied in size from 2 to 64 clumps. In the rehabilitation area two clumps of *Tetratheca juncea* were recorded.

One regionally significant plant species, *Macrozamia flexuosa,* was recorded. This species is listed as a regionally significant species by NPWS (2003). This species was recorded in Quadrats 6 and 7 (2008) and in Transects 2, 5, 10, 15, 16 and 24 (2002).

Three noxious weed species (*Ageratina adenophora*, *Cortaderia selloana* and *Lantana camara)* were recorded.

4.3 2011 FLORA SURVEYS

A total of 169 species (152 native and 17 exotic) were recorded in eleven 20m x 20m quadrats in March 2011.

Two forest vegetation communities were identified and mapped, Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland and Blue Gum - White Stringybark Shrubby Open Forest.

No vegetation communities of National or State conservation significance were recorded.

In January 2011*Tetratheca juncea,* previously recorded on the Project Site by Anne Clements & Associates (2008) and listed as Vulnerable under the Commonwealth EPBC Act and the NSW TSC Act, was relocated by targeted search. Four of the five sub-populations of *Tetratheca juncea* were relocated (the fifth small population of 6 plants was not visited due to time constraints). No new occurrences of *Tetratheca juncea* were detected. The identified populations included a total of 77 clumps, with populations varying in size from 1 to 40 clumps.

Due to the difficulty of identifying the extent of a clump, the number of clumps recorded in 2008 and 2011 may not be comparable. Of the two clumps of *Tetratheca juncea* recorded in 2008 in the rehabilitation area, one had been smothered by fallen vegetation.

In September 2011 all populations identified by Anne Clements & Associates (2008) were re-surveyed and 8 new sub-populations were detected in the southern part of the Project Site. These included 74 new clumps.

One regionally significant plant species, *Macrozamia flexuosa,* was recorded as occurring in two survey quadrats (1 & 6).

Three noxious weed species (*Ageratina adenophora*, *Cortaderia selloana* and *Lantana camara)* were recorded. *Ageratina adenophora* and *Lantana camara* were widespread and common in moist sheltered positions.

4.4 DESCRIPTION OF VEGETATION COMMUNITIES

Table 5
Key species and distribution of vegetation communities in the Study Area

Community	***Key species***	**Distribution**
Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland	*Corymbia maculata, Eucalyptus acmenoides*	Most common trees throughout all drier parts of Study Area
	E. paniculata, E. punctata, Angophora costata, E. umbra	Less common trees throughout drier parts of Study Area,
	Acacia implexa, A ulicifolia, Podolobium ilicifolium	Most common understorey shrubs throughout drier parts of Study Area
	Lomandra filiformis, Entolasia stricta, Imperata cylindrica, Themeda australis.	Most common ground layer plants throughout drier parts of Study Area
Blue Gum - White Stringybark Shrubby Open Forest	*Eucalyptus saligna*	Most common trees in moist protected part of the Study Area
	E. globoidea, Corymbia maculata	Less common trees in moist protected part of the Study Area
	Daphnandra apatala, Cryptocarya spp, Synoum glandulosum, Acmena smithii.	Occasional rainforest tree species in moist protected part of the Study Area
	Rubus moluccana, Dioscorea transversa, Eustrephus latifolius, Smilax australis	Most common vines in moist protected part of the Study Area
	Doodia aspera, Blechnum cartilagineum, Pteridium esculentum, Entolasia spp, Oplismenus spp,	Most common ground layer species in moist protected part of the Study Area

4.4.1 Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland

4.4.1.1 Structure

Either open forest or woodland of height from about 14m on ridge tops to 22m in gullies. Canopy foliage cover varied from about 10% to 40% (**Photographs 8-15**).

The midstorey typically consisted of saplings and suppressed trees of the canopy species and a variable shrub layer from 2m to 6m tall. Midstorey foliage cover varied from 4% to 25%, or higher where the tree canopy had been partly cleared.

The ground layer was sparse to occasionally dense with native grasses dominant.

4.4.1.2 Floristics

The most common canopy dominants were *Corymbia maculata* and *Eucalyptus acmenoides* (occurred in over 80% of sampled areas) followed by *E. paniculata* and *E. punctata* (occurred in about 50% of sampled areas). The associated species were *Angophora costata* and *Eucalyptus umbra* (occurred in about 30% of the sampled areas). Uncommon species (1-11% of sampled areas) were *Eucalyptus piperita, Eucalyptus resinifera subsp. resinifera, Syncarpia glomulifera, Eucalyptus fibrosa, Eucalyptus saligna* and *Corymbia gummifera*.

Within the shrub layer *Acacia* spp. were the most common species, often dominating this vegetation layer. The most common species were *Acacia implexa* and *Acacia ulicifolia.* Other common shrubs included *Podolobium ilicifolium, Polyscias sambucifolia, Breynia oblongifolia* and *Persoonia linearis*.

The most commonly recorded grasses and graminoid species were *Lomandra filiformis subsp. filiformis*, *Entolasia stricta*, *Imperata cylindrica* and *Themeda australis*.

Exotic species were found in very low densities (mostly less than 1% cover). The most commonly recorded species were *Lantana camara* and *Ageratina adenophora*.

4.4.1.3 Ecology, disturbance & dynamics

Observed disturbances within this community included timber harvesting tracks, soil disturbance associated with mine subsidence, dense regrowth following fire, weed invasion especially in moist protected parts of the community, fire damage in the form of basal scars and dead trees, and storm damage in the form of broken and uprooted trees.

The vegetation community is dependent on fire for establishment of the overstorey trees and seed germination of many of the understorey shrubs. Recommended intervals between fires for this forest type are 5 to 50 years, including some intervals greater than 25 years (NPWS 2003a). The last reported fire in the Study Area was on 25 November 2002.

Large old trees and large woody debris were rare, trees in the regrowth growth stage are common and most trees are in the early mature and mature growth stages, indicating that the Study Area has a history of major disturbances such as heavy logging and severe fire.

There was little observed variation in species dominance, vegetation height or foliage density in response to topographic position. This is ascribed to the effects of heavy logging, fire and the impacts on drainage of subsidence following mining of underlying coal measures.

4.4.1.4 Classification

Named in this report as a Spotted Gum - White Mahogany - Grey Ironbark Tall Open Forest & Woodland vegetation community after the schema of Walker & Hopkins (1990).

The vegetation community is classified in NSW as the Vegetation Type *Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin* (Biometric 2011). Not listed as rare or threatened within NSW or the Hunter-Central Rivers catchment.

The vegetation community is classified regionally as *Coastal Foothills Spotted Gum-Ironbark Forest* (NPWS 2003).

4.4.1.5 Conservation Status

The vegetation community has been identified as Regionally Significant Habitat by City of Lake Macquarie. The majority (67%) of vegetation in the City is identified as Regionally Significant Habitat.

The Vulnerable plant species *Tetratheca juncea*, which is known to be associated with the Biometric Vegetation Type *Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin*, occurs in the Spotted Gum - White Mahogany - Grey Ironbark Tall Open Forest & Woodland vegetation community of the Teralba Study Area.

Callistemon linearifolius and *Grevillea parviflora* subspecies *parviflora*, which are recorded as occurring in the locality, are also known to be associated with that Biometric Vegetation Type These species have not been recorded from the Study Area despite targeted searches and the possibility of their occurrence is low.

No flora species characteristic of any Endangered Populations were recorded in this community.

Flora species characteristic of the Endangered Ecological Community (EEC) EEC *Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion*, namely Spotted Gum *Corymbia maculata*, occur in this community. This EEC is not mapped by NPWS (2003) as occurring in or near the Study Area, but was mapped as occurring along and immediately to the north of Rhondda Road (LMCC 2010). However, the floristics of both the overstorey and the understorey of the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland at this location and in the Teralba Study Area differ significantly from those of the EEC (Section 4.2.2) and the Study Area occurs on soil types not listed in the determination as occupied by the EEC. It is concluded that the EEC *Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion* is unlikely to occur in the Teralba Study Area.

4.4.2 Blue Gum - White Stringybark Shrubby Open Forest

4.4.2.1 Structure

Comprises an open forest about 25m tall. Both canopy cover and foliage cover was sparse (11% foliage cover) **(Photographs 6, 7**).

The native midstorey typically consisted of occasional rainforest trees and shrubs to about 6m tall, with a developing stand of *Acmena smithii* and occasional other rainforest trees in the valley bottom at the eastern extremity and lowest point of the Study Area (9% foliage cover, Plot 2). Slender vines were common.

There was usually a dense midstorey of the exotic *Lantana* to 4m tall and 60% foliage cover.

On steeper slopes the ground layer consisted mostly of native ferns of up to 30% foliage cover (Plot 1) whereas on lower slopes it consisted mostly of a dense cover of soft native grasses to 70% foliage cover (Plot 2)

4.4.2.2 Floristics

The most common species was *Eucalyptus saligna*, with *E. globoidea* and *Corymbia maculata* less common and occurring mainly as small stands on rises and gully edges.

The occasional shrubs included *Astrotricha latifolius, Indigophora australis, Polyscias sambucifolius* and *Phyllanthus gunnii*. Occasional rainforest trees included *Daphnandra apatala, Cryptocarya spp, Synoum glandulosum* and *Acmena smithii*.

The large woody vines *Sarcopetalum harveyanum* and *Cissus antarctica* occurred occasionally, whereas the slender vines *Rubus moluccana, Dioscorea transversa, Eustrephus latifolius* and *Smilax australis* were common.

There were seven species of fern recorded in the ground layer of which the most common were *Doodia aspera, Blechnum cartilagineum* and *Pteridium esculentum*. Other common ground layer species included *Entolasia spp* and *Oplismenus spp*, which formed a dense sward in open areas of the valley floor.

The exotic species *Lantana camara* and *Ageratina adenophora* were common and often found together in high densities (up to 60% foliage cover). Other significant weeds included *Cinnamomum camphora, Ligustrum sinense* and *Cortaderia selloana.*

4.4.2.3 Ecology, disturbance & dynamics

Observed disturbances within this community included timber harvesting, canopy dieback, soil disturbance associated with mine subsidence, weed invasion, fire damage in the form of basal scars and dead trees, and storm damage in the form of broken and uprooted trees.

Large old trees were rare to absent and most trees are in the early mature and mature growth stages, indicating that the Study Area has a history of major disturbances such as heavy logging and severe fire.

The vegetation community exhibited a very low density of overstorey trees presumably due to the loss of trees to timber harvesting, subsequent fire and storm damage and a general absence of regeneration of overstorey trees. The absence of regenerating tree cover and the canopy dieback are associated with the severe infestation of lantana and a large bellbird population respectively.

It appears likely that the weed infestations in this community have prevented establishment of new eucalypts and most rainforest trees, and in the absence of intervention to reduce weed cover will continue to do so for the foreseeable future.

4.4.2.4 Classification

Named in this report as a Blue Gum - White Stringybark Shrubby Very Tall Open Forest vegetation community after the schema of Walker & Hopkins (1990).

Classified in NSW as the Vegetation Type S*ydney Blue Gum moist shrubby open forest on coastal ranges of the North Coast and northern Sydney Basin* (Biometric 2011), but with *Eucalyptus globoidea* replacing *E. acmenoides* and *E. microcorys* largely absent.

Classified regionally as *Coastal Narrabeen Moist Forest* (NPWS 2003).

Although mapped by NPWS (2003) as Alluvial Tall Moist Forest it lacks the characteristic deep alluvial soils and presence of swamp species such as *E. robusta, Glochidion ferdinandi*, , *Melaleuca styphelioides*, *Melaleuca linariifolia*, and *Callistemon salignus* described for that community.

The following description of the understorey of *Coastal Narrabeen Moist Forest* (NPWS 2003) more accurately describes the remnants of the understorey of the Blue Gum - White Stringybark vegetation community in the Study Area:

> *…a mesic understorey dominated by warm temperate rainforest influences including* Cryptocarya microneura, Rhodamnia rubescens *and* Synoum glandulosum*. Ferns such as* Doodia aspera, Adiantum formosum *and* Blechnum cartilegineum *characterise the species of the forest floor. Herbs including* Pseuderanthemum variabile *and* Oplismenus imbecillis *are found along with a diversity of climbers of which most common are* Smilax australis *and* Dioscorea transversa*.*

4.4.2.5 Conservation status

No threatened flora species were detected or are known or considered likely to be associated with this community in the locality.

No flora species characteristic of any Endangered Populations were recorded in this community.

Flora species listed as characteristic of the Critically Endangered Community (CEC) *Blue Gum High Forest in the Sydney Basin Bioregion* occur in this community, in particular *Eucalyptus saligna,* listed as a dominant species by the Determination, and *E. globoidea,* listed as part of the characteristic overstorey species assemblage*.*

However, the CEC is not regarded as occurring in or near the Study Area, being confined to the north shore and northern suburbs of Sydney. It is not recorded as occurring within the Lake Macquarie LGA. The mapped geology of the Study Area differs from that described for the CEC in the determination as Wianamatta Shale, adjacent areas of Hawkesbury Sandstone and localised volcanic intrusions. It is concluded that the CEC *Blue Gum High Forest in the Sydney Basin Bioregion* is unlikely to occur in the Study Area.

