Tasman Extension Project

Environmental Impact Statement

APPENDIX F

TERRESTRIAL FLORA ASSESSMENT

Resource Strategies

DONALDSON COAL

Part of Gloucester Coal

TERRESTRIAL FLORA ASSESSMENT SURFACE FACILITIES

Tasman Extension Project
Environmental Impact Statement

APPENDIX F

Resource Strategies

DONALDSON COAL
Part of Gloucester Coal

Tasman Underground Mine – Tasman Extension Project
Surface Facilities
Vegetation Ecology and Impact Assessment

A report for Donaldson Coal

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Executive Summary

Donaldson Coal Pty Limited (Donaldson Coal) proposes the Tasman Extension Project which would extend current underground mining of the Fassifern seam into the West Borehole seam.

A new pit top is proposed, to provide more immediate access to the resource than would be possible from the existing Tasman underground portal. This is a report of the vegetation and flora ecology of the proposed disturbance area and immediate surrounds.

Four main vegetation communities were identified and mapped. Two of these communities were listed as endangered ecological communities in the schedules of the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act). These were: *Lower Hunter Spotted Gum - Ironbark Forest* in the Sydney Basin Bioregion (LHSGIF) and *Hunter Lowland Redgum Forest* (HLRF) in the Sydney Basin Bioregion and the North Coast Bioregion. Approximately 9 ha of LHSGIF would be cleared which is just over 1% of the mapped extent of the community in the locality. The proposed disturbance area avoids the HLRF community.

Two threatened flora species were recorded in and beyond the investigation area: *Rutidosis heterogama* and *Tetratheca juncea*. The disturbance area was designed to avoid the *Tetratheca juncea* with the inclusion of a 20 m buffer. A small population of 417 *Rutidosis heterogama* plants lies within the proposed disturbance area. This population represents under 4% of the extended population in the locality.

An impact assessment (TSC Act 7-part test) concluded that the proposed action would not have a significant impact on the LHSGIF community or on *Rutidosis heterogama* such that the local occurrences would be placed at risk of extinction. No habitat isolation or fragmentation would result.

Cover: *Rutidosis heterogama*

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Tasman Underground Mine – Tasman Extension Project

Surface Facilities

Vegetation Ecology and Impact Assessment

1 Introduction

The Tasman Extension Project (the Project) would involve the extension of underground mining operations at the existing Tasman Underground Mine for an additional operational life of 15 years. Donaldson Coal Pty Limited (Donaldson Coal), owns and operates the Tasman Underground Mine. Donaldson Coal is a wholly owned subsidiary of Gloucester Coal Ltd (GCL).

The proposed mine is located approximately 20 kilometres (km) west of the Port of Newcastle in New South Wales (NSW) within the Newcastle Coalfield (**Figure 1**).

A new pit top is proposed to provide access to the West Borehole Seam and associated surface facilities required for underground coal mining and run-of-mine (ROM) coal handling. The pit top would be located off George Booth Drive approximately 2 km north-northwest of the existing Tasman Underground Mine pit top (**Figure 2**). The extent of surface disturbance within the property boundary is shown in **Figure 2**, along with current approved Fassifern mining area and the proposed West Borehole mine plan and extents. The *subject site* for this assessment consists of all area within the property boundary and also includes access and disturbance area for a downcast ventilation shaft that lies outside of the property boundary (**Figure 3**).

The pit top infrastructure would comprise of two drifts (tunnels) from the box cut at the pit top which would be constructed to allow for employee, machines and materials access to the underground roadways. It would also comprise of ROM coal handling infrastructure, administration facilities, worker amenities and stores buildings, workshop compound, bunded fuel tank area, transformer and mine infrastructure.

Development of the access road to the new pit top would involve construction of a new intersection with George Booth Drive.

An upcast ventilation shaft (from the surface to the West Borehole Seam) and associated fan and ancillary infrastructure would also be constructed. Adequate ventilation of the underground workings is essential for a safe and efficient operation. Areas where people are working would be ventilated by the mine intake entry (i.e. one of the drift entries) which provides intake air and the upcast ventilation shaft, and ventilation return (i.e. the other drift entry) which expel exhaust air after the air has circulated through the mine.

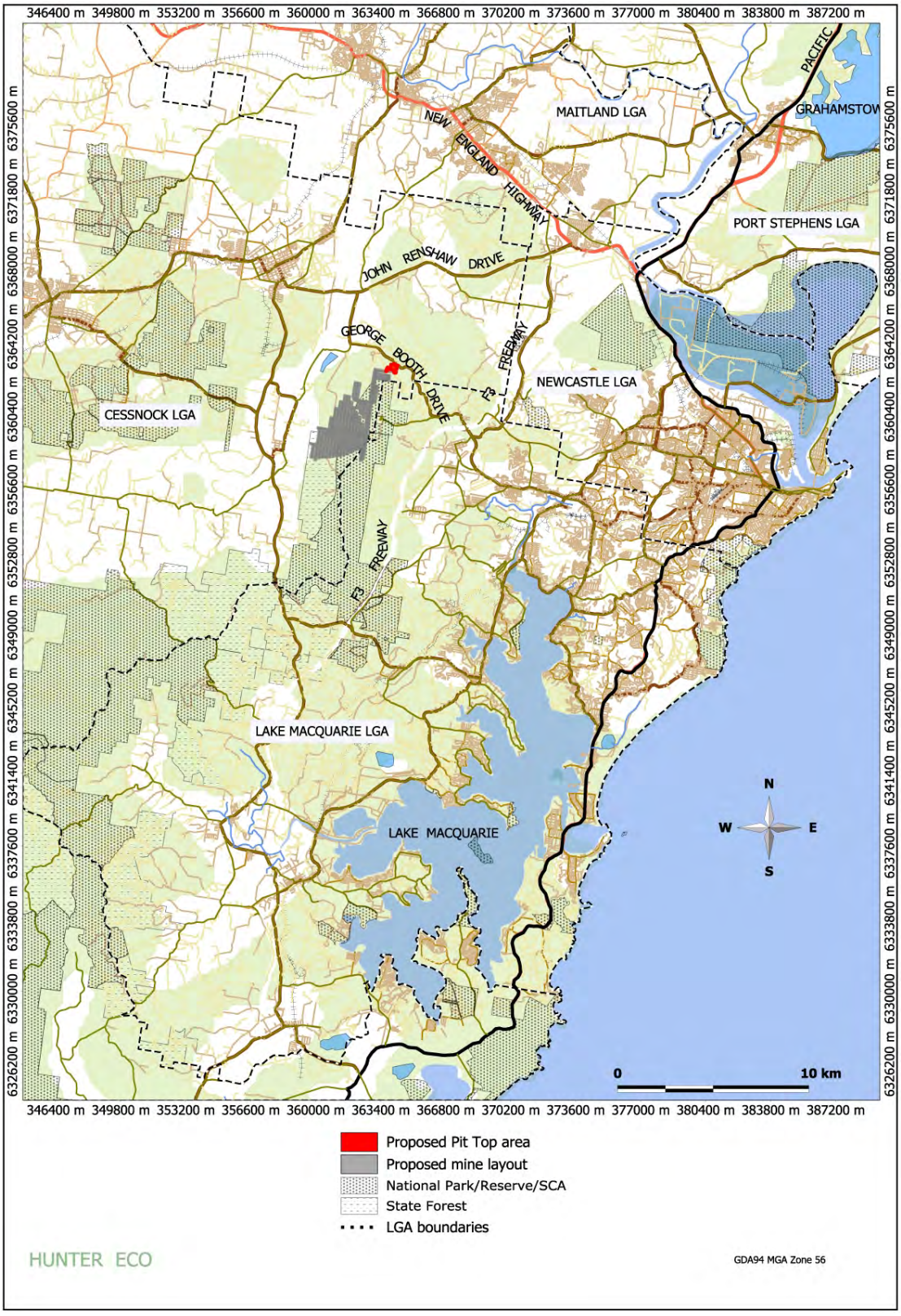

Figure 1 The investigation area in a local and regional context

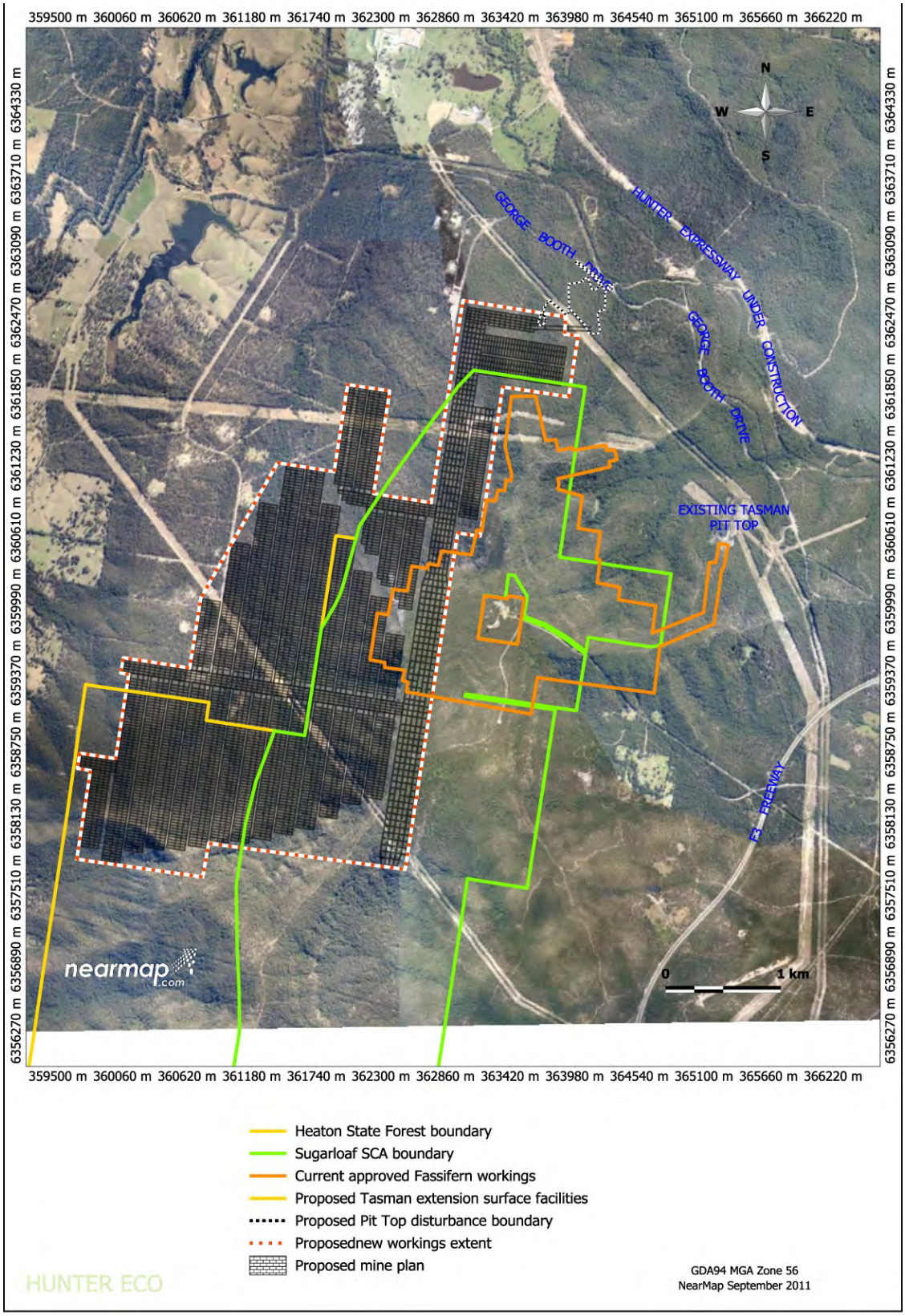

Figure 2 The proposed Tasman Extension Project West Borehole workings and current approval

Figure 3 The property and proposed surface facilities disturbance area

2 Subject Site Physiography

The Project is located at the northern edge of the Wyong sub-region in the Sydney Basin Bioregion; at the northern edge of the Wyong sub-region of the Hunter – Central Rivers Catchment Management Authority (CMA); and at the southern end of the North Coast Botanical Division.