4.4.3 Cleared

This classification includes all areas where tree cover is absent as a result of clearing. These areas fall within one of three categories:

- bare areas such as roads and quarries that have been catastrophically disturbed and carry at best occasional plants;
- areas cleared for power line easements and occupied by mixed grassland with the native grasses *Aristida vagans, Digitaria parviflora, Imperata cylindrica,* and *Themeda australis* and the exotic species *Ageratina adenophora, Andropogon virginicus*, *Hypochaeris radicata* and *Senecio madagascariensis* and scattered tree seedlings.
- cleared low-lying areas in the south-eastern corner of the Study Area dominated by exotic grasses and associated with two artificial aquatic habitats formed by dams.

Of these only power line easements occupied by mixed grassland are considered to be potential habitat for threatened flora. To address the issue raised by OEH, search transects were undertaken on 6 September 2011 in easements south of the existing quarry. These detected no threatened flora in the easements proper, although numerous *Tetratheca juncea* clumps were detected along forest edges adjoining the easements. No threatened flora were detected by previous plot survey of easements undertaken by Anne Clements & Associates.

Accordingly, no threatened flora species are considered likely to be associated with this artificial community in the study area.

5. FLORA CONSERVATION SIGNIFICANCE

5.1 LIKELIHOOD OF OCCURRENCE OF THREATENED FLORA SPECIES, POPULATIONS, COMMUNITIES OR HABITAT

The likelihood of occurrence of threatened flora species in the Study Area assessed in **Table 6** below considers the detectability of the species, the occurrence of its habitat and associated vegetation type in the Study Area, and whether or not the species is known to occur in the locality. The likelihood of occurrence of species is defined as follows:

"Known" = the species has been observed in the Study Area;

"Likely" = there is a medium to high probability that a species occupies the Study Area;

"Potential" = suitable habitat for a species occurs in the Study Area but there is insufficient information to categorise the species as likely or unlikely to occur;

"Unlikely" = a low probability that a species occupies the Study Area;

"No" = habitat in the Study Area is unsuitable for the species.

One species, the shrub *Tetratheca juncea*, occurs in Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland in parts of the Study Area including within the Subject Site **(**Figure 1 of **Appendix 2)**. Two other species, the shrubs *Callistemon linearifolius* and *Grevillea parviflora subsp. parviflora*, were assessed as potential occurrences in this community, although the intensity of survey of parts of the Study Area indicates that its occurrence in the Subject Site is unlikely.

The rainforest shrub or small tree *Syzygium paniculatum* occurs in Blue Gum dominated shrubby open forest near the south eastern corner of the Study Area and it has potential for occurrence in the Blue Gum - White Stringybark Shrubby Very Tall Open Forest in the north east of the Study Area despite the highly modified understorey vegetation. Potential habitat for the species does not extend to the Subject Site.

Threatened ecological communities do not occur because the vegetation communities of the Study Area do not meet floristic, edaphic and/or locational requirements of the relevant Determinations, as discussed in Sections 4.4.1.5 and 4.4.2.5.

No species characteristic of Endangered populations were detected in the Study Area.

Table 6
Assessment of Likelihood of Occurrence of Threatened Flora Species in the Teralba Study Area

Scientific name	**TSC Act status**	**EPBC Act status**	**Detectability**	**Habitat (DECCW Threatened Species website)**	Associated forest type present?	Known from locality?	**Likelihood of occurrence in Study Area**
Acacia bynoeana	Endangered	Vulnerable	Best when in flower - September to March	open, sometimes slightly disturbed sites in heath or dry sclerophyll forests on sandy soils	Yes	No	Unlikely. Not detected by targeted survey. Not known from locality
Angophora inopina	Vulnerable	Vulnerable	All year	occurs most frequently in four main vegetation communities: (i) Eucalyptus haemastoma–Corymbia gummifera–Angophora inopina woodland/forest; (ii) Hakea teretifolia–Banksia oblongifolia wet heath; (iii) Eucalyptus resinifera–Melaleuca sieberi–Angophora inopina sedge woodland; (iv) Eucalyptus capitellata–Corymbia gummifera–Angophora inopina woodland/forest.	No	Yes	No. Habitat requirements not met.
Callistemon linearifolius	Vulnerable	not listed	Best detected when in flower - September to March	dry sclerophyll forest on the coast and adjacent ranges.	Yes	Yes	**Potential** in Spotted Gum- White Mahogany- Grey Ironbark Open Forest & Woodland. Not detected in Study Area but known from 1.7km away.
Cryptostylis hunteriana	Vulnerable	Vulnerable	Nov - Feb	Coastal Plains Scribbly Gum or Smoothbarked Apple Woodland*	No	Yes	No Not detected by targeted survey. Habitat not suitable (*Bell 2001). One record in locality.
Cynanchum elegans	Vulnerable	Endangered	All year	rainforest gullies, scrub, scree slopes	Yes	No	Unlikely. Not detected by targeted survey. Not known from locality
Grevillea parviflora subsp. parviflora	Vulnerable	Vulnerable	Best when flowering - July to December	in a range of vegetation types from heath and shrubby woodland to open forest, on sandy or light clay soils usually over thin shales	Yes	Yes	**Potential** in Spotted Gum- White Mahogany- Grey Ironbark Open Forest & Woodland Not detected in Study Area but known from 2.5km away. Targeted survey in 2011 not within flowering period.
Melaleuca biconvexa	Vulnerable	Vulnerable	Easiest when in flower and fruit - December to March	swamps, swamp margins or creek edges	Yes	No	Unlikely. Not detected by targeted survey. Not known from locality
Syzygium paniculatum	Vulnerable	Vulnerable	All year	on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities	No	Yes	**Potential** in Blue Gum - White Stringybark Shrubby Open Forest. Not detected in Study Area but known from near SE corner of Study Area. Habitat requirements not met in subject site
Tetratheca juncea	Vulnerable	Vulnerable	Cryptic, only detectable when in flower - July to December but may vary with climatic conditions	low open forest/woodland with a mixed shrub understorey and grassy groundcover, also recorded in heathland and moist forest.	Yes	Yes	**Known** from Spotted Gum- White Mahogany- Grey Ironbark Open Forest & Woodland
Pterostylis gibbosa	Endangered	Endangered	when leafy or in flower (winter to spring, dependent on rainfall	open woodland dominated by Narrow-leaved Ironbark E. crebra, Forest Red Gum and Black Cypress Pine	No	No	No. Not detected by targeted survey. Not known from locality. Habitat requirements not met.

5.2 LIKELIHOOD OF OCCURRENCE OF GROUNDWATER DEPENDENT ECOSYSTEMS (GDEs)

The primary aquifer in the region is a sedimentary system contained within the strata and voids of the mined Great Northern Coal Seam (GNCS) that exist below the Study Area. Locally, groundwater is partially intercepted within a mine adit located in the south of the Study Area where it is collected in a dam before discharging over a weir into an open channel (RCA Australia 2011).

The strata overlying the GNCS at the Teralba Quarry (i.e. the conglomerate resource) have high infiltration rates, due in part to fracturing associated with subsidence. The voids in the coal seam greatly increase the permeability of the aquifer. The effect of mining has most likely been to drain groundwater away from beneath most parts of the Study Area.

This drainage is reflected in the minimal variation between upper and lower topographic positions in floristics and structure of forest vegetation. It may to some extent be remediated by the proposed quarry extensions due to groundwater flow regime effects because the overall aquifer transmissivities would be reduced as the mine voids (underlying the quarried areas) are filled with collapsed conglomerate rubble and fines.

The types of ecosystems present in the Study Area are limited to Open Forests and Cleared areas that previously supported them. Terrestrial woody vegetation potentially dependent on groundwater such as swamp sclerophyll forest and wet heath do not occur in the Study Area. Two of the cleared areas support small areas of aquatic vegetation dominated by rushes and grasses, one associated with the dam at the mine adit, the other with an earthen weir south of the existing quarry (G. Elks pers. obs).

6. AVOIDING IMPACTS ON THREATENED FLORA AND NATIVE VEGETATION

The proposed Southern Extension footprint was originally designed to avoid threatened flora species *Tetratheca juncea* sub-populations 1, 4 and 6 (**Figure 7)**.

Relocation of power lines across the Study Area would utilise existing cleared areas wherever possible, and elsewhere would locate power lines adjacent to the haul road so as to minimise the area of clearing required.

7. OFFSETTING IMPACTS ON THREATENED FLORA AND NATIVE VEGETATION

7.1 BIODIVERSITY OFFSETS

7.1.1 Biodiversity principles

There are 13 Biodiversity Offset Principles that must be addressed as part of consideration of environmental impacts and development of offset proposals. (www.environment.nsw.gov.au /biocertification/offsets.htm).

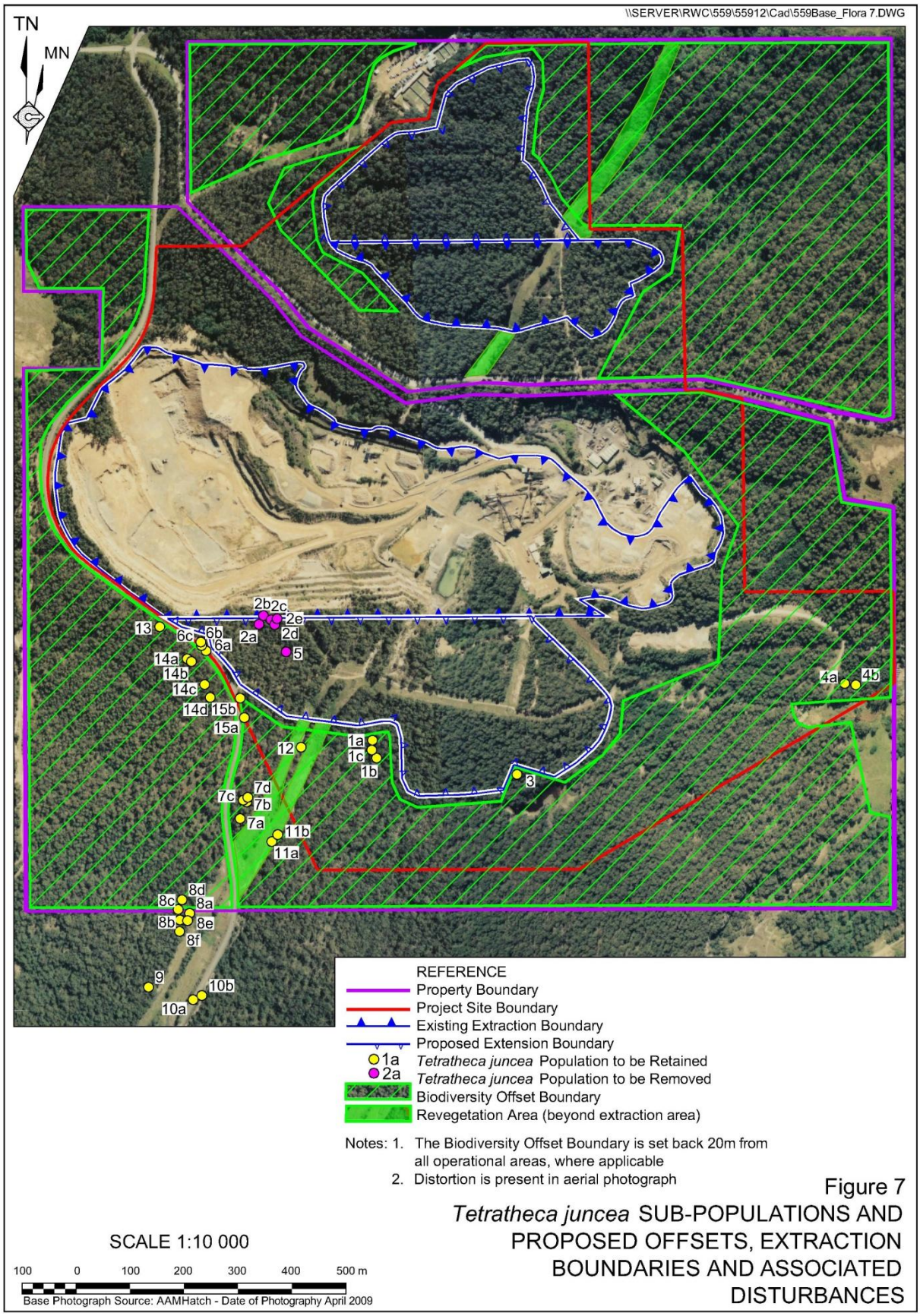


Figure 7
***Tetratheca juncea* Sub-populations and Proposed Offsets, Extraction Boundaries and associated disturbances**

1. Impacts must be *avoided first* by using prevention and mitigation measures.

The quarry footprint has been designed to minimise clearing of native vegetation and to avoid sub-populations of the threatened flora species *Tetratheca juncea*.

2. All regulatory requirements must be met.

Offsets are not proposed to satisfy approvals or assessments under other legislation.