Data interpolated from regional historical records indicates that rainfall in the Project area is 900-1000 millimetres (mm) per year (Driscoll unpub.).

Elevation starts at around 50 metres (m) along George Booth Drive and slopes gradually south to 65 m at the transmission line easement.

Geology is Permian, Newcastle Coal Measures made up of Conglomerate, Sandstone and Tuff (NSW Department of Mineral Resources [DMR] 1999).

Soils are Killingworth erosional landscape in the eastern and southern parts, Cockle Creek alluvial in the centre and Beresfield residual landscape at the western side of the lower part near George Booth Drive (Matthie 1995).

The subject site is well forested but there is a wide transmission line easement crossing from east to west and two main bush tracks entering from George Booth Drive.

3 Previous Studies

The property on which the surface facilities are proposed (**Figure 3** above) was the outcome of an exchange of land from within the existing Tasman surface facilities property. In 2006 the ecological values of the subject site were investigated as part of the land exchange process (Ecobiological 2006a). The study recorded the presence and general distribution of *Tetratheca juncea* but *Rutidosis heterogama* was not recorded. A vegetation map was also prepared that identified the communities present and their approximate distribution. The current report provides greater detail than the earlier report.

Other studies of areas adjacent to, but not including, the surface facilities flora and vegetation investigation area have been Gunninah (2002) assessing flora and fauna for the proposed Tasman underground coalmine and Ecobiological (2005, 2006b, 2007a, 2007b, 2008a, 2008b, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b) annual monitoring of the Tasman underground coalmine surface disturbance, compensatory habitat areas.

4 Survey Aims and Methods

This survey was primarily framed by the NSW Department of Environment and Conservation (DEC) (2004) threatened species survey guidelines. While the study area was primarily within the property boundary (**Figure 3**), for context, habitat and specific plant population continuity into the surrounding area was also evaluated. As described in the following sections, a thorough ground search was conducted and all plant species were positively identified. This method ensures that all threatened species are found, even those that might not have been previously recorded in the locality.

4.1 Survey Effort

Floristic and threatened flora data from the investigation area were collected over nine days from April 2011 to February 2012 (**Table 1**). The investigation period covered the most opportune time for locating otherwise cryptic threatened flora species.

Table 1 Survey effort

Date	Task
April/May 2011	Collect plot data
September 2011	*Tetratheca juncea* population count
October 2011	Floristic meander
October 2011	*Rutidosis heterogama* population count
November 2011	*Rutidosis heterogama* extended population estimate
February 2012	Collect Plot 12 data

4.2 Vegetation community determination and mapping

A vegetation map was prepared from ground-truthed point data, floristic plot data and ground-truthed community boundary determination, applying methods developed in part by the author, as published in NSW Department of Environment and Climate Change (DECC) (2008). Vegetation community types were determined by matching floristic content to data from the NSW National Parks and Wildlife Service (NPWS) (2000) regional classification.

The investigation area was sufficiently small for a thorough field inspection. Ground-truth vegetation data were collected at several locations at which the dominant species in the canopy, shrub and ground structural layers were recorded. These points were given a tentative community classification by comparison with the NPWS (2000) community profiles.

To verify the differentiation between the identified communities, data were collected from standard 20x20 m floristic plots using the modified Braun-Blanquet cover-abundance scale (**Table 2**). These data were analysed using ordination in Primer 6 (Clarke and Gorley 2001) which grouped the plots into those whose diversity and biomass were most similar. Finally, the ecotonal boundary between each community was walked and recorded using a handheld GPS (Garmin GPS60CSx) with the data being transferred to a GIS for preparation of the final vegetation map.

Table 2. The Braun-Blanquet cover-abundance scores

Cover range	Score
<5% few individuals	1
<5% many individuals	2
5% - <25%	3
25% - <50%	4
50% - <75%	5
75% - 100%	6

Biometric data were also collected at the floristic plot sites with the plot being extended to 20 x 50 m. Biometric community types were determined by matching the classified communities to biometric community descriptions. Biometric parameters recorded were:

- Native plant species richness (total native species present)
- Native overstorey cover
- Native midstorey cover
- Native ground cover (grasses)
- Native ground cover (other)
- Percentage regrowth (proportion of canopy species with diameter <10 centimetres [cm])
- Number of trees with habitat hollows
- Total length of fallen logs (metres)

Overall floristic content was compiled from plot data, ground-truth points, targeted meander and opportunistic observation. Meanders were designed to cross all mapped vegetation types.

4.3 Threatened Flora

Flora species and vegetation communities listed as threatened in the NSW *Threatened Species Conservation Act 1995* (TSC Act) were a particular focus of the survey. Species listed in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were not considered here because the Commonwealth Department of Sustainability, Environment, Water, Population and Communities determined that the Project was not a controlled action.

Initially a desktop analysis was conducted by drawing threatened flora records from the Atlas of NSW Wildlife data base for an area within a radius of 5 km of the subject site boundary (**Table 3**).

Table 3 Threatened flora species from the Atlas of NSW Wildlife
Extracted September 2011

Family	Scientific Name	Common Name	TSC Act Status[1]
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V
Myrtaceae	*Eucalyptus parramattensis* subsp. *decadens*	Earp's Gum	V
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V
Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum	V
Proteaceae	*Grevillea parviflora* subsp. *parviflora*	Small-flower Grevillea	V

[1] Threatened Species Status under the TSC Act (current at 21 March 2012).
V = vulnerable

4.3.1 Threatened Species Population size determination

The population size of threatened flora species was determined by directly counting individuals. To achieve this, transects were walked that ensured all of the area was visually inspected. At each encounter with the target species the number of individuals was recorded, a small piece of flagging tape was dropped on each and a length of tape tied to a shrub. This process all but eliminated the possibility of double counting. A waypoint was taken with a handheld GPS (Garmin GPS Map60CSx) fitted with an antenna booster. Resolution was 3 – 6 m radius so all individuals within that radius could be counted as the number occurring at that waypoint.

Tetratheca juncea grows in sometimes dense clonal patches where it is difficult to determine what constitutes an individual. A standard method (used here) was developed (Payne *et al.* 2002) where an individual (referred to as a clump) was any group of stems separated from the next nearest by 30 cm or more.

There are similar problems when counting *Rutidosis heterogama* with plants often occurring in dense groups. It is unknown whether these are clonal groups or a consequence of germination of seed that generally disperses close to the parent plant. There is no convention for counting this species so a best estimate was made of individuals in dense patches. A record from the Atlas of NSW Wildlife database pointed to a group of the species occurring in the powerline easement south east of the investigation area. This group was located and counted. Plants were also discovered along both sides of George Booth Drive and counting continued through there. The NSW Atlas records indicated that the population north of George Booth Drive might be continuous for some distance beyond the counted population. A wide area was then surveyed along parallel transects around 70 m apart to determine the approximate extent of the entire population. The number of plants in this wider area was estimated by extrapolation of the density of plants in the area of detailed count.

5 Results

Overall, the habitat was found to be moderately disturbed by rubbish dumping, vehicle tracks and firewood collecting. **Appendix 4** lists the 155 flora species, from 47 families, recorded across the surveyed area. There were only five weed species present.

5.1 Vegetation communities

Four vegetation communities were mapped across the investigation area (profiled in **Appendix 5**). These were:

- MU15 Coastal Foothills Spotted Gum – Ironbark Forest;
- MU17 Lower Hunter Spotted Gum – Ironbark Forest (including a paperbark variant, MU17(p);
- MU19 Hunter Lowland Redgum Forest; and
- MU30 Coastal Plains Smooth-barked Apple Woodland.

The composition of two of these communities was consistent with the following endangered ecological communities (EEC) listed in the NSW TSC Act:

- MU 17, Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion; and
- MU19, Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions.

The floristic content of the sampled plots was classified by comparison with the community profiles in NPWS (2000). **Figure 4** shows ordination results with plots grouped according to similarity of floristic content and biomass. Data for all plots are provided in **Appendix 3**.

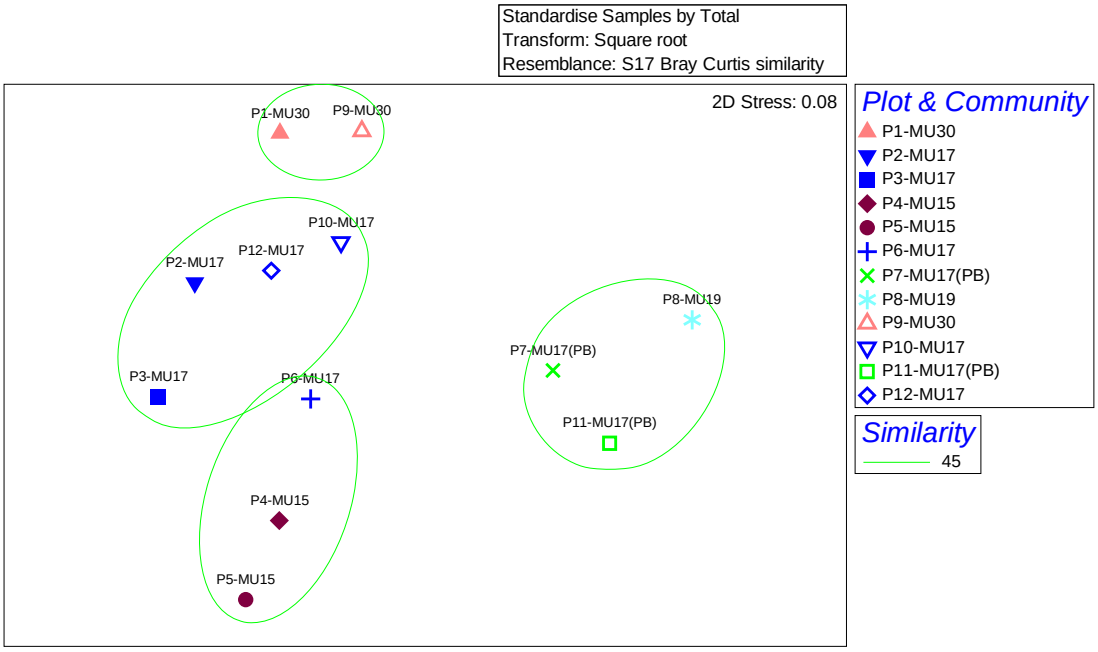

Figure 4 nMDS ordination of the floristic plots

Non-metric multi-dimensional scaling (nMDS) shows the 12 plots grouped according to their floristic similarity. The ellipses are from an underlying hierarchical agglomerative cluster analysis. Symbol colours indicate the vegetation community in which the plot was recorded.

Figure 4 shows Plot 6 lying between the MU17 Lower Hunter Spotted Gum – Ironbark Forest and MU15 Coastal Foothills Spotted Gum – Ironbark Forest groups, which is explained by its location at the interface between these two communities, as seen in the **Figure 5**. A dense midstorey of paperbarks has brought Redgum Plot 8 into the same group as MU17 paperbark variant, even though the main canopy species were different.

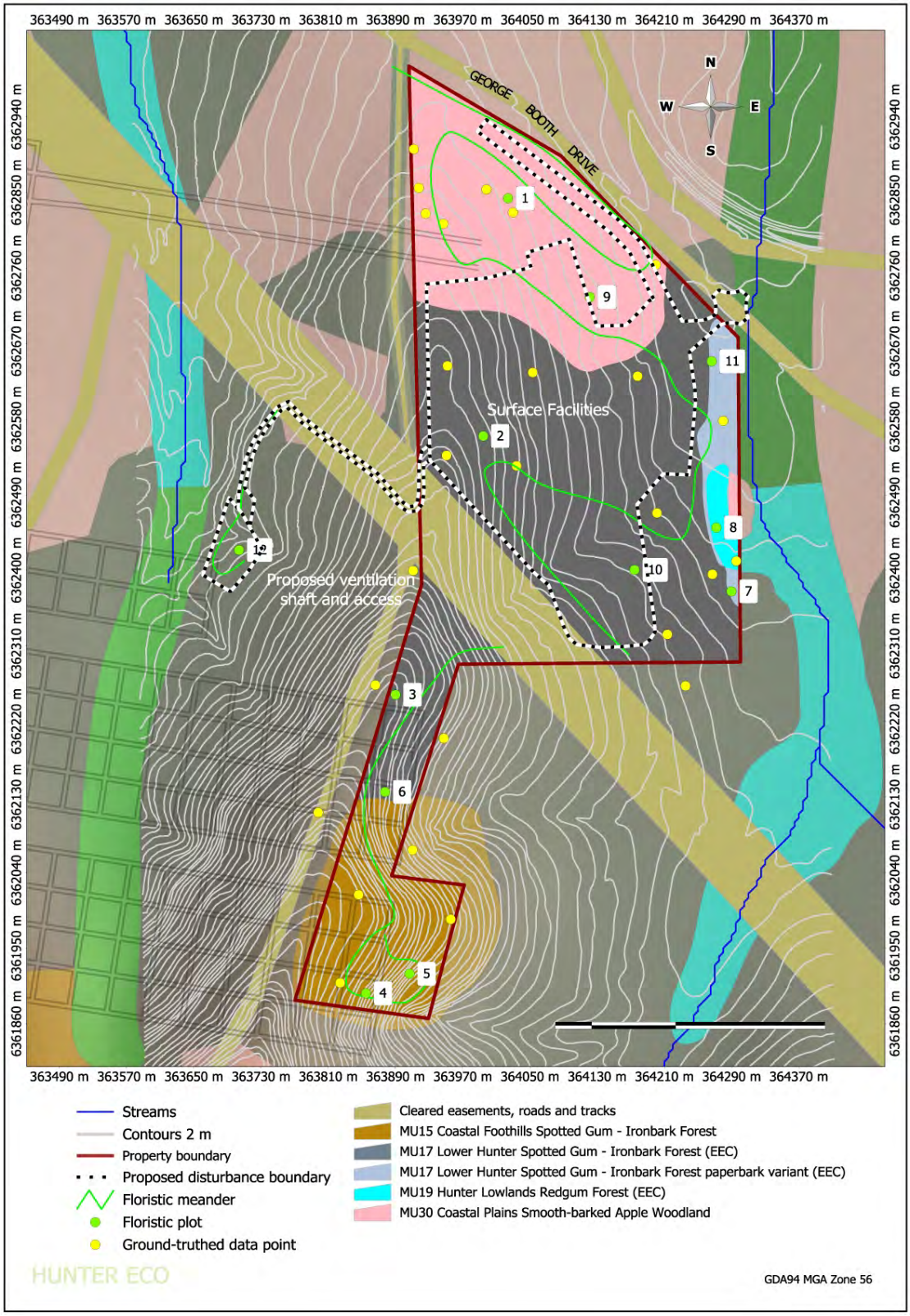

Figure 5 Vegetation communities mapped across and beyond the investigation area

Survey points, plots and transects also shown. The surrounding vegetation map is part of a wider 5 km x 6.5 km area that includes the extent of proposed underground workings.

5.2 Biometric data

The biometric vegetation system links local community classification with NSW state-wide broad groups (**Table 4**). Quantitative data are provided in the form of benchmark values for several diversity and structural parameters and these data have been compiled in **Table 5**.

Table 4 Vegetation types and classification

Biometric Veg Type	Keith Formation	Keith (2004) Class	NPWS (2000)
HU551 Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Grassy woodlands	Coastal Valley Grassy Woodlands	MU15 Coastal Foothills Spotted Gum - Ironbark Forest
HU629 Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin	Dry sclerophyll forests (shrub/grass sub-formation)	Hunter-Macleay Dry Sclerophyll Forests	MU17 Lower Hunter Spotted Gum - Ironbark Forest (EEC)
HU546 Forest Red Gum - Rough-barked Apple open forest on poorly drained lowlands of the Central Coast, Sydney Basin	Forested Wetlands	Coastal Floodplain Wetlands	MU19 Hunter Lowlands Redgum Forest (EEC)
HU622 Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Dry sclerophyll forests (shrubby sub-formation)	Sydney Coastal Dry Sclerophyll Forests	MU30 Coastal Plains Smooth-barked Apple Woodland

Table 5 Biometric data recorded at vegetation plot sites
Benchmark values for each parameter are in parentheses.

			% Cover						
Biometric type	**Plot**	**Native Species Richness**	**Canopy**	**Shrub**	**Grass**	**Other ground**	**Fallen logs (m)**	**% Regrowth**	**Habitat trees**
HU551	4	44 (41)	40 (15-40)	25 (5-10)	50 (30-40)	5 (20-40)	82 (5)	50	1 (3)
HU551	5	45 (41)	40 (15-40)	50 (5-10)	10 (30-40)	10 (20-40)	37 (5)	25	3 (3)
HU629	2	34 (38)	30 (15-40)	1 (3-15)	50 (30-60)	0 (10-25)	31 (10)	50	1 (1.2)
HU629	3	38 (38)	20 (15-40)	50 (3-15)	25 (30-60)	25 (10-25)	11 (10)	75	1 (1.2)
HU629	6	43 (38)	30 (15-40)	0 (3-15)	3 (30-60)	3 (10-25)	35 (10)	50	0 (1.2)
HU629	7	55 (38)	20 (15-40)	70 (3-15)	50 (30-60)	10 (10-25)	46 (10)	50	0 (1.2)
HU629	10	33 (38)	30 (15-40)	1 (3-15)	90 (30-60)	2 (10-25)	7 (10)	100	1 (1.2)
HU629	11	42 (38)	5 (15-40)	80 (3-15)	25 (30-60)	5 (10-25)	21 (10)	0	0 (1.2)
HU629	12	35 (38)	40 (15-40)	5 (3-15)	80 (30-60)	5 (10-25)	91 (10)	75	2 (1.2)
HU546	8	54 (15)	10 (15-65)	70 (1-5)	60 (0-90)	5 (2-90)	27 (10)	0	0 (0.8)
HU622	1	47 (35)	20 (18-45)	5 (5-30)	90 (1-30)	0 (3-30)	9 (70)	100	1 (3)
HU622	9	36 (35)	30 (18-45)	2 (5-30)	90 (1-30)	5 (3-30)	24 (70)	100	0 (3)

5.3 Threatened flora species

An evaluation of the species listed in **Table 3** above against their know habitat requirements resulted in an assessment of likelihood of occurrence in the Project area presented in **Table 6**. Habitat preference information was drawn from the following online resources:

- http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx
- http://plantnet.rbgsyd.nsw.gov.au/

Table 6 The likelihood of threatened species occurring within the investigation area (source Table 3)

Scientific Name	Distribution and habitat	Likelihood of occurring
Rutidosis heterogama	Recorded from Warnervale to Kurri and far northern NSW. Grows in heath, open forest and grasslands.	Recorded within and around the subject site.
Tetratheca juncea	Recorded from Wyong to Bulahdelah. Grows in heath, open woodland and coastal sands.	Recorded within and around the subject site.
Eucalyptus parramattensis subsp. *decadens*	In the local area this species is a characteristic species in the EEC *Kurri Sand Swamp Woodland in the Sydney Basin Bioregion*.	Unlikely as suitable habitat is not present.
Callistemon linearifolius	Recorded from Sydney to Nelson Bay. Grows in dry sclerophyll forest.	Suitable habitat present.
Eucalyptus glaucina	Recorded from Maitland to Casino. Grows on deep, well-watered soils.	A small amount of suitable habitat in the area where Forest Redgums are growing outside of the disturbance area.
Grevillea parviflora subsp. *parviflora*	Recorded from Sydney to Kurri. Grows in sandy or light clay soils in heath, woodland or forest.	Suitable habitat is present.

Two threatened flora species, *Rutidosis heterogama* (**Figure 6**) and *Tetratheca juncea* (**Figure 7**), were recorded within, and extending beyond, the proposed disturbance area (**Figure 8**).