3. Offsets must never reward ongoing poor performance.

The proposed offset would include a legal requirement for the land holder to manage the habitat for biodiversity according to the provisions of a vegetation management plan and would not encourage deliberately degradation or mismanagement of offset areas in order to increase the value from the offset.

4. Offsets will complement other government programs.

The proposed offset would help to achieve the NSW Government's conservation objectives by means of positive long-term biodiversity outcomes including legal protection and medium to long-term management of a significant area of native vegetation for conservation.

5. Offsets must be underpinned by sound ecological principles.

There are 169.3ha of Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland and 3.5ha of Blue Gum - White Stringybark Shrubby Open Forest in the Study Area The proposed offsets would reserve 114.5ha of Spotted Gum - White Mahogany - Grey Ironbark and all of the Blue Gum - White Stringybark community.

The Spotted Gum - White Mahogany - Grey Ironbark community to be reserved as offset consists of the same vegetation community and has similar structural, floristic and functional elements, including soils and threatened flora, to those which would be lost to the proposal. 10.7 ha of the proposed offset Spotted Gum - White Mahogany - Grey Ironbark community is rehabilitated forest dating to 1992, but is nonetheless suitable for the creation of ecosystem credits.

The Blue Gum - White Stringybark community to be reserved as offset is expected to occupy a similar habitat to the vegetation community that would be established in parts of the proposed quarry after extraction of the conglomerate resource. As similar communities are uncommon in the locality this offset would be important as a local source of propagules.

Reservation of Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland would contribute to the conservation status of the community, regarded as Regionally Significant Habitat in the Lake Macquarie LGA, and would contribute to wildlife movement in the locality. Proposed management of the offset, such as weed control, fire management and enhancement of existing habitat, would contribute to the value of the offset.

While it is acknowledged that reconstruction of the Spotted Gum - White Mahogany - Grey Ironbark and Blue Gum - White Stringybark communities as part of proposed rehabilitation involves some risks and uncertainties, the existing rehabilitation provides evidence that such communities and *Tetratheca juncea* habitat can be reconstructed in the Study Area and can contribute to the viability and functionality of biodiversity in NSW.

6. Offsets should aim to result in a net improvement in biodiversity over time.

The offset areas to be set aside for biodiversity conservation are approximately four times the areal extent of the areas to be cleared for the proposed quarry extensions and associated works and with additional management and increased security are expected to be sufficient to offset against the loss of biodiversity.

7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.

As impacts on biodiversity are likely to be permanent, the offset would also be permanent and secured by a conservation agreement or reservation and management for biodiversity.

8. Offsets should be agreed prior to the impact occurring.

Legal commitments to the offset actions would be entered into prior to the commencement of works under approval.

9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.

Proposed offsets have been based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology includes the area of impact, the types of ecological communities and flora habitat affected, its condition, conservation status, security and proposed management actions. Data was collected in Biometric format suitable for application of the Biobanking methodology. The data is presented in Appendix 2 to the original flora report.

The following actions proposed as part of the offset strategy for the Proposal contribute to biodiversity and would generate ecosystem credits:

- weed control
- management of fire for conservation
- management of human disturbance
- retention of regrowth and remnant native vegetation
- replanting or supplementary planting where natural regeneration will not be sufficient
- retention of dead timber
- erosion control

10. Offsets must be targeted.

They offset impacts on the basis of like-for-like or better conservation outcome. Offsets target biodiversity priorities in the area, based on the conservation status of the ecological community (regionally significant habitat), the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal to or greater in conservation status to the type of ecological community lost have been used for offsets. One type of environmental benefit has not been traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

11. Offsets must be located appropriately.

Proposed offsets are located in a vegetation community that has the same or similar ecological characteristics as the area affected by the development.

12. Offsets must be supplementary.

Proposed offsets are beyond existing requirements and not already funded under another scheme.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

Offsets may be audited as required to ensure that the actions have been carried out, Monitoring would be undertaken as part of a vegetation management plan to confirm whether or not the actions are leading to positive biodiversity outcomes.

7.1.2 Location and Extent of Offsets

It is proposed that 118ha of retained vegetation would be protected and managed as a biodiversity offset in legal perpetuity for the clearing of 28.7ha of native vegetation for the quarry extension and associated infrastructure. The 118ha of remnant vegetation to be retained represents approximately 80% of the native vegetation remaining on the entire property. **Figure 7** presents the proposed biodiversity offset areas and **Table 7** presents the forest vegetation to be retained, removed and rehabilitated.

Table 7
Areas of vegetation to be removed and retained

	Area (ha)	Dimension (m)
Vegetation to be Removed		
Relocated Exit Road	0.2	
Southern Extension	16.5	
Northern Extension	9.3	
33kV and 11kV Power Line on same pole (within property)	1.8	1400 x 13
33kV Power Line (north of property)	0.6	460 x 13
33kV and 11kV Power Line (within property boundary)	0.2	160 x 13
Conveyor and associated service road	0.1	
Subtotal	28.7	
Vegetation to be Remain Undisturbed on the property		
North of Rhondda Road	56.8	
South of Rhondda Road	90.2	
Subtotal	147.0	
Vegetation identified for Biodiversity Offsets	118	
Vegetation to be Enhanced		
33kV Power Line	1.2	
11kV Power Line	0.9	
Subtotal	2.1	

7.2 PROGRESSIVE REHABILITATION

7.2.1 Rehabilitation to Date

Approximately 10.7ha of previously cleared land in the south-east of the Study Area has been rehabilitated to forest since 1992 **(Figure 8)**. The rehabilitation method involved direct transfer of soil and biomass from vegetation clearing to the rehabilitation area and subsequent weed control over a period of approximately 15 years (Bill Sanderson, pers.comm.)

The threatened flora species *Tetratheca juncea* has been recorded in the rehabilitation area by Survey Methodology & Results compiled by Anne Clements & Associates (2008) and Elks (2011).

7.2.2 Rehabilitation of Unused Power Line Easements

The current quarry proposal would relocate power lines leaving 2.1ha of previously cleared land supporting mixed grassland available for rehabilitation. This area occurs on elevated land associated with a ridgeline in the southern part of the Study Area and extends southwards from between the main sub-populations of *T. juncea* in the Study Area.

It is proposed that topsoil and vegetation extracted from the immediate area of the existing *T. juncea* sub-population 2 within the quarry footprint would be relocated to selected parts of the easement. These would be prepared by removal of the existing soil surface so as to minimise the number of remaining propagules of exotic species such as *Ageratina adenophora, Andropogon virginicus*, *Hypochaeris radicata* and *Senecio madagascariensis*.

Given that *T. juncea* successfully established in rehabilitation elsewhere in the Study Area and the location and topography of the power line easements this approach is likely to be the most practical method of re-establishing *T. juncea* sub-populations in the Project Site.

7.2.3 Rehabilitation of Final Quarry Landforms

It is proposed that those parts of the quarry not required for future industrial development would be rehabilitated to native vegetation **(Figure 10)**. VENM or overburden would be spread with soil and biomass. This would be transferred directly from vegetation clearing operations wherever possible. Where direct transfer is not possible stockpiled material would be used, together with seed harvested from local trees if required.

Uncertainties as to the ongoing scheduling of operations would require flexibility as to the precise location and timing of rehabilitation operations. Detailed prescriptions for rehabilitation would be contained in a Vegetation Management Plan for the Project Site.

7.3 MANAGEMENT OF OFFSETS & REHABILITATED AREAS

7.3.1 Weed Control

Lantana, Crofton Weed, Camphor Laurel, Privet, and invasive exotic grasses including Pampas, Kikuyu, Paspalum, Setaria, Veldt Grass and Green Panic are weeds of concern in the Study Area. All would need ongoing control in areas disturbed by Extraction operations in order to prevent establishment of new loci of infestation near reserved vegetation.

Figure 8
SOUTH-EAST STUDY AREA SHOWING REHABILITATION IN 1992 AND 2010

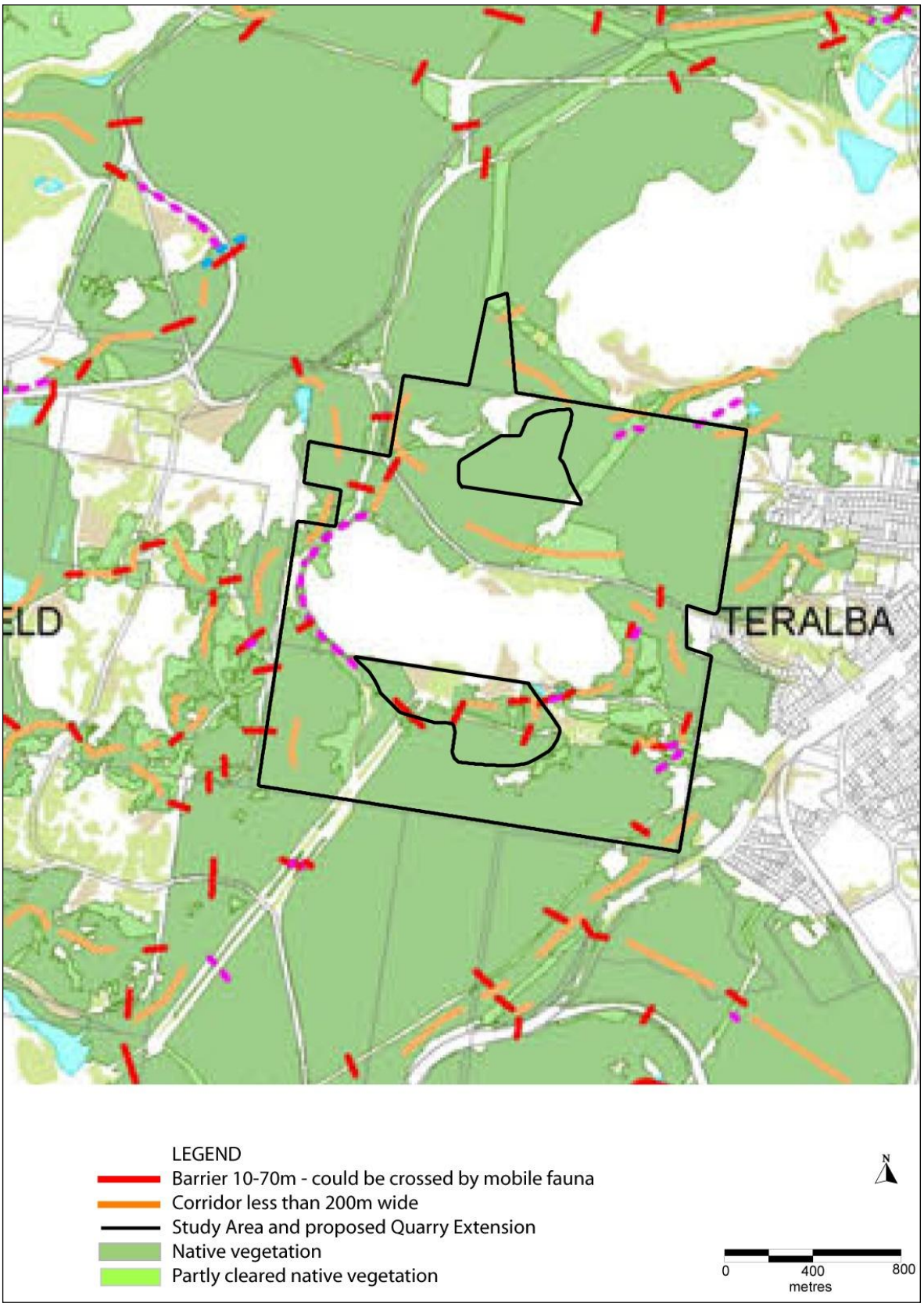
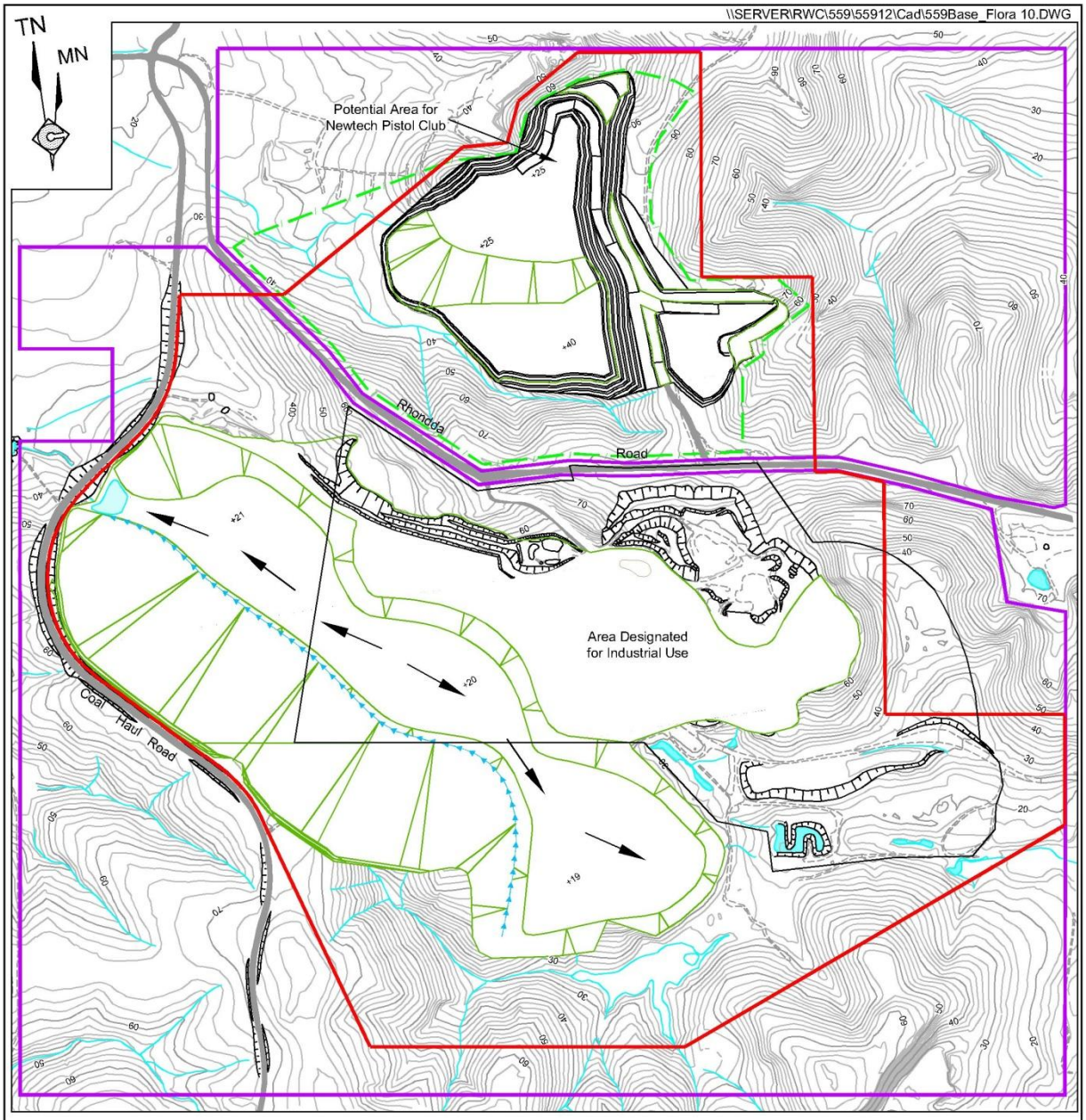