Figure 6 *Rutidosis heterogama*

Figure 7 *Tetratheca juncea*

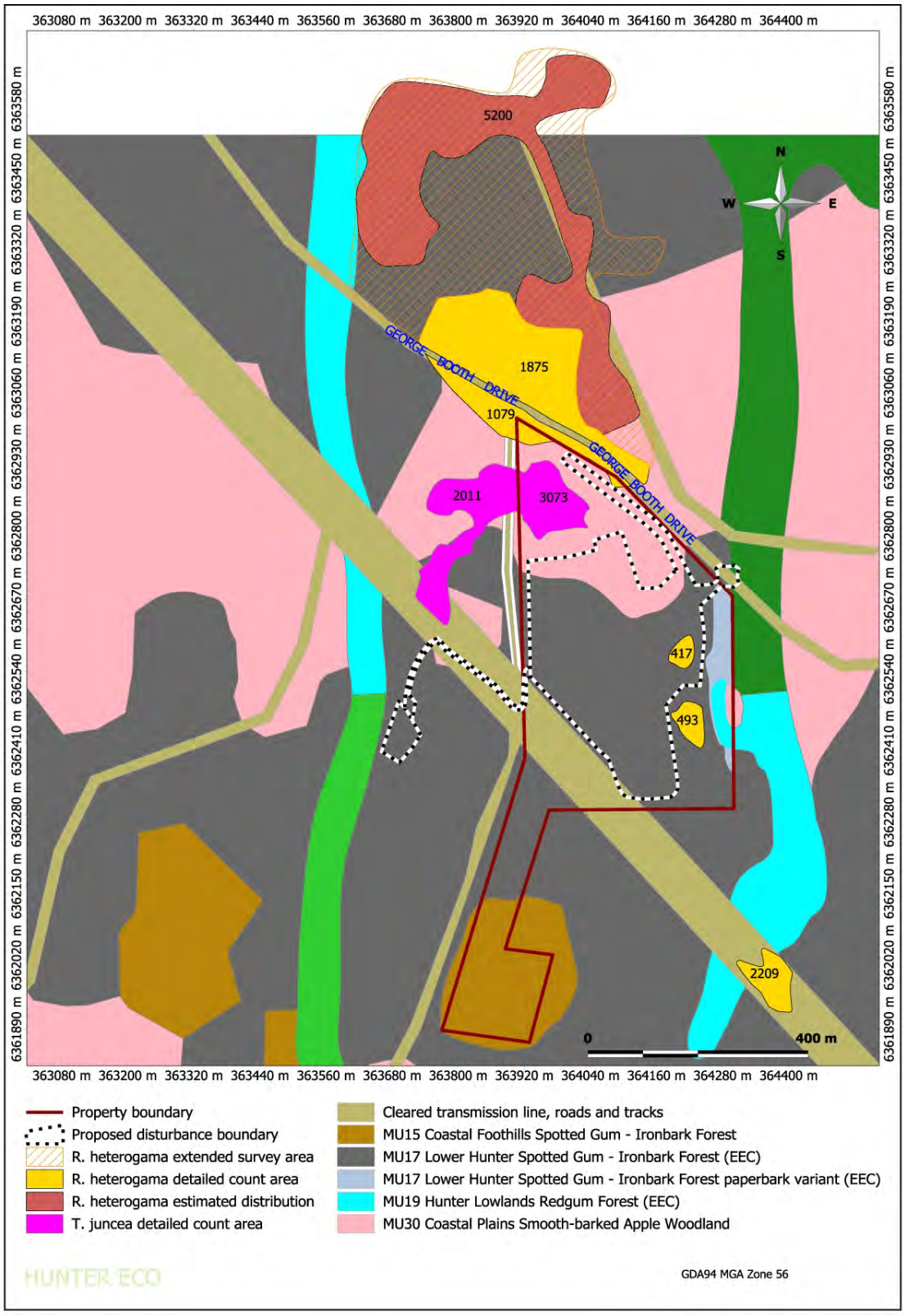

Figure 8 Area of occupation and number of individuals of threatened flora species
Total plants counted or estimated in each group are shown.

There were over 11,000 *Rutidosis heterogama* plants of which two groups of 417 and 493 were within the investigation area. The group of 417 plants was within the proposed disturbance area. Distribution of the species extended beyond the investigation area with 2209 plants to the south and more than 8000 to the north, extending across John Renshaw Drive.

The *Tetratheca juncea* population extended well beyond the investigation area and consisted of 5084 clumps, of which 3073 were within the investigation area and 2011 outside.

6 Impact assessment

Table 7 lists the direct impact resulting from total clearing of the surface facilities infrastructure area.

Table 7 Vegetation communities and threatened species lost

Community or species	Loss
MU17 Lower Hunter Spotted Gum – Ironbark Forest EEC	8.9 ha
MU 30 Coastal Foothills Smooth-barked Apple Woodland	2.3 ha
Rutidosis heterogama	417 individuals

Impact assessment for flora species and vegetation communities listed as threatened in the NSW TSC Act was prepared through the application of the 7-part test (**Appendix 1**). Appendix 6 also provides a letter from Hunter Eco assessing the potential impacts of the Project on *Rutidosis heterogama* for the EPBC Act Referral.

7 Mitigation Measures

Land clearance and management procedures will be conducted in accordance with the current *Tasman Flora and Fauna Management Plan* (Ecobiological 2007c). This plan includes measures for pre-clearing surveys and revegetation of disturbed areas that would not be in use following construction.

Measures specific to the subject site, and not included in Ecobiological (2007c), are protocols to protect the *Tetratheca juncea* and *Rutidosis heterogama* populations from damage. This should include fencing around buffer areas, specific induction of plant operators and any other relevant personnel, and regular inspection to ensure damage is being avoided.

8 Conclusion and Recommendations

The conclusion of the impact assessments (**Appendix 1**) was that there would be no significant impact on either the threatened species *Rutidosis heterogama* and *Tetratheca juncea* or the Lower Hunter Spotted Gum – Ironbark Forest EEC as a consequence of establishing the Project surface facilities.

The loss of habitat would not have an impact on threatened species that might be present under favourable circumstances, or at some time in the future. None of the habitat types to be cleared were unique to the site or within the immediate locality.

Rather than waste a biological resource and research opportunity, experimental translocation is recommended for the 417 *Rutidosis heterogama* individuals located in the disturbance area. These plants could easily be moved adjacent to the next nearest population just 70 m to the south. This experiment should include both translocation of as many of the plants as can readily be retrieved, and collection and planting of seed. A formal plan should be prepared for approval by the NSW Office of Environment and Heritage prior to any work commencing and, the principles in Vallee *et al.* (2004) should be applied.

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Appendix 1 Impact assessment, the 7-part test applied to threatened flora species

The subjects of this impact assessment are flora species that were either recorded within the subject site, or suitable habitat was considered as possibly present (**Table 4** of the main report), therefore species possibly occurring. As required by DECC (2007) the focus of the 7-part test is local, dealing with the immediate impact on species or communities that occur within, adjacent to, or continuous with the proposed disturbance area.

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,

Following careful searching, no *Callistemon linearifolius* were found in the subject site. No viable local population was present so would not be placed at risk of extinction.

(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,

No endangered population of this species has been listed.

(c) in the case of an 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

Not applicable

(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,

Not applicable

(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,

It is unknown whether the habitat to be removed would be suitable for the species. The fact that the species is not growing there could indicate either that the habitat is unsuitable or that the species has not yet dispersed there. Furthermore, a detailed vegetation map prepared for a 5 km x 6.5 km area that includes the extent of the proposed new underground workings revealed that there was 550 ha of MU15, 700 ha of MU17 and 980 ha of MU30 habitat connected to that within the subject site. The proposed action would not result in habitat loss, fragmentation or alteration that would impact on the long-term survival of the species.

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

No critical habitat was present.

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

No recovery plan has been prepared for this species.

The following actions are recommended for the recovery of this species:
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10129)

1. ***Search for the species in suitable habitat in areas that are proposed for development or management actions, protect any such site found.***
   The subject site was searched for this species and none were found.

2. ***Protect known habitat from clearing or disturbance.***
   No known habitat would be cleared or disturbed.

3. ***Determine response of species to fire and develop and promote a recommended fire regime.***
   Beyond the scope of this investigation.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key threatening processes relevant to the species under consideration involved would be:
The Clearing of Native Vegetation.

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,

Following careful searching, no *Grevillea parviflora* subsp. *parviflora* were found in the investigation area. No viable local population was present so would not be placed at risk of extinction.

(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,

No endangered population of this species has been listed.

(c) in the case of an 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

Not applicable

(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,

Not applicable

(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,

It is unknown whether the habitat to be removed would be suitable for the species. The fact that the species is not growing there could indicate either that the habitat is unsuitable or that the species has not yet dispersed there. Furthermore, a detailed vegetation map prepared for a 5 km x 6.5 km area that includes the extent of the proposed new underground workings revealed that there was 550 ha of MU15, 700 ha of MU17 and 980 ha of MU30 habitat connected to that within the subject site. The proposed action would not result in habitat loss, fragmentation or alteration that would impact on the long-term survival of the species.

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

No critical habitat was present.

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

No recovery plan has been prepared for this species.

The following actions are recommended for the recovery of this species:
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10373)

1. ***Ensure that personnel planning and undertaking road maintenance are able to identify the species and are aware of its habitat.***
   Not applicable to this project.

2. ***Reinstate an appropriate fire regime (either restrict fire or undertake ecological burns as required).***
   A bushfire management plan is to be prepared for the project.

3. ***Ensure that this species is considered in all planning matters on land that contains or may contain populations.***
   The investigation area was carefully searched for the species and none was found.

4. ***Mark and fence off sites during development/road maintenance activities.***
   The investigation area was carefully searched for the species and none was found.

5. ***Undertake weed control using methods that will not impact on populations of* G. parviflora *subsp.* parviflora *(avoid spraying in the vicinity of the plants and either hand pull weeds or cut and paint them).***
   The investigation area was carefully searched for the species and none was found.

6. ***Ensure these populations and this habitat are protected.***
   The investigation area was carefully searched for the species and none was found.

7. ***Mark known sites and potential habitat onto maps used for planning maintenance work.***
   The investigation area was carefully searched for the species and none was found.

8. ***Conduct searches in potential habitat for new populations .***
   The investigation area was carefully searched for the species and none was found.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key threatening processes relevant to the species under consideration involved would be:
The Clearing of Native Vegetation

Rutidosis heterogama

(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,

This assessment has been drawn from an assessment of the potential impact of the Project on this species undertaken as part of the EPBC Referral in November 2011, included in full as Appendix 6 of this report.

The area of occupation of *Rutidosis heterogama* was found to be 17.6 ha, made up of four groups (**Figure 8** of the main report). Two of these groups, containing 417 and 493 plants, were within the investigation area. The group containing 417 plants occurs within the infrastructure disturbance area and so would be lost as a result of the proposed action.

There is no published information on the biology of *Rutidosis heterogama*. However, studies of the biology and genetics of its also threatened congeners *Rutidosis leptorrhynchoides* and *Rutidosis leiolepis* (from southern NSW and Victoria) provide useful insights (Morgan 1995a, 1995b; Young *et al.* 1999; Young & Murray 2000; Young *et al*. 2000; Young *et al*. 2002). The pappus (structures at the top of Asteraceae seed to aid in wind dispersal) on *Rutidosis* seed is in the form of rudimentary scales and seed are dispersed within a short distance (0.5 m of the plant) and generally germinate within that area. Seed are only viable in soil for about four months. Clonality exists but varies with species and location so there is little evidence of clonality in *Rutidosis leptorrhynchoides* while *Rutidosis leiolepis* can be significantly clonal, particularly at higher elevations. It is unknown whether, or to what degree, *Rutidosis heterogama* is clonal.

Pollinators are native bees and other insects; during the field survey native bees, moths, flies and beetles were observed on flowers. *Rutidosis* are genetically self-incompatible. However it has been shown that in small populations (<200 individuals) self-incompatibility can break down with consequential inbreeding potentially leading to local extinction. Genetic studies have also shown the potential for locally adaptive genotypes in geographically separated populations. This being so, any group of *Rutidosis heterogama* plants existing in genetic isolation from any others would be an important population because of the potential uniqueness of its genotype.

With seed dispersal being limited to such short distances and having a short period of viability, genetic transfer between populations would be restricted to pollen transfer. Genetic isolation would occur at separation distances beyond which pollen would be transferred. This then raises a question as to the structure of the George Booth Drive population as mapped. It is conceivable that George Booth Drive itself has already had a significant fragmenting effect on the original population. It has been demonstrated, for example, that Bumble Bees will not under normal circumstances cross a road (Bhattacharya *et al.* 2003) and these are much larger insects than *Rutidosis* pollinators. However, the possibility exists that, at least on rare occasions, pollen is transferred across the road, thus maintaining genetic heterogeneity between the groups of *Rutidosis heterogama* on either side of George Booth Drive.

With the potential for genetic material to be exchanged between all of the mapped groups, however infrequently, they would all comprise the local population and given its size, it can be assumed to be viable. Loss of the 417 plants that occur within the infrastructure disturbance area would not place the remainder of the local population at risk of extinction.

(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,

No endangered population of this species has been listed.

(c) in the case of an 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

Not applicable

(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,

Not applicable

(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,

The amount of known habitat to be removed would be 0.2 ha. No habitat fragmentation or isolation would occur.

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

No critical habitat was present.

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

No recovery plan has been prepared for this species.

The following actions are recommended for the recovery of this species:
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10737)

1. ***Stay on formed tracks when visiting heath areas to avoid trampling plants.***
   The group of plants retained within the investigation area will be protected from disturbance.

2. ***Photograph wildflowers instead of picking or collecting them.***
   The group of plants retained within the investigation area will be protected from disturbance.

3. ***Protect areas of habitat from frequent fire.***
   A bushfire management plan will be prepared.

4. ***Identify roadside populations and protect during roadside maintenance works.***

No roadside populations occur within the investigation area.

5. ***Protect areas of heath and moist open forest from clearing and development.***

Clearing of habitat will be restricted to only that necessary for the project. All other areas of habitat will be protected.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key threatening processes relevant to the species under consideration involved would be:
The Clearing of Native Vegetation

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,

A substantial population was found to be present within, and continuing beyond, the bounds of the investigation area (**Figure 8** of the main report). The infrastructure disturbance area was designed to avoid any *Tetratheca juncea* through provision of a 20 m buffer between disturbance boundary and the area occupied by the plants. Consequently, a viable local population of the species would not be placed at risk of extinction.

(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,

No endangered population of this species has been listed.

(c) in the case of an 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

Not applicable

(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,

Not applicable

(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,

The proposed action would not result in any habitat modification, isolation or fragmentation.

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

No critical habitat was present.

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

No recovery plan has been prepared for this species.

The following actions are recommended for the recovery of this species:
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10799)

1. ***Reinstate an appropriate fire regime which protects the species from frequent fire.***

A bushfire management plan will be prepared.

2. ***Install stormwater control mechanisms to prevent off-site impacts from development upslope of populations.***

A stormwater management plan will be prepared.

3. ***Undertake weed control as required using removal methods that will not impact on the species (hand pull or cut and paint weeds).***

A weed management plan will be prepared.

4. ***Protect and actively manage large populations and those at the limit of the species range through conservation mechanisms such as covenanting and the preparation/implementation of site-specific vegetation management plans.***

A vegetation management plan will be prepared.

5. ***Improve vegetative connectivity within and between populations through revegetation/regeneration programs.***

Existing connectivity will not be modified.

6. ***Monitor population health and numbers for any changes (refer to counting method in the references).***

A *Tetratheca juncea* management and monitoring plan will be prepared.

7. ***Undertake targeted searches for the species in known or potential habitat during its flowering period prior to any clearing or development.***

A targeted search for the species was conducted resulting in the discovery of the species within and outside of the investigation area.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Key threatening processes relevant to the species under consideration involved would be:
The Clearing of Native Vegetation

Appendix 2 Impact assessment, the 7-part test applied to an Endangered Ecological Community

The subject of this impact assessment is EEC that was recorded within the subject site. As required by DECC (2007) the focus of the 7-part test is local, dealing with the immediate impact on communities that occur within, adjacent to, or continuous with the proposed disturbance area.

Lower Hunter Spotted Gum – Ironbark Forest

(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,

Not applicable to the consideration of an EEC.

(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,

Not applicable to the consideration of an EEC.

(c) in the case of an 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,

Clearing the infrastructure area would result in the loss of just under 9 ha of this EEC, which needs to be placed in context with the surrounding habitat. In addition to the subject site, a vegetation map has been prepared over a 5 km x 6.5 km area that includes both the subject site and the area of the proposed underground mine. This wider area map was prepared using the same methods described in Section 4.2 of the main report and showed that the 9 ha of EEC to be cleared was part of just over 700 ha of the community.

(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,

Just under 9 ha of this community would be cleared for the surface facilities and this area is at the eastern edge of over 700 ha of this community. Consequently, there would be no habitat fragmentation or isolation. The clearing would not have a negative impact on the long-term survival of this community in the locality.

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

No critical habitat was present.

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

No recovery plan has been prepared for this species.

The following actions are recommended for the recovery of this species:
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10942)

1. ***Promote public involvement in restoration activities.***
2. ***Ensure that the fire sensitivity of the community is considered when planning hazard reduction and asset management burning.***
3. ***Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.***
4. ***Promote regeneration by avoiding prolonged or heavy grazing.***
5. ***Fence remnants where necessary to protect from off-road vehicle use and rubbish dumping.***
6. ***Weed control.***
7. ***Undertake restoration including bush regeneration and revegetation.***

(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.

The key threatening process, *The Clearing of Native Vegetation*, would be in operation with 8.9 ha of MU17 Lower Hunter Spotted Gum – Ironbark Forest proposed to be cleared.

Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae is a key threatening process with the potential to impact on Myrtaceous species. These fungi are generically referred to as 'Myrtle Rust'. None was found during the field surveys for this assessment. Dispersal vectors for Myrtle Rust appear to include wind and direct physical transfer by humans or animals having had contact with infected plants. Management plans should include awareness of this threat and measures to minimise the risk of transfer from infected areas.

Appendix 3 Floristic Plot Data

CA = Cover Abundance (Table 2 above)

Plot 1

Scientific Name	Family Name	CA
Vittadinia cuneata	**Asteraceae**	1
Pandorea pandorana	**Bignoniaceae**	2
Allocasuarina littoralis	**Casuarinaceae**	2
Lepidosperma laterale	**Cyperaceae**	1
Ptilothrix deusta	**Cyperaceae**	2
Hibbertia aspera	**Dilleniaceae**	2
Hibbertia empetrifolia	**Dilleniaceae**	2
Lissanthe strigosa	**Epacridaceae**	1
Daviesia ulicifolia	**Fabaceae (Faboideae)**	1
Dillwynia retorta	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Podolobium aciculiferum	**Fabaceae (Faboideae)**	1
Pultenaea euchila	**Fabaceae (Faboideae)**	2
Acacia elongata	**Fabaceae (Mimosoideae)**	1
Acacia myrtifolia	**Fabaceae (Mimosoideae)**	1
Goodenia hederacea	**Goodeniaceae**	1
Goodenia heterophylla	**Goodeniaceae**	1
Gonocarpus teucrioides	**Haloragaceae**	2
Pratia purpurascens	**Lobeliaceae**	2
Logania pusilla	**Loganiaceae**	2
Lomandra confertifolia subsp. rubiginosa	**Lomandraceae**	1
Lomandra glauca	**Lomandraceae**	1
Lomandra multiflora	**Lomandraceae**	1
Lomandra obliqua	**Lomandraceae**	3
Angophora costata	**Myrtaceae**	4
Corymbia gummifera	**Myrtaceae**	4
Eucalyptus sparsifolia	**Myrtaceae**	3
Acianthus fornicatus	**Orchidaceae**	1
Pterostylis sp.	**Orchidaceae**	1
Dianella caerulea	**Phormiaceae**	1
Dianella longifolia	**Phormiaceae**	1
Bursaria spinosa	**Pittosporaceae**	1
Aristida vagans	**Poaceae**	2
Cymbopogon refractus	**Poaceae**	1
Dichelachne rara	**Poaceae**	1
Echinopogon caespitosus	**Poaceae**	2
Entolasia stricta	**Poaceae**	3

Scientific Name	Family Name	CA
Eragrostis brownii	**Poaceae**	1
Imperata cylindrica	**Poaceae**	3
Joycea pallida	**Poaceae**	3
Panicum simile	**Poaceae**	1
Tetratheca juncea	**Poaceae**	2
Themeda australis	**Poaceae**	2
Persoonia levis	**Proteaceae**	1
Xanthorrhoea latifolia	**Xanthorrhoeaceae**	1

Plot 2

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Alternanthera denticulata	**Amaranthaceae**	1
Vittadinia cuneata	**Asteraceae**	1
Lepidosperma laterale	**Cyperaceae**	1
Acrotriche divaricata	**Epacridaceae**	1
Lissanthe strigosa	**Epacridaceae**	1
Phyllanthus hirtellus	**Euphorbiaceae**	1
Dillwynia retorta	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Podolobium aciculiferum	**Fabaceae (Faboideae)**	1
Pultenaea villosa	**Fabaceae (Faboideae)**	1
Acacia elongata	**Fabaceae (Mimosoideae)**	1
Goodenia hederacea	**Goodeniaceae**	1
Lomandra confertifolia subsp. rubiginosa	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	3
Lomandra filiformis subsp. filiformis	**Lomandraceae**	1
Lomandra glauca	**Lomandraceae**	1
Lomandra multiflora	**Lomandraceae**	2
Geitonoplesium cymosum	**Luzuriagaceae**	1
Corymbia maculata	**Myrtaceae**	4
Eucalyptus fibrosa	**Myrtaceae**	3
Eucalyptus punctata	**Myrtaceae**	2
Eucalyptus umbra	**Myrtaceae**	1
Acianthus fornicatus	**Orchidaceae**	1
Billardiera scandens	**Pittosporaceae**	1
Bursaria spinosa	**Pittosporaceae**	1
Aristida vagans	**Poaceae**	2
Dichelachne rara	**Poaceae**	1
Entolasia stricta	**Poaceae**	3
Joycea pallida	**Poaceae**	4

Scientific Name	Family Name	CA
Microlaena stipoides	**Poaceae**	1
Panicum simile	**Poaceae**	1
Themeda australis	**Poaceae**	2

Plot 3

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	1
Alternanthera denticulata	**Amaranthaceae**	1
Vittadinia cuneata	**Asteraceae**	1
Pandorea pandorana	**Bignoniaceae**	1
Maytenus silvestris	**Celastraceae**	2
Lepidosperma laterale	**Cyperaceae**	2
Hibbertia obtusifolia	**Dilleniaceae**	1
Phyllanthus hirtellus	**Euphorbiaceae**	1
Daviesia ulicifolia	**Fabaceae (Faboideae)**	1
Desmodium rhytidophyllum	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Hovea linearis	**Fabaceae (Faboideae)**	1
Podolobium aciculiferum	**Fabaceae (Faboideae)**	1
Podolobium ilicifolium	**Fabaceae (Faboideae)**	1
Swainsona galegifolia	**Fabaceae (Faboideae)**	1
Acacia parvipinnula	**Fabaceae (Mimosoideae)**	1
Goodenia hederacea	**Goodeniaceae**	1
Lomandra confertifolia subsp. pallida	**Lomandraceae**	3
Lomandra cylindrica	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	2
Lomandra multiflora	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	1
Corymbia gummifera	**Myrtaceae**	1
Corymbia maculata	**Myrtaceae**	3
Eucalyptus fergusonii	**Myrtaceae**	1
Eucalyptus fibrosa	**Myrtaceae**	3
Eucalyptus punctata	**Myrtaceae**	2
Eucalyptus umbra	**Myrtaceae**	1
Syncarpia glomulifera	**Myrtaceae**	1
Dianella longifolia	**Phormiaceae**	2
Bursaria spinosa	**Pittosporaceae**	1
Entolasia stricta	**Poaceae**	3
Imperata cylindrica	**Poaceae**	1
Joycea pallida	**Poaceae**	3
Panicum simile	**Poaceae**	1
Themeda australis	**Poaceae**	1

Scientific Name	Family Name	CA
Persoonia linearis	**Proteaceae**	1
Macrozamia reducta	**Zamiaceae**	4