Figure 9
LMCC Mapping of Native Vegetation and Corridors in the Study Area



REFERENCE

- Property Boundary
- Project Site Boundary
- Access Road to Public Road Network
- Proposed Security Fence
- Contour (m AHD)(Interval =1m)
- Drainage Line
- Sealed Road
- Unsealed Road / Track
- Power Transmission Line
- Area Backfilled with Silts, Overburden and VENM/ENM
- Area Backfilled with Overburden and VENM/ENM
- Area to be Progressively Planted with Native Vegetation

SCALE 1:10 000

100 0 100 200 300 400 500 m

Figure 10
FINAL LANDFORM SHOWING AREAS TO BE REHABILITATED TO NATIVE WOODLAND VEGETATION

The most significant of these weeds in terms of existing area of occupation and density of infestation are Lantana and Crofton Weed. They occur in both the Blue Gum – White Stringybark community and in moist protected parts of the Spotted Gum - White Mahogany - Grey Ironbark community.

Weed control would be addressed in a Vegetation Management Plan for the Project Site. It is anticipated that bush regeneration activities associated with weed control will be required in rehabilitation areas and in the more severely Lantana infested areas of the Blue Gum – White Stringybark community in the medium to long term.

7.3.2 Fire intervals

Recommended intervals between fires would be included as a consideration in the Vegetation Management Plan. Fire intervals are to be applied at a landscape scale and accordingly decisions as to whether fire is required would need to consider the fire interval condition of other forest vegetation in the locality.

Recommended intervals for the Spotted Gum - White Mahogany - Grey Ironbark community are 5 to 50 years, including some intervals greater than 25 years. Recommended intervals for the Blue Gum – White Stringybark community are 25 to 60 years.

The Project Site was last burnt in 2002.

8. ASSESSMENT OF IMPACTS

8.1 VEGETATION CLEARING

In total, 28.7ha of native vegetation classified and mapped in this report as Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland lies within the footprint of the proposed quarry extensions **(Table 7)**.

It is expected that all of this vegetation would be cleared in tranches up to a year before required for the next stage of quarrying. All felled trees and understorey brush would be retained for use as biomass for enhancement or rehabilitation of habitat. This biomass would be relocated to rehabilitation areas in accordance with the Teralba Quarry Vegetation Management Plan to be developed. Topsoil and subsoil would be removed and relocated immediately to a final location in a rehabilitation area, or where this is not possible, to a stockpile.

Vegetation and topsoil from areas occupied by *T. juncea* would be harvested in isolation from other vegetation and transported for immediate spreading at previously prepared locations either in the disused power easements or at other suitable sites. All machinery required for these operations would be cleaned of all soil and seed residues immediately beforehand to minimise potential problems from soil-borne seeds and diseases.

The proposed quarry extension would also remove up to 68 of the 189 clumps of the threatened flora species *T. juncea* within the study area **(Table 8)**. A clump is defined as a group of stems separated from the nearest group of stems by 50cm or more.

Table 8
***Tetratheca. juncea* sub-populations and Project impacts**

Sub-population (Elks)	Population (Clements)	mga 56 Easting	Northing	No of Clumps				
				Elks Sep 2011	Elks Jan 2011	Clements Dec 2008	Clements Nov 2008	Clements Nov 2002
1a	1	367945	6351900	16	8	15	8	0
1b	1	367947	6351866	13	19	22	23	0
-	1	367958	6351881		0	0	0	49
1c	-	367941	6351882	4				
1				**33**	**27**	**37**	**31**	**49**
2a	2	367771	6352145		1	0	0	37
2b	2	367782	6352160		1	0	3	0
2c	2	367795	6352150		8	0	4	0
2d	2	367800	6352140		16	0	20	0
2e	2	367806	6352150		14	70	14	0
2				**66**	**40**	**70**	**41**	**37**
5	3	367813	6352087	**2**	**-**	**0**	**2**	**5**
	4	368225	6351813		0	0	0	1
	4	368199	6351795		9	0	7	0
	5	368210	6351839		0	0	0	1
	5	368204	6351850		0	0	0	1
	7	368202	6351798		0	12	0	0
3				**-**	**9**	**12**	**7**	**3**
	8	368825	6351865		1	1	0	0
	8	368845	6351859		0	1	0	0
4				**-**	**1**	**2**	**0**	**0**
6a	6	367667	6352112	1				
6b	6	367660	6352123	1				
6c	6	367660	6353130	5		6	4	0
6				**7**	**-**	**6**	**4**	**0**
7a		367680	6351795	6				
7b		367697	6351824	2				
7c		367691	6351828	1				
7d		367700	6351832	2				
7				**11**	**-**	**-**	**-**	**-**
8a		367560	6351637	14				
8b		367540	6351628	3				
8c		367540	6351647	5				
8d		367550	6351664	2				
8e		367554	6351624	3				
8f		367536	6351607	2				
8				**29**	**-**	**-**	**-**	**-**
9		367463	6351514	**10**	**-**	**-**	**-**	**-**
10a		367541	6351478	1				
10b		367558	6351483	2				
10				**3**	**-**	**-**	**-**	**-**
11a		367731	6351744	6				
11b		367744	6351755	3				
11				**9**	**-**	**-**	**-**	**-**
12		367812	6351908	**1**	**-**	**-**	**-**	**-**
13		367589	6352170	**1**	**-**	**-**	**-**	**-**
14a		367630	6352103	6				
14b		367637	6352097	16				
14c		367654	6352051	14				
14d		367661	6352026	1				
14				**37**	**-**	**-**	**-**	**-**
15a		367717	6351979	3				
15b		367715	6352016	2				
15				**5**	**-**	**-**	**-**	**-**

Note: Subpopulations 8A, B, E, F, 10A and B are outside of the Study Area.

8.2 IMPACTS ON ANY LOCAL CORRIDOR LINKS AND WILDLIFE MOVEMENT

The proposed Southern extension would increase the size of the current quarry without creating any new barriers or significant restrictions to the existing north-south corridors (**Figure 9)**. It is unlikely that local wildlife movements, including that of flora propagules and of mobile insect fauna thought to be associated with pollination of *T. juncea*, would be significantly restricted by the resulting removal of vegetation.

The removal of vegetation in proposed Northern Extension would increase the length of separation between the two existing north – south corridors on the eastern and western sides of the property.. It is expected that this would not result in a significant restriction to local wildlife movement, at least for flora and for mobile fauna associated with pollination and seed dispersal.

8.3 CUMULATIVE IMPACTS

Hunter-Central Rivers Bioregion:

45% of the Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin has been cleared since settlement (Biometric 2011).

30% of Sydney Blue Gum moist shrubby open forest on coastal ranges of the North Coast and northern Sydney Basin has been cleared since settlement (Biometric 2011).

Lake Macquarie Local Government Area:

Coastal Foothills Spotted Gum-Ironbark Forest (NPWS 2003). 32175ha at settlement, 7971 remaining, 75% cleared (Lake Macquarie State of the Environment Report 2009)

Coastal Narrabeen Moist Forest (NPWS 2003) N/A

Remnant Vegetation 38,321ha, 59.6% of the LGA (Lake Macquarie SoEE Report 2009)

During the period 2004-2007 144ha of native vegetation was completely cleared, which has declined from in excess of 1000ha per 3 year reporting period (does not include partial clearing). Mining is the largest source of complete clearing (44ha)

During the period 2004-2007 forestry, rural, urban development and mining account for the largest areas of clearing (279.80, 140.11, 107.14, and 95.25 ha, respectively – includes partial clearing). The major areas of clearing were: forestry in Olney and Awaba State Forests; mining and quarrying at Westside Mine, Rhonda Colliery, Metromix Quarry and Newstan Colliery; industrial development at Cameron Park; residential development at North Wallarah Peninsula and Toronto; and rural clearing.

Bushland managed for biodiversity values (National Park, State Forest Reserves, Council owned bushland) 9,213 ha, or 24% of remaining bushland.

The Lower Hunter Regional Strategy, a NSW Government strategy, identifies areas that support native vegetation for development including a number of sites for urban development. The development of these areas may exacerbate native vegetation clearing rates in the city.

8.4 IMPLICATIONS OF WEED INFESTATION

Weed control in the quarry operational areas and the rehabilitation areas has been regularly undertaken for at least 15 years (Bill Sanderson, pers.comm.)

Infestations of Lantana, Crofton Weed, Camphor Laurel, Privet, and invasive exotic grasses including Pampas, Kikuyu, Paspalum, Setaria, Veldt Grass and Green Panic already occur in the Study Area and in some parts of the Subject Site. It is proposed that all would be controlled, particularly in areas disturbed by extraction operations. This would be necessary to prevent or remove infestations adjoining reserved vegetation and subsequent invasion of the vegetation communities of the Study Area.

From the point of view of biodiversity, Lantana and Crofton Weed are the most significant of the weeds because they occupy most of the moister and more fertile parts of the Project Site, in places so dense that they are preventing natural processes of regeneration. Because of this these weeds would be the focus of weed control and bush regeneration activities in rehabilitation areas, the Blue Gum – White Stringybark community and moister parts of the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland.

The knowledge and ability to control these weeds is readily available. Weed control is not expected to present any major problems and would be addressed in a Vegetation Management Plan for the Project Site.

8.5 DESCRIPTIONS OF THE SUBJECT SPECIES

8.5.1 *Tetratheca juncea*

The following information is from DSEWPaC (2011).

T. juncea is a low shrub that grows in clumps of single or multiple stems arising from a single rootstock. It is found in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. Most populations occur in the Wyong and Lake Macquarie LGAs.

T. juncea has hanging pink flowers with a dark centre. They are bisexual, odourless and nectarless. Fruit is a non-fleshy capsule which opens spontaneously at maturity to release brown, shiny seeds of very low viability. Seeds have a large chalazal appendage that is attractive to ants and aids dispersal. Seeds may also be dispersed by macropods.

An individual plant is very slow growing and can grow into a clump of as many as 500 individual stems and bear several hundred flowers. The plant usually spreads by underground stems which can be up to 50 cm long. Plants appear to be long-lived, with the inside of the clump becoming senescent while the outside of the clump remains vigorous.

Requires a special class of native bees capable of buzz pollination. In any local population the establishment of a new plant from seed which was the product of fertilisation by pollen from a different local population need only occur every 100 years or so to maintain healthy genetic variability, thus avoiding the onset of inbreeding depression.

Found in sandy, occasionally moist heath and in dry sclerophyll vegetation. Forms arbuscular mycorrhizal associations and typically grows in low nutrient soils of moderate to strong acidity Occurs predominantly in erosional soil landscapes in areas where annual rainfall exceeds 1000 mm. Shows a distinct preference for the Coastal plains smoothbarked apple woodland

(MU 30) vegetation community, but 10% of the known occurrences are located in Coastal Foothills Spotted Gum-Ironbark Forest (MU 15).