Plot 4

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Adiantum aethiopicum	**Adiantaceae**	2
Alternanthera denticulata	**Amaranthaceae**	1
Caesia parviflora	**Anthericaceae**	1
Polyscias sambucifolia	**Araliaceae**	1
Lagenifera stipitata	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Pandorea pandorana	**Bignoniaceae**	1
Allocasuarina torulosa	**Casuarinaceae**	1
Hibbertia empetrifolia	**Dilleniaceae**	1
Doryanthes excelsa	**Doryanthaceae**	2
Desmodium gunnii	**Fabaceae (Faboideae)**	2
Desmodium rhytidophyllum	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Podolobium ilicifolium	**Fabaceae (Faboideae)**	1
Lindsaea microphylla	**Lindsaeaceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	2
Corymbia maculata	**Myrtaceae**	4
Eucalyptus acmenoides	**Myrtaceae**	3
Eucalyptus fibrosa	**Myrtaceae**	1
Eucalyptus placita	**Myrtaceae**	1
Eucalyptus punctata	**Myrtaceae**	2
Eucalyptus siderophloia	**Myrtaceae**	1
Acianthus fornicatus	**Orchidaceae**	2
Pterostylis reflexa	**Orchidaceae**	1
Pterostylis sp.	**Orchidaceae**	2
Dianella caerulea	**Phormiaceae**	1
Dianella longifolia	**Phormiaceae**	1
Aristida vagans	**Poaceae**	2
Dichelachne rara	**Poaceae**	1
Entolasia stricta	**Poaceae**	2
Imperata cylindrica	**Poaceae**	1
Joycea pallida	**Poaceae**	2
Oplismenus imbecillis	**Poaceae**	1

Scientific Name	Family Name	CA
Panicum pygmaeum	**Poaceae**	1
Poa labillardierei var. labillardierei	**Poaceae**	2
Themeda australis	**Poaceae**	2
Galium propinquum	**Rubiaceae**	1
Smilax glyciphylla	**Smilacaceae**	1
Cayratia clematidea	**Vitaceae**	1
Macrozamia reducta	**Zamiaceae**	3

Plot 5

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Adiantum aethiopicum	**Adiantaceae**	2
Caesia parviflora	**Anthericaceae**	1
Platysace lanceolata	**Apiaceae**	2
Vittadinia cuneata	**Asteraceae**	1
Pandorea pandorana	**Bignoniaceae**	1
Allocasuarina torulosa	**Casuarinaceae**	1
Maytenus silvestris	**Celastraceae**	1
Davallia solida var. pyxidata	**Davalliaceae**	1
Hibbertia empetrifolia	**Dilleniaceae**	1
Hibbertia scandens	**Dilleniaceae**	1
Dioscorea transversa	**Dioscoreaceae**	1
Breynia oblongifolia	**Euphorbiaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Podolobium ilicifolium	**Fabaceae (Faboideae)**	1
Acacia maidenii	**Fabaceae (Mimosoideae)**	2
Lomandra confertifolia subsp. rubiginosa	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	2
Myrsine variabilis	**Myrsinaceae**	1
Corymbia maculata	**Myrtaceae**	4
Eucalyptus acmenoides	**Myrtaceae**	2
Eucalyptus fergusonii	**Myrtaceae**	1
Eucalyptus fibrosa	**Myrtaceae**	1
Eucalyptus placita	**Myrtaceae**	1
Eucalyptus punctata	**Myrtaceae**	2
Syncarpia glomulifera	**Myrtaceae**	1
Acianthus fornicatus	**Orchidaceae**	1
Pterostylis reflexa	**Orchidaceae**	1

Scientific Name	Family Name	CA
Pterostylis sp.	**Orchidaceae**	2
Dianella caerulea	**Phormiaceae**	2
Billardiera scandens	**Pittosporaceae**	1
Pittosporum revolutum	**Pittosporaceae**	1
Entolasia stricta	**Poaceae**	1
Imperata cylindrica	**Poaceae**	1
Joycea pallida	**Poaceae**	2
Oplismenus imbecillis	**Poaceae**	1
Poa labillardierei var. labillardierei	**Poaceae**	2
Platycerium superbum	**Polypodiaceae**	1
Persoonia linearis	**Proteaceae**	1
Galium binifolium	**Rubiaceae**	1
Macrozamia reducta	**Zamiaceae**	3

Plot 6

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Alternanthera denticulata	**Amaranthaceae**	1
Caesia parviflora	**Anthericaceae**	1
Lagenifera gracilis	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Pandorea pandorana	**Bignoniaceae**	2
Maytenus silvestris	**Celastraceae**	1
Lepidosperma laterale	**Cyperaceae**	1
Hibbertia empetrifolia	**Dilleniaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Pultenaea villosa	**Fabaceae (Faboideae)**	1
Goodenia hederacea	**Goodeniaceae**	1
Lomandra confertifolia subsp. rubiginosa	**Lomandraceae**	2
Lomandra cylindrica	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	2
Lomandra filiformis subsp. filiformis	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	1
Lomandra multiflora	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	2
Corymbia maculata	**Myrtaceae**	4
Eucalyptus acmenoides	**Myrtaceae**	1
Eucalyptus fergusonii	**Myrtaceae**	3
Eucalyptus fibrosa	**Myrtaceae**	1
Eucalyptus punctata	**Myrtaceae**	2

Scientific Name	Family Name	CA
Syncarpia glomulifera	**Myrtaceae**	1
Acianthus fornicatus	**Orchidaceae**	1
Dianella caerulea	**Phormiaceae**	2
Dianella longifolia	**Phormiaceae**	1
Billardiera scandens	**Pittosporaceae**	1
Bursaria spinosa	**Pittosporaceae**	1
Aristida vagans	**Poaceae**	1
Austrodanthonia tenuior	**Poaceae**	1
Entolasia stricta	**Poaceae**	1
Imperata cylindrica	**Poaceae**	2
Joycea pallida	**Poaceae**	1
Panicum pygmaeum	**Poaceae**	1
Panicum simile	**Poaceae**	1
Poa labillardierei var. labillardierei	**Poaceae**	1
Themeda australis	**Poaceae**	2
Persoonia linearis	**Proteaceae**	1
Macrozamia reducta	**Zamiaceae**	2

Plot 7

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	1
Alternanthera denticulata	**Amaranthaceae**	1
Caesia parviflora	**Anthericaceae**	1
Centella asiatica	**Apiaceae**	1
Hydrocotyle laxiflora	**Apiaceae**	1
Hydrocotyle tripartita	**Apiaceae**	1
**Senecio madagascariensis*	**Asteraceae**	1
Euchiton gymnocephalus	**Asteraceae**	1
Lagenifera gracilis	**Asteraceae**	1
Allocasuarina torulosa	**Casuarinaceae**	1
Casuarina glauca	**Casuarinaceae**	1
Maytenus silvestris	**Celastraceae**	1
Polymeria calycina	**Convolvulaceae**	2
Carex gaudichaudiana	**Cyperaceae**	1
Lepidosperma laterale	**Cyperaceae**	1
Leucopogon muticus	**Epacridaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Pultenaea villosa	**Fabaceae (Faboideae)**	1
Acacia falcata	**Fabaceae (Mimosoideae)**	1

Scientific Name	Family Name	CA
Acacia longifolia	**Fabaceae (Mimosoideae)**	1
Gonocarpus teucrioides	**Haloragaceae**	1
Pratia purpurascens	**Lobeliaceae**	2
Lomandra confertifolia subsp. pallida	**Lomandraceae**	1
Lomandra cylindrica	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	2
Lomandra multiflora	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	1
Angophora bakeri	**Myrtaceae**	1
Angophora floribunda	**Myrtaceae**	1
Callistemon salignus	**Myrtaceae**	2
Corymbia maculata	**Myrtaceae**	1
Eucalyptus fibrosa	**Myrtaceae**	1
Eucalyptus resinifera	**Myrtaceae**	1
Melaleuca decora	**Myrtaceae**	5
Melaleuca linariifolia	**Myrtaceae**	2
Melaleuca nodosa	**Myrtaceae**	2
Melaleuca styphelioides	**Myrtaceae**	3
Oxalis exilis	**Oxalidaceae**	1
Dianella caerulea	**Phormiaceae**	1
Bursaria spinosa	**Pittosporaceae**	1
Aristida vagans	**Poaceae**	1
Echinopogon ovatus	**Poaceae**	1
Entolasia stricta	**Poaceae**	1
Eragrostis brownii	**Poaceae**	1
Microlaena stipoides	**Poaceae**	2
Oplismenus aemulus	**Poaceae**	1
Oplismenus imbecillis	**Poaceae**	2
Panicum simile	**Poaceae**	1
Poa labillardierei var. labillardierei	**Poaceae**	1
Themeda australis	**Poaceae**	2
Ranunculus lappaceus	**Ranunculaceae**	1

Plot 8

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	1
Cheilanthes sieberi	**Adiantaceae**	1
Centella asiatica	**Apiaceae**	1
**Taraxacum officinale*	**Asteraceae**	1
Eclipta platyglossa	**Asteraceae**	1
Epaltes australis	**Asteraceae**	1
Euchiton gymnocephalus	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Dichondra repens	**Convolvulaceae**	1
Polymeria calycina	**Convolvulaceae**	2
Carex gaudichaudiana	**Cyperaceae**	2
Gahnia clarkei	**Cyperaceae**	1
Lepidosperma laterale	**Cyperaceae**	1
Glochidion ferdinandi	**Euphorbiaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Pultenaea retusa	**Fabaceae (Faboideae)**	1
Acacia falcata	**Fabaceae (Mimosoideae)**	1
Acacia longifolia	**Fabaceae (Mimosoideae)**	1
Acacia ulicifolia	**Fabaceae (Mimosoideae)**	1
Gonocarpus teucrioides	**Haloragaceae**	1
Juncus usitatus	**Juncaceae**	1
Pratia purpurascens	**Lobeliaceae**	2
Lomandra confertifolia subsp. pallida	**Lomandraceae**	1
Lomandra cylindrica	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	1
Angophora costata	**Myrtaceae**	1
Callistemon linearis	**Myrtaceae**	1
Callistemon salignus	**Myrtaceae**	3
Corymbia maculata	**Myrtaceae**	1
Eucalyptus tereticornis	**Myrtaceae**	3
Leptospermum polygalifolium	**Myrtaceae**	2
Melaleuca decora	**Myrtaceae**	3
Melaleuca linariifolia	**Myrtaceae**	3
Melaleuca styphelioides	**Myrtaceae**	3
Melaleuca thymifolia	**Myrtaceae**	2
Oxalis exilis	**Oxalidaceae**	1
Dianella caerulea	**Phormiaceae**	1
Dianella longifolia	**Phormiaceae**	1
Bursaria spinosa	**Pittosporaceae**	1

Scientific Name	Family Name	CA
**Plantago lanceolata*	**Plantaginaceae**	1
Aristida vagans	**Poaceae**	1
Cymbopogon refractus	**Poaceae**	3
Echinopogon caespitosus	**Poaceae**	1
Entolasia stricta	**Poaceae**	1
Eragrostis brownii	**Poaceae**	1
Eragrostis leptostachya	**Poaceae**	1
Imperata cylindrica	**Poaceae**	2
Oplismenus imbecillis	**Poaceae**	1
Paspalidium distans	**Poaceae**	1
Poa labillardierei var. labillardierei	**Poaceae**	1
Themeda australis	**Poaceae**	2
Ranunculus lappaceus	**Ranunculaceae**	1
Exocarpos cupressiformis	**Santalaceae**	1
Dodonaea triquetra	**Sapindaceae**	1
Veronica sp.	**Scrophulariaceae**	1

Plot 9

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Polyscias sambucifolia	**Araliaceae**	1
Lagenifera gracilis	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Allocasuarina littoralis	**Casuarinaceae**	3
Lepidosperma laterale	**Cyperaceae**	1
Hibbertia aspera	**Dilleniaceae**	1
Leucopogon juniperinus	**Epacridaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Desmodium rhytidophyllum	**Fabaceae (Faboideae)**	1
Dillwynia retorta	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Pultenaea retusa	**Fabaceae (Faboideae)**	1
Pultenaea villosa	**Fabaceae (Faboideae)**	1
Acacia myrtifolia	**Fabaceae (Mimosoideae)**	1
Acacia ulicifolia	**Fabaceae (Mimosoideae)**	1
Goodenia hederacea	**Goodeniaceae**	1
Goodenia heterophylla	**Goodeniaceae**	1
Gonocarpus teucrioides	**Haloragaceae**	1
Lomandra multiflora	**Lomandraceae**	1
Lomandra obliqua	**Lomandraceae**	2

Scientific Name	Family Name	CA
Geitonoplesium cymosum	**Luzuriagaceae**	2
Angophora costata	**Myrtaceae**	3
Corymbia gummifera	**Myrtaceae**	3
Eucalyptus fibrosa	**Myrtaceae**	1
Eucalyptus resinifera	**Myrtaceae**	3
Melaleuca styphelioides	**Myrtaceae**	1
Aristida vagans	**Poaceae**	2
Entolasia stricta	**Poaceae**	4
Joycea pallida	**Poaceae**	4
Panicum simile	**Poaceae**	2
Themeda australis	**Poaceae**	3
Persoonia linearis	**Proteaceae**	1
Xanthorrhoea latifolia	**Xanthorrhoeaceae**	1

Plot 10

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Alternanthera denticulata	**Amaranthaceae**	1
Lagenifera gracilis	**Asteraceae**	1
Ozothamnus diosmifolius	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Lepidosperma laterale	**Cyperaceae**	2
Ptilothrix deusta	**Cyperaceae**	3
Lissanthe strigosa	**Epacridaceae**	1
Phyllanthus hirtellus	**Euphorbiaceae**	1
Desmodium gunnii	**Fabaceae (Faboideae)**	1
Dillwynia retorta	**Fabaceae (Faboideae)**	2
Glycine clandestina	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Pultenaea euchila	**Fabaceae (Faboideae)**	1
Pultenaea villosa	**Fabaceae (Faboideae)**	1
Goodenia heterophylla	**Goodeniaceae**	2
Gonocarpus teucrioides	**Haloragaceae**	2
Pratia purpurascens	**Lobeliaceae**	1
Lomandra cylindrica	**Lomandraceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Lomandra glauca	**Lomandraceae**	1
Lomandra multiflora	**Lomandraceae**	1
Lomandra obliqua	**Lomandraceae**	2
Geitonoplesium cymosum	**Luzuriagaceae**	2
Corymbia maculata	**Myrtaceae**	4
Eucalyptus fibrosa	**Myrtaceae**	4

Scientific Name	Family Name	CA
Dianella caerulea	**Phormiaceae**	1
Dianella longifolia	**Phormiaceae**	1
Bursaria spinosa	**Pittosporaceae**	3
Aristida vagans	**Poaceae**	2
Joycea pallida	**Poaceae**	4
Panicum simile	**Poaceae**	1
Themeda australis	**Poaceae**	4

Plot 11

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	2
Cheilanthes sieberi	**Adiantaceae**	1
Alternanthera denticulata	**Amaranthaceae**	1
Centella asiatica	**Apiaceae**	2
Epaltes australis	**Asteraceae**	1
Euchiton gymnocephalus	**Asteraceae**	1
Lagenifera gracilis	**Asteraceae**	1
Vittadinia cuneata	**Asteraceae**	1
Dichondra repens	**Convolvulaceae**	1
Polymeria calycina	**Convolvulaceae**	1
Carex gaudichaudiana	**Cyperaceae**	1
Hibbertia empetrifolia	**Dilleniaceae**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Hardenbergia violacea	**Fabaceae (Faboideae)**	1
Acacia longifolia	**Fabaceae (Mimosoideae)**	1
Gonocarpus teucrioides	**Haloragaceae**	1
Juncus usitatus	**Juncaceae**	1
Pratia purpurascens	**Lobeliaceae**	1
Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Lomandra longifolia	**Lomandraceae**	2
Lomandra multiflora	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	1
Eucalyptus fibrosa	**Myrtaceae**	3
Eucalyptus saligna	**Myrtaceae**	1
Melaleuca decora	**Myrtaceae**	2
Melaleuca linariifolia	**Myrtaceae**	1
Melaleuca nodosa	**Myrtaceae**	4
Melaleuca styphelioides	**Myrtaceae**	4
Acianthus fornicatus	**Orchidaceae**	1
Pterostylis sp.	**Orchidaceae**	1
Oxalis exilis	**Oxalidaceae**	1
Dianella caerulea	**Phormiaceae**	1

Scientific Name	Family Name	CA
Dianella longifolia	**Phormiaceae**	1
Bursaria spinosa	**Pittosporaceae**	1
**Setaria sphacelata*	**Poaceae**	1
**Sporobolus africanus*	**Poaceae**	1
Digitaria breviglumis	**Poaceae**	1
Echinopogon ovatus	**Poaceae**	1
Entolasia stricta	**Poaceae**	1
Eragrostis brownii	**Poaceae**	1
Imperata cylindrica var. major	**Poaceae**	2
Panicum simile	**Poaceae**	1

Plot 12

Scientific Name	Family Name	CA
Pseuderanthemum variabile	**Acanthaceae**	1
Lepidosperma laterale	**Cyperaceae**	1
Phyllanthus hirtellus	**Euphorbiaceae**	1
Pratia purpurascens	**Lobeliaceae**	1
Persoonia linearis	**Proteaceae**	1
Macrozamia reducta	**Zamiaceae**	1
Alternanthera denticulata	**Amaranthaceae**	1
Dillwynia retorta	**Fabaceae (Faboideae)**	1
Glycine clandestina	**Fabaceae (Faboideae)**	1
Glycine microphylla	**Fabaceae (Faboideae)**	1
Acacia elongata	**Fabaceae (Mimosoideae)**	1
Acacia linifolia	**Fabaceae (Mimosoideae)**	1
Lomandra confertifolia subsp. rubiginosa	**Lomandraceae**	1
Lomandra obliqua	**Lomandraceae**	1
Geitonoplesium cymosum	**Luzuriagaceae**	1
Dianella caerulea	**Phormiaceae**	1
Dianella longifolia	**Phormiaceae**	1
Cymbopogon refractus	**Poaceae**	1
Panicum simile	**Poaceae**	1
Paspalidium distans	**Poaceae**	1
Gonocarpus teucrioides	**Haloragaceae**	2
Lissanthe strigosa	**Epacridaceae**	2
Podolobium aciculiferum	**Fabaceae (Faboideae)**	2
Pultenaea villosa	**Fabaceae (Faboideae)**	2
Lomandra filiformis subsp. coriacea	**Lomandraceae**	2
Lomandra multiflora subsp. multiflora	**Lomandraceae**	2
Bursaria spinosa	**Pittosporaceae**	2
Aristida vagans	**Poaceae**	2
Eucalyptus punctata	**Myrtaceae**	3

Scientific Name	Family Name	CA
Eucalyptus acmenoides	**Myrtaceae**	3
Entolasia stricta	**Poaceae**	3
Joycea pallida	**Poaceae**	3
Themeda australis	**Poaceae**	4
Corymbia maculata	**Myrtaceae**	4
Eucalyptus fibrosa	**Myrtaceae**	4

Appendix 4 Combined Floristic List

Family Name	Scientific Name
Acanthaceae	*Pseuderanthemum variabile*
Adiantaceae	*Adiantum aethiopicum*
Adiantaceae	*Cheilanthes sieberi*
Amaranthaceae	*Alternanthera denticulata*
Anthericaceae	*Caesia parviflora*
Apiaceae	*Platysace lanceolata*
Apiaceae	*Centella asiatica*
Apiaceae	*Hydrocotyle laxiflora*
Apiaceae	*Hydrocotyle tripartita*
Araliaceae	*Polyscias sambucifolia*
Asteraceae	*Vittadinia cuneata*
Asteraceae	*Lagenifera stipitata*
Asteraceae	*Lagenifera gracilis*
Asteraceae	**Senecio madagascariensis*
Asteraceae	*Euchiton gymnocephalus*
Asteraceae	**Taraxacum officinale*
Asteraceae	*Eclipta platyglossa*
Asteraceae	*Epaltes australis*
Asteraceae	*Ozothamnus diosmifolius*
Bignoniaceae	*Pandorea pandorana*
Casuarinaceae	*Allocasuarina littoralis*
Casuarinaceae	*Allocasuarina torulosa*
Casuarinaceae	*Casuarina glauca*
Celastraceae	*Maytenus silvestris*
Convolvulaceae	*Polymeria calycina*
Convolvulaceae	*Dichondra repens*
Cyperaceae	*Lepidosperma laterale*
Cyperaceae	*Ptilothrix deusta*
Cyperaceae	*Carex gaudichaudiana*
Cyperaceae	*Gahnia clarkei*
Davalliaceae	*Davallia solida* var. *pyxidata*
Dilleniaceae	*Hibbertia aspera*
Dilleniaceae	*Hibbertia empetrifolia*
Dilleniaceae	*Hibbertia obtusifolia*
Dilleniaceae	*Hibbertia scandens*
Dioscoreaceae	*Dioscorea transversa*
Doryanthaceae	*Doryanthes excelsa*
Epacridaceae	*Lissanthe strigosa*
Epacridaceae	*Acrotriche divaricata*
Epacridaceae	*Leucopogon muticus*

Family Name	Scientific Name
Epacridaceae	*Leucopogon juniperinus*
Euphorbiaceae	*Phyllanthus hirtellus*
Euphorbiaceae	*Breynia oblongifolia*
Euphorbiaceae	*Glochidion ferdinandi*
Fabaceae (Faboideae)	*Daviesia ulicifolia*
Fabaceae (Faboideae)	*Dillwynia retorta*
Fabaceae (Faboideae)	*Glycine clandestina*
Fabaceae (Faboideae)	*Glycine microphylla*
Fabaceae (Faboideae)	*Hardenbergia violacea*
Fabaceae (Faboideae)	*Podolobium aciculiferum*
Fabaceae (Faboideae)	*Pultenaea euchila*
Fabaceae (Faboideae)	*Pultenaea villosa*
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*
Fabaceae (Faboideae)	*Hovea linearis*
Fabaceae (Faboideae)	*Podolobium ilicifolium*
Fabaceae (Faboideae)	*Swainsona galegifolia*
Fabaceae (Faboideae)	*Desmodium gunnii*
Fabaceae (Faboideae)	*Pultenaea retusa*
Fabaceae (Mimosoideae)	*Acacia elongata*
Fabaceae (Mimosoideae)	*Acacia myrtifolia*
Fabaceae (Mimosoideae)	*Acacia parvipinnula*
Fabaceae (Mimosoideae)	*Acacia maidenii*
Fabaceae (Mimosoideae)	*Acacia falcata*
Fabaceae (Mimosoideae)	*Acacia longifolia*
Fabaceae (Mimosoideae)	*Acacia ulicifolia*
Goodeniaceae	*Goodenia hederacea*
Goodeniaceae	*Goodenia heterophylla*
Haloragaceae	*Gonocarpus teucrioides*
Juncaceae	*Juncus usitatus*
Lindsaeaceae	*Lindsaea microphylla*
Lobeliaceae	*Pratia purpurascens*
Loganiaceae	*Logania pusilla*
Lomandraceae	*Lomandra confertifolia* subsp. *rubiginosa*
Lomandraceae	*Lomandra glauca*
Lomandraceae	*Lomandra multiflora*
Lomandraceae	*Lomandra obliqua*
Lomandraceae	*Lomandra filiformis* subsp. *coriacea*
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*
Lomandraceae	*Lomandra confertifolia* subsp. *pallida*
Lomandraceae	*Lomandra cylindrica*
Lomandraceae	*Lomandra longifolia*
Luzuriagaceae	*Geitonoplesium cymosum*