Regeneration and spread is aided by hot, fast and medium intensity fires which result in seed germination. Slow cool fires completely burn out the rootstock and kill the plant. Seeds germinate after exposure to smoke or scarification of the seed coat (such as from heat acting on the seed coat during fire), suggesting that fire will increase the likelihood of germination. Because the longevity of the soil seed bank is short, limited germination is likely unless a fire occurs soon after seed release.

In 2002 the total population size of *T. juncea* was estimated to be between 9881 and 11 893 plant clumps, but more recent surveys have increased this to at least 50 000 clumps.

Reserved in Awabakal Nature Reserve, Glenrock State Recreation Area, Lake Macquarie Recreation Area, Jilliby State Recreation Area and Munmorah State Recreation Area, Wallarah National Park, Wallaroo Nature Reserve, Karuah Nature Reserve and Green Point Recreation Reserve.

The plant pathogen *Phytophthora cinnamoni* has been declared a key threatening process in NSW with *T. juncea* listed as a species that may be adversely affected by direct infestation or habitat degradation.

Key management actions include:.

- Protect and actively manage large populations and those at the limit of the species range through conservation covenanting and the preparation and implementation of site specific vegetation management plans;
- Improve vegetative connectivity within and between populations through revegetation and regeneration programs;
- Ensure stormwater infrastructure and associated development involving substrate or vegetation disturbance do not adversely impact on Black-eyed Susan and manage any associated hydrological change, such as increased runoff ;
- Undertake weed control activities at priority sites on private and public land ;
- Develop and implement a suitable fire management strategy. No more than one quick, low intensity fire event in an eight year period, and avoid slow or high intensity fire events;
- Implement suitable hygiene protocols to protect known sites from further outbreaks of dieback caused by *Phytophthora cinnamomi*.

8.5.2 *Callistemon linearifolius*

The following information is from the DECC Threatened Species profile for *C. linearifolius.*

C. linearifolius is a shrub up to 3-4m tall. It flowers spring – summer and grows in dry sclerophyll forest on the coast and adjacent ranges. It is known to be associated with Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin. It occurs from Georges R. to the Hawkesbury R, but extends north to the Nelson Bay area. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River.

The species was more widespread across its distribution in the past. The spread of urbanisation is the most likely cause of its decline. There is a high risk of local extinction due to low population numbers.

8.5.3 *Grevillea parviflora* subsp. *parviflora*

The following information is from the DECC Threatened Species profile for *G. parviflora* subsp. *parviflora.*

G. parviflora subsp. *parviflora* is a low spreading to erect shrub, usually less than a metre high. It is capable of suckering from a rootstock and most populations demonstrate a degree of vegetative spread, particularly after disturbance such as fire.

Sporadically distributed throughout the Sydney Basin and also further north from Putty to Wyong and Lake Macquarie on the Central Coast and Cessnock and Kurri Kurri in the Lower Hunter. It is found over a range of altitudes from low-lying areas to ridge crests and often occurs in open, slightly disturbed sites such as along tracks. Grows in sandy or light clay soils usually over thin shales and occurs in a range of vegetation types from heath and shrubby woodland to open forest. Known to be associated with Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin.

Loss and fragmentation of habitat associated with clearing for urban development, agriculture and road maintenance activities and habitat degradation as a result of weed invasion and inappropriate fire regimes are the main threats.

8.5.4 *Syzygium paniculatum*

The following information is from the DECC Threatened Species profile for *S. paniculatum.*

S. paniculatum is a small to medium sized rainforest tree to 8m tall. It is confined to in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.

S. paniculatum is associated with rainforest vegetation and is not known to be associated with the open forest vegetation types occurring in the Study Area.

Loss of habitat is associated with clearing for residential development and weed invasion, particularly of Lantana.

8.6 ASSESSMENT OF SIGNIFICANCE

Assessment of the nature and magnitude of the impacts includes the following considerations:

1. Pre-construction, construction and occupation/maintenance phases

The pre-construction phase is expected to last for one or two years. It is envisaged that the construction and occupation phases would extend over approximately 30 years.

2. All on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones.

On-site impacts are confined to vegetation clearance. No off-site impacts on flora are likely. All auxiliary infrastructure such as the road and electricity easements would be confined to the disturbance envelope shown in **Figure 7.**

3. All direct and indirect impacts

Direct impacts are expected to consist of progressive removal of native vegetation cover over an area of approximately 28.7 hectares.

Indirect impacts consist of weed control and bush regeneration in offsets and rehabilitation areas and are expected to have a positive impact on ecological structure and function.

4. The frequency and duration of each known or likely impact/action

As for 1 above.

5. The total impact which can be attributed to that action over the entire geographic area affected, and over time

As for 2 & 3 above.

6. The sensitivity of the receiving environment

The receiving environment has been subjected to a long period of disturbance resulting in substantial modifications to vegetation and weed invasion. There is no evidence to indicate that the receiving environment might be unduly sensitive to the impacts of the proposal.

7. The degree of confidence with which the impacts of the action are known and understood.

Actions of the type proposed have been frequently undertaken over a long period and their impacts are known and understood.

8.6.1 *Tetratheca juncea*

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

There are now 189 clumps known from within the study area, of which 68 are within the construction footprint. A further 35 clumps were detected and adjoining land along the haul road immediately to the south of the study area.

About two-thirds of the known clumps in the Study Area are outside of the Subject Site and would be retained, together with the large contiguous areas of potential habitat for *T juncea* occurring outside the Subject Site but within the Study Area.

Subpopulations 3 and 6 are located adjacent to the construction footprint and not within the proposed offset. However, the concern that these would be lost to ‘edge effects’ is not supported by the known distribution of T. juncea in the study area as 118 of the 189 clumps occur on or within 20 metres of edges associated with the existing quarry operations (subpopulation 2), powerline easements (subpopulations 8, 9, 11 and 12) and roads (subpopulations 6, 10 and 15). There is no indication that subpopulation 2 has declined since its discovery in 2002.

A review of edge studies by Beer & Fox (1997) found that there is little consistency between edge studies and inadequate replication within studies to enable the development of a universal edge theory.

A study of woodlands between Bathurst and Lithgow in the Central Western Region of New South Wales (Beer & Fox 1997)found that exotic species made up a greater proportion of the flora at forest edge sites of remnants small in area or with more irregular shapes, and exotic species invasion may also be moderated by factors such as the nature and management of the adjacent land use, as well as the resilience of the vegetation community in question. They concluded that long term remnant viability will require integrated management including control of invasive exotic species and regeneration of native species. These actions are included as part of the Project.

A more recent study of the effect of clearfell logging on the understorey light environment in adjoining tall Mountain Ash wet sclerophyll forest (Dignan & Bren 2001) found major increases in light penetration, with the zone close to the edge experiencing light increases at ground level in excess of 100% and significant change penetrating 60-90m. However, light changes at 3m above ground level (above the dense treefern strata) were only about 30%. There was also a significant influence from site characteristics such as slope and orientation (light penetration is lower on steeper slopes and on southerly facing edges). An observed effect of light penetration was an increase in the density of understorey vegetation.

It is expected that increased light penetration would result from vegetation clearance associated with the Project, but because of the lower and more open canopy, it would not be as severe or extend so far into the retained vegetation, and the likely response of the vegetation would be a minor increase in the density of understorey vegetation.

A recent study of the long-term impacts of clearing on remnant vegetation (Marques, Beijo & Ramos 2010) examined seedling establishment and differences in environmental descriptors (canopy openness, temperature, soil moisture, bamboo and liana coverage and litterfall). It found no differences in seedling survival or, except for temperature, environmental factors, between the edge and interior in fragments of Atlantic rainforest. Fragment sizes ranged from 14 to 65ha. The lack of differences between the edge and interior fragments was ascribed to their size, and the time since onset of adjacent clearing (~200 years), which allowed time for the existing vegetation to adapt.

Because of the relatively small size, openness and long history of disturbance of the vegetation remnants in the study area it is expected that the Proposal would not have a significant impact on canopy openness, soil moisture or litterfall, or a significant impact on temperatures, within the remnants.

The clearing associated with the Proposal would temporarily increase the perimeter edge, but this would be offset by the reduction in perimeter associated with the relocation of powerlines to a single corridor along existing cleared transport corridors and revegetation and rehabilitation of the existing twin powerline easements. Together with ongoing weed control to address the issues these actions would mitigate the impacts of the Project in the adjoining bushland and proposed conservation area.

Rehabilitation of habitat is proposed. Topsoil and vegetation extracted from the immediate area of the existing *T. juncea* sub-population 2 within the quarry footprint would also be relocated to prepared parts of a disused easement selected for its suitability as habitat. Substantial parts of the existing and proposed quarry footprint would also be rehabilitated to

native vegetation. These measures have already been successfully implemented in part of the quarry area, resulting in re-establishment of *T. juncea*.

This constitutes a type of translocation known as *augmentation*, defined as movement of individuals into a population of conspecifics (Weeks et al 2011). The objects are to increase population size to avoid the stochastic loss of a small population, and to allow for the possibility of genetic restoration, i.e. maintaining levels of genetic variation and adaptive potential to alleviate possible detrimental genetic effects that arise in small fragmented populations.

T. juncea naturally occurs adjoining the proposed restoration site. The proposed source material is from within 400 metres of the proposed restoration site . There are no known or apparent differences in the growth habit, flowering time, flower and fruit production, breeding system, or mode of regeneration. It is likely to be the local provenance for that area as it occurs in an area with similar abiotic characteristics and similar vegetation. There are no known or observed pests or diseases in the source material, or at the proposed restoration site. The source sub-population is of a similar size to the sub-population near the proposed relocation site.

It is therefore unlikely that the relocation would lead to inbreeding depression. The relocated material is unlikely to be weedy in the relocation habitat. The proposed relocation would utilise appropriate suitable hygiene protocols to prevent the introduction or transmission of diseases such as Phytophthora cinnamomi. Application of the simplified risk assessment in Figure 2 of Weeks et al (2011) indicates that translocation can proceed.

Leimu, Mutikainen, Koricheva & Fischer (2006) found that mean correlations between population size, fitness and genetic variation were all significantly positive and tended to be stronger for the rare species than for common species and strongest in self-incompatible species. T. juncea is self incompatible (Gross et al 2003). They also found that male fitness, measured as pollinator visitation and pollen removal, was significantly reduced in smaller populations of rare species, suggesting that reduced pollinator activity generally contributes to reduced fitness of plants in small populations of rare species. T. juncea is pollinator limited (ibid). Ecological mechanisms such as pollinator limitation may therefore act to further reduce fitness in smaller populations (Leimu et al 2006).

The Leimu et al study findings support the idea of an extinction vortex of interdependently ever decreasing population size, genetic variation and fitness. To minimise the potential for actions in the study area to contribute to this process it is proposed to attempt re-establishment of T. juncea sub-populations in the Project Site by means of relocation of topsoil and vegetation extracted from the immediate area of the existing T. juncea sub-populations 2 and 5 within the quarry footprint to an appropriate location within the adjoining offset. This method has successfully translocated T. juncea into rehabilitated vegetation elsewhere in the Study Area.

Habitat, in the form of flowering understorey plants and tree hollows for native bees that pollinate *T juncea*, would also be retained. Currently, tree hollows are likely to be limited because of the reduction in numbers of late mature and older trees resulting from prior logging and other disturbance operating in the Study Area. The proposed reservation and rehabilitation of vegetation in the Study Area and its management for conservation would increase the number of late mature trees and associated tree hollows as well as retaining flowering understorey plants.

The local population of *T. juncea*, which is assumed to be viable, consists of those individuals occurring in the Study Area and those in habitat adjoining and contiguous with the Study Area that could reasonably be expected to cross-pollinate with those in the Study Area.

A map obtained from the Wildlife Atlas of NSW online shows those kilometre grid squares occupied by the 540 *T. juncea* records in the locality and confirms that the Study Area is more or less surrounded by *T. juncea* records **(Figure 11).**

T. juncea clumps are thought to be able to live in excess of 100 years. Some of these individuals could reasonably be expected to cross-pollinate with those of the Study Area, especially given the indicative time scale of Driscoll (2009):

> *'In any local population the establishment of a new plant from seed which was the product of fertilisation by pollen from a different local population need only occur every 100 years or so to maintain healthy genetic variability, thus avoiding the onset of inbreeding depression'.*

It is likely that either a suitable pollinator or seed dispersal agent could successfully cross the intervening distance of up to 1.5km of forested land within a century or so. It is also likely that *T. juncea* would be re-established in rehabilitation areas. Extensive areas of habitat surrounding the known occurrences of *T. juncea* would be retained and managed for conservation. It is therefore considered unlikely that the local population would become extinct either in the short-term or in the long-term as a result of the proposal.

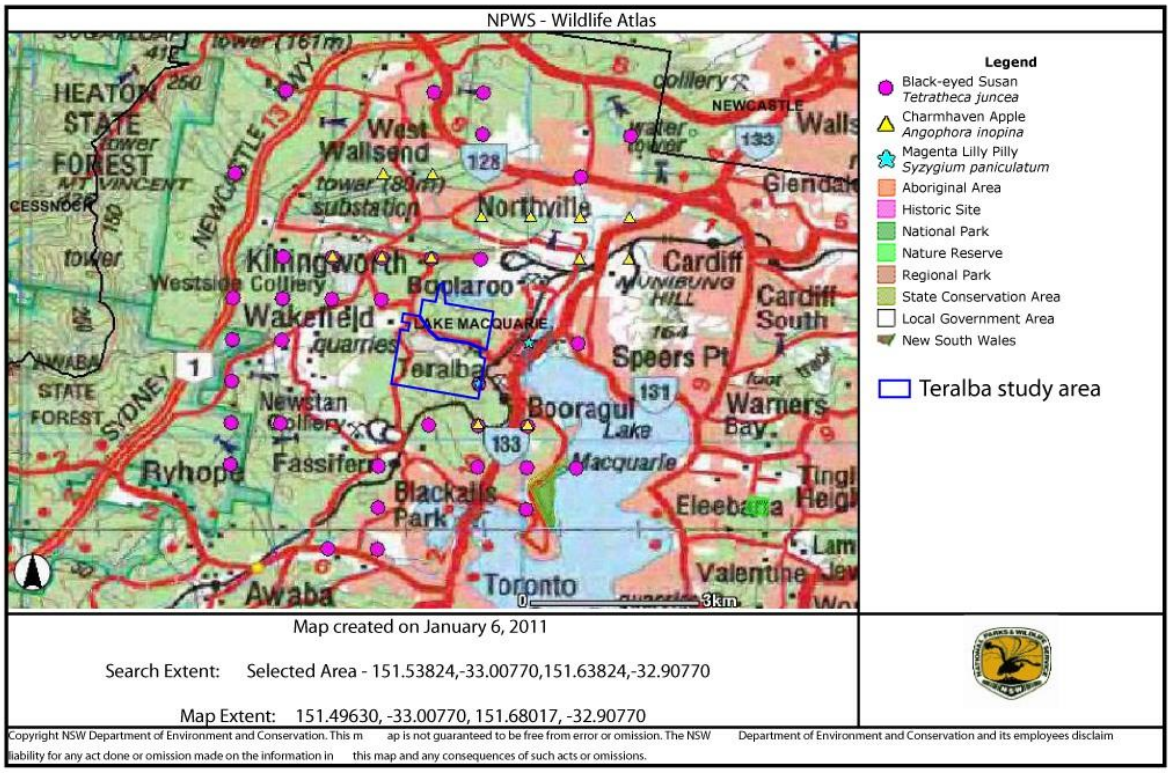
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Endangered populations do not occur in the Study Area

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

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

Endangered or critically endangered ecological communities do not occur in the Study Area.



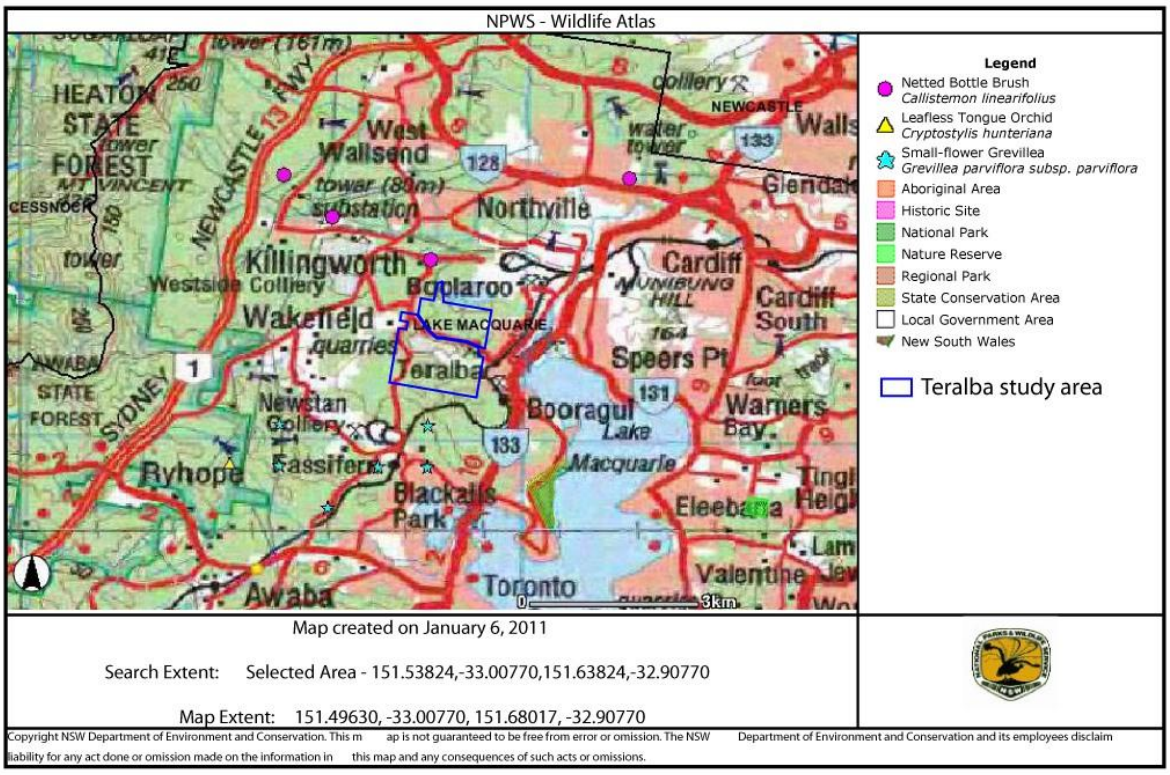


Figure 11
Wildlife Atlas of NSW Mapping Showing Distribution of Subject Species in the Locality

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

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Habitat for *T. juncea* includes the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland (also known as Coastal Foothills Spotted Gum-Ironbark Forest or MU 15) of the Study Area. The proposed quarry extensions would remove 28.7ha of this vegetation community and retain 147ha within the Study Area, 118ha of which would be managed for conservation. Large contiguous areas of *T. juncea* habitat extend to the north and south of the Study Area and further areas of known habitat occur to the east and west.

The proposed extension of quarry activities is of a shape and location that would not result in an area of habitat becoming fragmented or isolated from other areas of habitat. The habitat to be removed represents 5% of the 481ha of the Coastal Foothills Spotted Gum-Ironbark Forest (MU 15) and much less than 5% of *T. juncea* habitat, which includes substantial areas of Coastal Plains Smoothbarked Apple Woodland (MU 30) and Coastal Plains Scribbly Gum Woodland (MU 31) in the locality.

The ecological integrity of the habitat to be affected in the Study Area, in relation to the ecological integrity, tenure and security of the habitat which will remain both in the Study Area and in the locality, is likely to be very similar because the disturbance regime associated with these habitat areas is widespread and common in the locality, as are the drivers of that regime (mining, urban development, agriculture).

The habitat to be removed would therefore be unlikely to contribute significantly to fragmentation or isolation or be of importance to the long-term survival of *T. juncea* in the locality.

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

Critical habitat is not declared in the locality or in NSW.

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

There is no draft or approved recovery plan. No threat abatement plans are relevant to flora in the Study Area. The proposal is consistent with the following 12 actions listed in the Priority Action Statement (PAS) for *T. juncea:*

1. Determine a suitable fire regime and incorporate this information into relevant plans of management on public and private lands. (Medium priority)
2. Determine the key threats to the species and develop recovery actions to address these. (High priority)
3. Investigate population dynamics and genetic diversity within and between populations. (Medium priority)
4. Maintain or rehabilitate areas which provide connectivity within and between populations. (Medium priority)
5. Monitor population numbers and habitat condition of key populations. (Medium priority)

6. Prepare and implement site-specific management plans for important populations on private and public land which address key threats to the species. (Medium priority)
7. Prepare species profile and EIA guidelines as well as survey methodology to promote consistency of approach to assessments. (Medium priority)
8. Reassess the status of the species in the light of further surveys, monitoring and research on reproductive biology. (Low priority)
9. Seek to increase the level of legislative protection for the species on private land through appropriate land-use planning mechanisms and negotiating conservation agreements particularly large populations and those at the limits of distribution. (Medium priority)
10. Undertake a review of the extent and distribution of the species as well as the type of tenures on which it occurs. (Medium priority)
11. Undertake research on the reproductive biology of the species. (Medium priority)
12. Undertake weed control activities as appropriate using approved bush regeneration methods at priority sites on private and public land. (Medium priority).

(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

<u>Clearing of native vegetation:</u>

The proposal involves clearing of native vegetation, listed as a key threatening process (KTP) under the TSC Act. Impacts that result from clearing of native vegetation may include:

- destruction of habitat causing a loss of biological diversity;
- fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species;
- disturbance to habitat which may permit the establishment and spread of exotic species, and
- loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

Part (a) of this test indicates that the proposal would be unlikely to cause loss of biological diversity insofar as *T. juncea* is concerned. The area to be cleared is structurally and floristically similar to and relatively small in comparison with the area to be retained and managed for conservation. It is therefore unlikely that there would be a significant loss of plant biodiversity.

The evidence indicates that gene flow is infrequent and is likely to remain so in the medium to long term.

Exotic species are established in parts of the Study Area. They would be controlled as part of the proposal so as to prevent further impacts on habitat.

Introduction and establishment of Myrtle Rust

A variant of the *Puccinia psidii sens.* lat. fungal complex, *Uredo rangelii*, has recently arrived and naturalised in Australia, where it is referred to as 'Myrtle Rust'. Severe rust disease may kill shoot tips, causing loss of leader shoots and altering the plant's habit. Very severe infection may cause gross distortion of habit or plant death.

In South America, Myrtle Rust is capable of causing severe rust disease in non-native guava (Psidium) and Australian-origin eucalypts, and has been found to establish on a wide range of Australian-origin Myrtaceae, including genera that are ecologically important in Australian ecological communities such as Angophora, Corymbia, Eucalyptus, and Syncarpia. Susceptible native taxa occurring in the study area include Acmena smithii, Angophora costata, Backhousia myrtifolia, Callistemon salignus, Corymbia gummifera, C. maculata, E. acmenoides, E. fibrosa, E. globoidea, , E. microcorys, E. piperita, E. punctata, E. resinifera, E. saligna, E. umbra, Leptospermum polygalifolium, Rhodamnia rubescens, and Syncarpia glomulifera. Selection for resistant genotypes in native species would be slow and unlikely to prevent loss of populations, genotypes, and whole species, resulting in environmental degradation and habitat loss.

Options for physical, chemical and biological control under Australian conditions are limited and only likely to be effective for cultivated situations. Management options are currently limited to measures to minimise the spread of infection. Spores of Myrtle Rust are likely to be readily dispersed by movement on infected plant material, on clothing and personal effects of visitors to infected areas, wind, pollen, foraging honeybees and in the transport of bee hives, and by birds and mammals.

It is likely that Myrtle Rust will be or has already been dispersed to vegetation of the study area by means beyond control of quarry management. Of the known methods of dispersal only the movement of spores on infected plant material, on clothing and personal effects of visitors to infected areas and transport of beehives into the study area is within the control of quarry management. These potential sources of infection are addressed in Section 7.3.3 under the heading Biosecurity, where it is proposed that, among other things, actions identified by the Plant Biosecurity Unit of the NSW Department of Industry and Investment (2011) to limit the spread of Myrtle Rust would be implemented.

These actions include:

Undertake a risk assessment for quarry product export, rehabilitation and revegetation operations and employ appropriate measures as outlined in NSW Department of Industry and Investment (2011);

Utilise direct transfer or stockpiling of soil and biomass from Project vegetation clearing operations, together with seed harvested from local trees, minimise opportunities of transfer of Myrtle Rust into the Project Site from outside as part of rehabilitation operations.

Invasion, establishment and spread of *Lantana camara*

The proposal has the potential to contribute to the invasion, establishment and spread of *Lantana camara*. However the proposal includes measures for rehabilitation, bush regeneration and weed control that would reduce the current extent and severity of Lantana in the Study Area and prevent further invasion and spread.

Infection of native plants by *Phytophthora cinnamomi*

The proposal has the potential to contribute to the dispersal of soil and/or root material infected with *P. cinnamomi* by vehicles and earth moving equipment. However, the proposal would apply sanitation measures that would minimise opportunities for introduction of *P. cinnamomi*, (should it not already occur there) and its further spread.

Forest Eucalypt dieback associated with over-abundant psyllids and bell miners

Eucalypt dieback associated with over-abundant psyllids and bell miners is already evident in Blue Gum dominated forest in the north-eastern part of the Study Area. It was not detected in the Subject Site.

It is thought to involve interactions between habitat fragmentation, logging, nutrient enrichment, altered fire regimes and weed-invasion The problem is known to occur in areas with high soil moisture, suitable tree species and where the tree canopy has been reduced and a dense understorey of lantana is present, as occurs in the Blue Gum – White Stringybark vegetation community of the Study Area.

The proposal may help to reduce the impacts by means of proposed weed control, bush regeneration and fire management.

8.6.2 Callistemon linearifolius

(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.

C. linearifolius has not been recorded from the Study Area or detected by targeted search. A map obtained from the Wildlife Atlas of NSW online shows those kilometre grid squares occupied by the 34 *C. linearifolius* records as occurring in four areas to the north.

The nearest known population (30 Wildlife Atlas of NSW plant records) is located about 1km north of the Study Area in an area mapped as Quaternary alluvium. There is no indication that the species occurs in the Study Area.

The species has large showy flowers that are pollinated by a wide range of highly mobile avian and insect fauna. If it were to occur in the Subject Site the intensity of survey effort to date suggests that any occurrence would be very limited in number and extent and at best a small part of the local population.

It is therefore considered unlikely that the local population would become extinct either in the short-term or in the long-term as a result of the proposal.

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

Endangered populations do not occur in the Study Area

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

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

Endangered or critically endangered ecological communities do not occur in the Study Area.

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

- **(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

Habitat for *C. linearifolius* includes the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland (also known as Coastal Foothills Spotted Gum-Ironbark Forest or MU 15) of the Study Area. The proposed quarry extensions would remove 28.7ha of 147ha of this vegetation community and retain 118ha within the Study Area, which would be managed for conservation. Large contiguous areas of similar habitat extend beyond the Study Area.

The proposed extension of quarry activities is of a shape and location that would not result in an area of habitat becoming fragmented or isolated from other areas of habitat. The habitat to be removed represents 5% of the 481ha of the Coastal Foothills Spotted Gum-Ironbark Forest (MU 15) and much less than 5% of *C. linearifolius*, which includes substantial areas of other dry open forests in the locality.

The ecological integrity of the habitat to be affected in the Study Area, in relation to the ecological integrity, tenure and security of the habitat which will remain both in the Study Area and in the locality, is likely to be very similar because the disturbance regime associated with these habitat areas is widespread and common in the locality, as are the drivers of that regime (mining, urban development, agriculture).

The habitat to be removed would therefore be unlikely to contribute significantly to fragmentation or isolation or be of importance to the long-term survival of *C. linearifolius* in the locality.

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

Critical habitat is not declared in the locality or in NSW.

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

There is no draft or approved recovery plan. No threat abatement plans are relevant to flora in the Study Area. The proposal is consistent with the 13 actions listed in the Priority Action Statement (PAS) for *C. linearifolius:*

1. Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT - single provenance. (Medium priority)
2. Conduct management-related ecological research, particularly into fire response. (Medium priority)
3. Develop and implement a population and threat abatement monitoring program. (High priority)
4. Ensure that sites on Crown land are appropriately classified and managed. (Medium priority) 5. Identify, map and survey potential habitat. (Medium priority)
6. Incorporate a suitable fire regime for the species into plans of management for sites on public and private land. (Medium priority)
7. Liaise with landholders to facilitate the implementation of site-specific threat abatement measures. (Medium priority)

8. Prepare and implement site-specific management plans for sites that are located on public land. (Medium priority)
9. Prepare species profile and EIA guidelines. (Medium priority)
10. Review the status of the species in the light of further research and survey work. (Low priority)
11. Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements. (High priority)
12. Undertake a taxonomic review of the species to ascertain genetic make-up of populations. (Medium priority)
13. Undertake population viability analysis particularly for those small populations with a high risk of local extinction. (Medium priority)

(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

Clearing of native vegetation:

The proposal involves clearing of native vegetation, listed as a key threatening process (KTP) under the TSC Act. Impacts that result from clearing of native vegetation may include:

- destruction of habitat causing a loss of biological diversity;
- fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species;
- disturbance to habitat which may permit the establishment and spread of exotic species, and
- loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

Part (a) of this test indicates that the proposal would be unlikely to cause loss of biological diversity insofar as *C. linearifolius* is concerned. The area to be cleared is structurally and floristically similar to and relatively small in comparison with the area to be retained and managed for conservation. It is therefore unlikely that there would be a significant loss of plant biodiversity.

Exotic species are established in parts of the Study Area. They would be controlled as part of the proposal so as to prevent further impacts on habitat.

Introduction and establishment of Myrtle Rust

The proposal has the potential to contribute to the introduction and spread of Myrtle Rust. However the proposal includes risk assessment and mitigation measures to minimise the likelihood of this occurring.

Invasion, establishment and spread of *Lantana camara*

The proposal has the potential to contribute to the invasion, establishment and spread of *Lantana camara*. However the proposal includes measures for rehabilitation, bush regeneration and weed control that would reduce the current extent and severity of Lantana in the Study Area and prevent further invasion and spread.

Infection of native plants by *Phytophthora cinnamomi*

The proposal has the potential to contribute to the dispersal of soil and/or root material infected with *P. cinnamomi* by vehicles and earth moving equipment. However, the proposal would apply sanitation measures that would minimise opportunities for introduction of *P. cinnamomi*, (should it not already occur there) and its further spread.

Forest Eucalypt dieback associated with over-abundant psyllids and bell miners

Eucalypt dieback associated with over-abundant psyllids and bell miners is already evident in Blue Gum dominated forest in the north-eastern part of the Study Area. It was not detected in the Subject Site.

It is thought to involve interactions between habitat fragmentation, logging, nutrient enrichment, altered fire regimes and weed-invasion The problem is known to occur in areas with high soil moisture, suitable tree species and where the tree canopy has been reduced and a dense understorey of lantana is present, as occurs in the Blue Gum – White Stringybark vegetation community of the Study Area.

The proposal may help to reduce the impacts by means of proposed weed control, bush regeneration and fire management.

8.6.3 *Grevillea parviflora* subsp. *parviflora*

(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.

S. paniculatum has not been recorded from the Study Area or detected by targeted search. A map obtained from the Wildlife Atlas of NSW online shows those kilometre grid squares occupied by the 26 *G. parviflora* subsp. *parviflora* records to the south of the Study Area.

The nearest known population (14 Wildlife Atlas of NSW plant records) is located about 2km south of the Study Area. There is no indication that the species occurs in the Study Area.

The species has small white flowers that are likely to be pollinated by mobile avian and insect fauna. If it were to occur in the Subject Site the intensity of survey effort to date suggests that this occurrence would be very limited in number and extent and at best a small part of the local population.

It is therefore considered unlikely that the local population would become extinct either in the short-term or in the long-term as a result of the proposal.

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

Endangered populations do not occur in the Study Area

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

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

Endangered or critically endangered ecological communities do not occur in the Study Area.

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

- **(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

Habitat for *G. parviflora* subsp. *parviflora* includes the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland (also known as Coastal Foothills Spotted Gum-Ironbark Forest or MU 15) of the Study Area. The proposed quarry extensions would remove 28.7ha of this vegetation community and retain 143.1ha within the Study Area, which would be managed for conservation. Large contiguous areas of similar habitat extend beyond the Study Area.

The proposed extension of quarry activities is of a shape and location that would not result in an area of habitat becoming fragmented or isolated from other areas of habitat. The habitat to be removed represents 5% of the 481ha of the Coastal Foothills Spotted Gum-Ironbark Forest (MU 15) and much less than 5% of *G. parviflora* subsp. *parviflora* habitat, which includes substantial areas of other dry open forests in the locality.

The ecological integrity of the habitat to be affected in the Study Area, in relation to the ecological integrity, tenure and security of the habitat which will remain both in the Study Area and in the locality, is likely to be very similar because the disturbance regime associated with these habitat areas is widespread and common in the locality, as are the drivers of that regime (mining, urban development, agriculture).

The habitat to be removed would therefore be unlikely to contribute significantly to fragmentation or isolation or be of importance to the long-term survival of *G. parviflora* subsp. *parviflora* in the locality.

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

Critical habitat is not declared in the locality or in NSW.

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

There is no draft or approved recovery plan. No threat abatement plans are relevant to flora in the Study Area. The proposal is consistent with the 5 actions listed in the Priority Action Statement (PAS) for *G. parviflora* subsp. *parviflora:*

1. Identify and survey potential habitat to detect new populations. (Low priority)
2. Investigate genetic variation in collaboration with BGT. (Low priority)
3. Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage). (Low priority)
4. Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, particularly in fire management, bush regeneration, roadside management, weed control and fencing and signage. (Medium priority)
5. Monitor known populations, so that potential local extinctions are detected before they occur and mechanisms can be put in place to reverse trends. (Low priority)

(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

Clearing of native vegetation:

The proposal involves clearing of native vegetation, listed as a key threatening process (KTP) under the TSC Act. Impacts that result from clearing of native vegetation may include:

- destruction of habitat causing a loss of biological diversity;
- fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species;
- disturbance to habitat which may permit the establishment and spread of exotic species, and
- loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

Part (a) of this test indicates that the proposal would be unlikely to cause loss of biological diversity insofar as *G. parviflora* subsp. *parviflora* is concerned. The area to be cleared is structurally and floristically similar to and relatively small in comparison with the area to be retained and managed for conservation. It is therefore unlikely that there would be a significant loss of plant biodiversity.

Exotic species are established in parts of the Study Area. They would be controlled as part of the proposal so as to prevent further impacts on habitat.

Introduction and establishment of Myrtle Rust

The proposal has the potential to contribute to the introduction and spread of Myrtle Rust. However the proposal includes risk assessment and mitigation measures to minimise the likelihood of this occurring.

Invasion, establishment and spread of *Lantana camara*

The proposal has the potential to contribute to the invasion, establishment and spread of *Lantana camara*. However the proposal includes measures for rehabilitation, bush regeneration and weed control that would reduce the current extent and severity of Lantana in the Study Area and prevent further invasion and spread.

Infection of native plants by *Phytophthora cinnamomi*

The proposal has the potential to contribute to the dispersal of soil and/or root material infected with *P. cinnamomi* by vehicles and earth moving equipment. However, the proposal would apply sanitation measures that would minimise opportunities for introduction of *P. cinnamomi*, (should it not already occur there) and its further spread.

Forest Eucalypt dieback associated with over-abundant psyllids and bell miners

Eucalypt dieback associated with over-abundant psyllids and bell miners is already evident in Blue Gum dominated forest in the north-eastern part of the Study Area. It was not detected in the Subject Site.

It is thought to involve interactions between habitat fragmentation, logging, nutrient enrichment, altered fire regimes and weed-invasion The problem is known to occur in areas with high soil moisture, suitable tree species and where the tree canopy has been reduced and a dense understorey of lantana is present, as occurs in the Blue Gum – White Stringybark vegetation community of the Study Area.

The proposal may help to reduce the impacts by means of proposed weed control, bush regeneration and fire management.

8.6.4 *Syzygium paniculatum*

(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.

S. paniculatum has been recorded from near the south-eastern corner of the Study Area on an adjoining property, where it occurs in a Blue Gum dominated community next to a watercourse. A map obtained from the Wildlife Atlas of NSW online shows the 2 *S. paniculatum* records to the east of the Study Area.

S. paniculatum has not been detected in the Study Area by targeted search. Potential habitat for *S. paniculatum* may occur in the Blue Gum – White Stringybark vegetation community of the Study Area, but does not extend to the Subject Site.

It is therefore considered unlikely that the local population would become extinct either in the short-term or in the long-term as a result of the proposal.

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

Endangered populations do not occur in the Study Area

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

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

Endangered or critically endangered ecological communities do not occur in the Study Area.

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

- **(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality**

Habitat for *S. paniculatum* includes 3.5ha of the Blue Gum – White Stringybark vegetation community of the Study Area. The proposed quarry extensions would not remove or otherwise impact on this vegetation community. A further 40ha of similar Blue Gum dominated communities occur in the locality.

The proposed extension of quarry activities is of a shape and location that would not result in an area of habitat becoming fragmented or isolated from other areas of habitat.

The ecological integrity of the habitat in the Study Area, in relation to the ecological integrity, tenure and security of the habitat in the locality, is likely to be very similar because the associated disturbance regime is widespread and common in the locality, as are the drivers of that regime (mining, logging, urban development, agriculture).

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

Critical habitat is not declared in the locality or in NSW.

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

There is no draft or approved recovery plan. No threat abatement plans are relevant to flora in the Study Area. The proposal is consistent with the following action listed in the Priority Action Statement (PAS) for *S. paniculatum:*

1. Prepare a recovery plan for the species by 2007. (High priority)

(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

<u>Clearing of native vegetation:</u>

The proposal involves clearing of native vegetation, listed as a key threatening process (KTP) under the TSC Act. Impacts that result from clearing of native vegetation may include:

- destruction of habitat causing a loss of biological diversity;
- fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species;
- disturbance to habitat which may permit the establishment and spread of exotic species, and
- loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

Part (a) of this test indicates that the proposal would be unlikely to cause loss of biological diversity insofar as *S. paniculatum* is concerned.

Exotic species are established in parts of the Study Area. They would be controlled as part of the proposal so as to prevent further impacts on habitat.

<u>Introduction and establishment of Myrtle Rust</u>

The proposal has the potential to contribute to the introduction and spread of Myrtle Rust. However the proposal includes risk assessment and mitigation measures to minimise the likelihood of this occurring.

<u>Invasion, establishment and spread of *Lantana camara*</u>

The proposal has the potential to contribute to the invasion, establishment and spread of *Lantana camara*. However the proposal includes measures for rehabilitation, bush regeneration and weed control that would reduce the current extent and severity of Lantana in the Study Area and prevent further invasion and spread.

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Forest Eucalypt dieback associated with over-abundant psyllids and bell miners

Eucalypt dieback associated with over-abundant psyllids and bell miners is already evident in Blue Gum dominated forest in the north-eastern part of the Study Area. It was not detected in the Subject Site.

It is thought to involve interactions between habitat fragmentation, logging, nutrient enrichment, altered fire regimes and weed-invasion The problem is known to occur in areas with high soil moisture, suitable tree species and where the tree canopy has been reduced and a dense understorey of lantana is present, as occurs in the Blue Gum – White Stringybark vegetation community of the Study Area.

The proposal may help to reduce the impacts by means of proposed weed control, bush regeneration and fire management.

9. CONCLUSION

Impacts on *Tetratheca juncea* are assessed as not likely to be significant because of:

- the proposed retention of almost half of the known clumps in the Study Area together with large contiguous areas of potential habitat;
- rehabilitation of habitat;
- habitat would not be isolated or fragmented;
- the importance of the habitat to be removed is not critical to the long-term survival of the species in the locality;
- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Study Area;
- the proposal is consistent with the actions listed in the Priority Action Statement; and
- the Action proposed constitutes or is part of key threatening processes already operating in the Study Area but the proposal would apply measures that would avoid or reduce the impacts of those key threatening processes.

Impacts on *Callistemon linearifolius & Grevillea parviflora* subsp. *parviflora* are assessed as not likely to be significant because of:

- the proposed retention of large contiguous areas of potential habitat;
- rehabilitation of potential habitat;
- potential habitat would not be isolated or fragmented;
- the importance of the habitat to be removed is not likely to be of significance to the long-term survival of the species in the locality;
- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Study Area;

- the proposal is consistent with the actions listed in the Priority Action Statement; and
- the Action proposed constitutes or is part of key threatening processes already operating in the Study Area but the proposal would apply measures that would avoid or reduce the impacts of those key threatening processes.

Impacts on *Syzygium paniculatum* are assessed as not likely to be significant because of:

- the proposed retention of all areas of potential habitat;
- rehabilitation of potential habitat;
- potential habitat would not be isolated or fragmented;
- no draft or approved recovery plan or threat abatement plans are relevant to flora in the Study Area;
- the proposal is consistent with the actions listed in the Priority Action Statement; and
- the Action proposed constitutes or is part of key threatening processes already operating in the Study Area but the proposal would apply measures that would avoid or reduce the impacts of those key threatening processes.

10. REFERENCES

DSEWPaC 2010. *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable black-eyed susan,* Tetratheca juncea EPBC Act policy statement 3.26.

Beer J & M Fox 1997 Conserving vegetation in fragmented rural landscapes: edge effects and eucalypt forest remnants in P. Hale and D. Lamb (Eds) Conservation outside nature reserves Pages 313-318 . Centre for Conservation Biology, The University of Queensland

Bell SAJ 2001. Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* (Orchidaceae) from the Central Coast of New South Wales. Cunninghamia Vol. 7(2): 2001

Biometric 2011. Biometric Tool updated June 2008 accessed March 2011 http://www.environment.nsw.gov.au/projects/BiometricTool.htm.

Clements A & Associates 2008. Teralba quarry extensions flora assessment. Draft Report. RW Corkery Pty Ltd Brooklyn.

DEC 2005. *Threatened Species Survey and Assessment: Guidelines for developments and activities* (working draft). New South Wales Department of Environment and Conservation NSW.

DECC 2007. *Threatened species assessment guidelines: The assessment of significance.* Department of Environment and Climate Change NSW.

DECC & DPI 2008. Draft Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979.

Department of Environment and Climate Change NSW 2008. BioBanking Assessment Methodology

Dignan P & L Bren 2001. A study of the effect of logging on the understorey light environment in riparian buffer strips in a south-east Australian forest. Forest Ecology & Management 172 pp 161-172

Driscoll C 2003. *Pollination ecology of Tetratheca juncea (Tremandraceae): finding the pollinators*. Cunninghamia (2003) 8(1): 133–140

Driscoll, C. 2009 *A review of the ecology and biology of Tetratheca juncea Sm. (Elaeocarpaceae)* in DSEWPaC 2011. Draft report to Lake Macquarie City Council (original not seen)

DSEWPaC 2010. *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable black-eyed susan,* Tetratheca juncea EPBC Act policy statement 3.26.

DSEWPaC 2011. *Tetratheca juncea* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra

DLWC 2002. *NSW Groundwater Dependant Ecosystem Policy*. NSW Department of Land & Water Conservation, Sydney.

Harden G.J. 1990-2002 (Ed). *Flora of New South Wales.* Volumes 1 to 4. University of New South Wales Press, Kensington.

Harden GJ, WJF McDonald & JB Williams 2006. *Rainforest Trees & Shrubs. A guide to their identification*. Gwen Harden Publishing.

Harden GJ, WJF McDonald & JB Williams 2007. *Rainforest Climbing Plants. A guide to their identification*. Gwen Harden Publishing.

Lake Macquarie City Council 2008. 2008 State of the Environment Report.

Leimu R¶, P Mutikainen, J Koricheva & M Fischer 2006. How general are positive relationships between plant population size, fitness and genetic variation? Journal of Ecology 94, 942–952

Matthei L.E. 1995. *Soil landscapes of the Newcastle 1:100 000 Sheet.* Department of Land and Water Conservation, Sydney.

Murray M. & S Bell 2001. *Flora and fauna survey guidelines. Version 2.0.* Prepared for Lake Macquarie City Council.

Murray M & S Bell 2001. *Flora and Fauna Survey Guidelines Version 2*. Lake Macquarie City Council

National Parks and Wildlife Service 2003. *Vegetation Survey, Classification and Mapping. Lower Hunter and Central Coast Region* Version1.2. A project undertaken for The Lower Hunter and Central Coast Regional Environment Management Strategy. CRA Unit Sydney Zone

National Parks and Wildlife Service 2003a. *Guidelines for ecologically sustainable fire management*. Bushfire Research Unit, Biodiversity Research & Management Division, Hurstville.

National Parks and Wildlife Service 2005. *Species profile sheet for* Tetratheca juncea. Threatened Species Information & Environmental Assessment Guidelines. NSW NPWS, Hurstville.

NSW Department of Primary Industries 2011. Preventing spread of Myrtle Rust in bushland. Myrtle rust: everyday management

Payne R. 2001. *Lake Macquarie* Tetratheca juncea *Conservation Management Plan*. Prepared for Lake Macquarie City Council, NSW National Parks and Wildlife Service and Broken Hill Proprietary.

RCA Australia 2011. Specialist Consultant Studies Part 2: Groundwater Assessment, Metromix Pty Ltd. RW Corkery & Co, Brooklyn.

Rose G, WH Jones & DR Kennedy 1966. *Newcastle 1:250 000 Geological Sheet SI/56-02.* 1st edition. Department of Mines NSW, Sydney.

Specht RL, EM Re, VH Boughton (eds) 1974. *Conservation of major plant communities in Australia and New Guinea*. Aust J Bot Suppl Ser 7:1-667

Thamy Evellini Dias Marques, Luiz Alberto Beijo and Flavio Nunes Ramos (2007). Are biotic and abiotic factors and seedling mechanical damage in forest-edge fragments always different from the interior? Australian Journal of Botany 58(4) 241–247

Walker J & MS Hopkins 1990 in McDonald RC et al 1990. Vegetation. Australian soil and land survey field handbook.2nd Ed. Inkata Press.

Weeks A R, C M. Sgro, A G. Young, R Frankham, N J. Mitchell, K A. Miller, M Byrne, D J. Coates, Mark D. B. Eldridge, P Sunnucks, M F. Breed, E A. Jamesa nd A A. Hoffmann 2011. Assessing the benefits and risks of translocations in changing environments: a genetic perspective. Blackwell Publishing Ltd

Wheeler DJB, SWL Jacobs & RDB Whalley 2002. *Grasses of NSW.* 3rd Edition. UNE Armidale

11. PHOTOGRAPHS

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Photographs of *Tetratheca juncea* (11 January 2011)

Photograph 1. *T. juncea* seed pods (Population 1)

Photograph 2. T. juncea flowering clump (Population 2)

Photograph 3 *T. juncea* regeneration in rehabilitation area (Population 4)

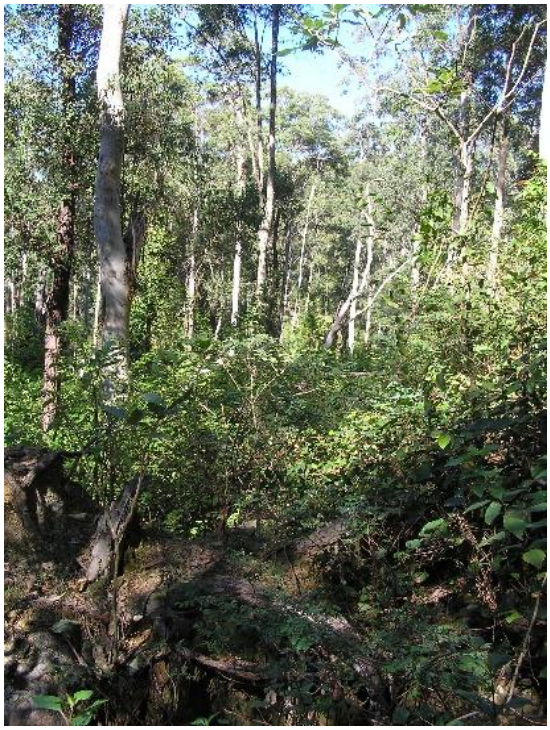
Photograph 4 (above):

***T. juncea* plants (marked with red flagging tape) and habitat, Population 1a**

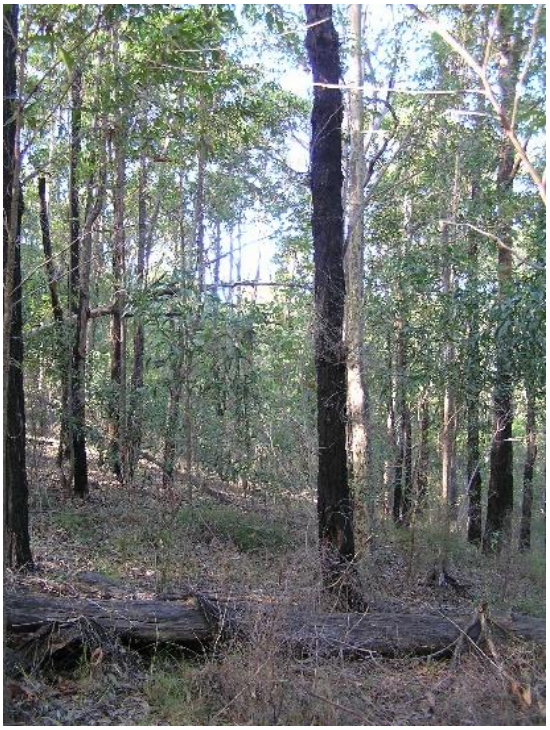
Photograph 5 (left):

***T. juncea* plants (marked) and habitat, Population 2a**

Photographs of survey quadrats



Photograph 6 Quadrat 1



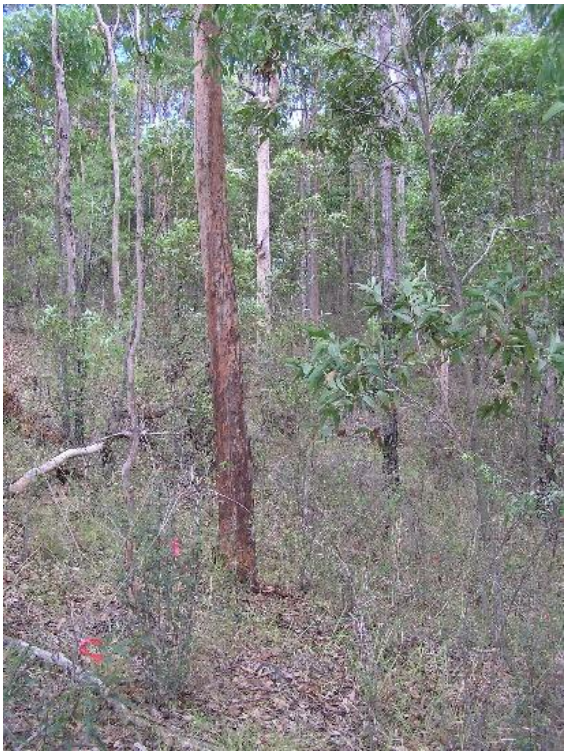
Photograph 8 Quadrat 4

Photograph 7 Quadrat 2

Photograph 9 Quadrat 5

Photograph 10 Quadrat 6

Photograph 12 Quadrat 8



Photograph 11 Quadrat 7

Photograph 13 Quadrat 9

Photograph 14 Quadrat 10

Photograph 15 Quadrat 11

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