Family Name	Scientific Name
Myrsinaceae	*Myrsine variabilis*
Myrtaceae	*Angophora costata*
Myrtaceae	*Corymbia gummifera*
Myrtaceae	*Eucalyptus sparsifolia*
Myrtaceae	*Corymbia maculata*
Myrtaceae	*Eucalyptus fibrosa*
Myrtaceae	*Eucalyptus punctata*
Myrtaceae	*Eucalyptus umbra*
Myrtaceae	*Eucalyptus fergusonii*
Myrtaceae	*Syncarpia glomulifera*
Myrtaceae	*Eucalyptus acmenoides*
Myrtaceae	*Eucalyptus placita*
Myrtaceae	*Eucalyptus siderophloia*
Myrtaceae	*Angophora bakeri*
Myrtaceae	*Angophora floribunda*
Myrtaceae	*Callistemon salignus*
Myrtaceae	*Eucalyptus resinifera*
Myrtaceae	*Melaleuca decora*
Myrtaceae	*Melaleuca linariifolia*
Myrtaceae	*Melaleuca nodosa*
Myrtaceae	*Melaleuca styphelioides*
Myrtaceae	*Callistemon linearis*
Myrtaceae	*Eucalyptus tereticornis*
Myrtaceae	*Leptospermum polygalifolium*
Myrtaceae	*Melaleuca thymifolia*
Myrtaceae	*Eucalyptus saligna*
Orchidaceae	*Acianthus fornicatus*
Orchidaceae	*Pterostylis* sp.
Orchidaceae	*Pterostylis reflexa*
Oxalidaceae	*Oxalis exilis*
Phormiaceae	*Dianella caerulea*
Phormiaceae	*Dianella longifolia*
Pittosporaceae	*Bursaria spinosa*
Pittosporaceae	*Billardiera scandens*
Pittosporaceae	*Pittosporum revolutum*
Plantaginaceae	**Plantago lanceolata*
Poaceae	*Aristida vagans*
Poaceae	*Cymbopogon refractus*
Poaceae	*Dichelachne rara*
Poaceae	*Echinopogon caespitosus*
Poaceae	*Entolasia stricta*
Poaceae	*Eragrostis brownii*

Family Name	Scientific Name
Poaceae	*Imperata cylindrica*
Poaceae	*Joycea pallida*
Poaceae	*Panicum simile*
Poaceae	*Tetratheca juncea*
Poaceae	*Themeda australis*
Poaceae	*Microlaena stipoides*
Poaceae	*Oplismenus imbecillis*
Poaceae	*Panicum pygmaeum*
Poaceae	*Poa labillardierei* var. *labillardierei*
Poaceae	*Austrodanthonia tenuior*
Poaceae	*Echinopogon ovatus*
Poaceae	*Oplismenus aemulus*
Poaceae	*Eragrostis leptostachya*
Poaceae	*Paspalidium distans*
Poaceae	**Setaria sphacelata*
Poaceae	**Sporobolus africanus*
Poaceae	*Digitaria breviglumis*
Poaceae	*Imperata cylindrica* var. *major*
Polypodiaceae	*Platycerium superbum*
Proteaceae	*Persoonia levis*
Proteaceae	*Persoonia linearis*
Ranunculaceae	*Ranunculus lappaceus*
Rubiaceae	*Galium propinquum*
Rubiaceae	*Galium binifolium*
Santalaceae	*Exocarpos cupressiformis*
Sapindaceae	*Dodonaea triquetra*
Scrophulariaceae	*Veronica* sp.
Smilacaceae	*Smilax glyciphylla*
Vitaceae	*Cayratia clematidea*
Xanthorrhoeaceae	*Xanthorrhoea latifolia*
Zamiaceae	*Macrozamia reducta*

Appendix 5 Vegetation Community Profiles

Descriptions follow, of the characteristics of the mapped vegetation communities. As noted in Section 4.2 of the main report, the community classification used was that of NPWS (2000).

MAP UNIT	MU15	
MAP NAME	Coastal Foothills Spotted Gum – Ironbark Forest	
CONSERVATION STATUS	Not listed as threatened	
AREAS		
Disturbance Area	**Investigation Area**	**Locality**
None	3.2 ha	550 ha

DESCRIPTION	
Canopy	*Corymbia maculata, Eucalyptus fergusonii, Eucalyptus acmenoides, Eucalyptus umbra* and *Eucalyptus punctata*
Shrubs	*Macrozamia reducta, Acacia parvipinnula, Doryanthes excelsa,* and *Podolobium ilicifolium*
Ground	*Themeda australis, Entolasia stricta* and *Joycea pallida*
Significant Species	None recorded

MAP UNIT	MU17	
MAP NAME	Lower Hunter Spotted Gum – Ironbark Forest	
CONSERVATION STATUS	EEC, Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	
AREAS		
Disturbance Area	**Investigation Area**	**Locality**
8.9 ha	13.3 ha	724 ha

DESCRIPTION	
Canopy	*Eucalyptus fibrosa, Corymbia maculata, Eucalyptus punctata, Eucalyptus umbra, Eucalyptus sparsifolia,* with scattered *Eucalyptus placita* and *Eucalyptus fergusonii*
Shrubs	*Podolobium ilicifolium, Pultenaea euchila, Bursaria spinosa, Acacia ulicifolia* and *Acacia elongata*
Ground	*Joycea pallida, Themeda australis* and *Entolasia stricta*
Significant Species	*Rutidosis heterogama*

MAP UNIT	MU17(p)	
MAP NAME	Lower Hunter Spotted Gum – Ironbark Forest	
CONSERVATION STATUS	EEC, Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	
AREAS		
Disturbance Area	**Investigation Area**	**Locality**
None	0.8 ha	0.8 ha

DESCRIPTION	
Canopy	Scattered *Eucalyptus fibrosa* over a dense mixture of paperbarks containing *Melaleuca linariifolia, Melaleuca styphelioides, Melaleuca nodosa, Melaleuca decora* and *Callistemon salignus* as well as a few *Casuarina glauca*
Shrubs	Sparse: *Bursaria spinosa, Acacia longifolia, Hibbertia empetrifolia*
Ground	Sparse: *Imperata cylindrica, Lomandra multiflora, Entolasia stricta, Cheilanthes sieberi*
Significant Species	None recorded

MAP UNIT	MU19	
MAP NAME	Hunter Lowland Redgum Forest	
CONSERVATION STATUS	EEC, Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	
AREAS		
Disturbance Area	**Investigation Area**	**Locality**
None	0.3 ha	113 ha

DESCRIPTION	
Canopy	Emergent *Eucalyptus tereticornis, Corymbia maculata, Eucalyptus resinifera* with a dense midstorey of *Melaleuca linariifolia, Melaleuca styphelioides, Melaleuca decora, Callistemon salignus*
Shrubs	Sparse: *Acacia longifolia, Acacia falcata, Acacia ulicifolia, Melaleuca thymifolia, Bursaria spinosa, Leptospermum polygalifolia*
Ground	Sparse: *Aristida vagans, Imperata cylindrica, Entolasia stricta, Centella asiatica, Cymbopogon refractus, Polymeria calycina*
Significant Species	None recorded

MAP UNIT	MU30	
MAP NAME	Coastal Plains Smooth-barked Apple Woodland	
CONSERVATION STATUS	Not listed as threatened	
AREAS		
Disturbance Area	**Investigation Area**	**Locality**
2.3 ha	6.6 ha	978 ha

DESCRIPTION	
Canopy	*Corymbia gummifera, Angophora costata, Eucalyptus sparsifolia, Eucalyptus umbra*
Shrubs	*Pultenaea euchila, Acacia ulicifolia, Acacia myrtifolia, Dillwynia retorta, Persoonia levis*
Ground	*Entolasia stricta*, *Themeda australis, Aristida vagans, Lomandra obliqua, Xanthorrhoea latifolia, Dianella caerulea*
Significant Species	*Tetratheca juncea*

Appendix 6 Hunter Eco letter assessing impact on *Rutidosis heterogama* included in the EPBC Referral

Gloucester Coal
Donaldson Mine
PO Box 2275 Greenhills
NSW 2323

Attn. Tony Sutherland

28 November 2011

Dear Tony

Proposed extension to Tasman Mine, new pittop area.

Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) threatened flora species impact assessment – *Rutidosis heterogama*.

During field flora surveys of the proposed pittop area a number of *Rutidosis heterogama* plants were recorded. Identification was confirmed to this researcher by the NSW Herbarium and specimens from the site are lodged there. The species is listed as vulnerable in the EPBC Act and this impact assessment has been prepared following the EPBC Act significant impact criteria for a vulnerable species.

The concept of an 'important population' is central to this assessment and is described in the *Environment Protection and Biodiversity Conservation Act 1999* Matters of National Environmental Significance Significant Impact Guidelines 1.1 as:

...a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal;*
- *populations that are necessary for maintaining genetic diversity; and/or*
- *populations that are near the limit of the species range.*

To determine whether the George Booth Drive population of *Rutidosis heterogama* qualifies as an *important population* its biology and wider distribution should be considered.

The species was thought to be extinct until rediscovered in the late 1980's (Benson 1991). Since then, in the Sydney Basin Bioregion alone, the species has been recorded in large numbers from Warnervale, Mandalong, Howes Valley, Kurri Kurri and coastal grasslands from Wybung in the south to Newcastle; it is also found in northern NSW. The George Booth Drive population is not near the limits of the species range.

There is no published information on the biology of *Rutidosis heterogama.* However, studies of the biology and genetics of its also threatened congeners *Rutidosis leptorrhynchoides* and *Rutidosis leiolepis* (from southern NSW and Victoria) provide useful insights (Morgan 1995a, 1995b; Young et al. 1999; Young & Murray 2000; Young et al. 2000; Young et al. 2002). The pappus (structures at the top of Asteraceae seed to aid in wind dispersal) on Rutidosis seed is in the form of rudimentary scales and seed are dispersed within a short distance (0.5 m of the plant) and generally germinate within that area. Seed are only viable in soil for about four months. Clonality exists but varies with species and location so there is little evidence of clonality in *Rutidosis leptorrhynchoides* while *Rutidosis leiolepis* can be significantly clonal, particularly at higher elevations. It is unknown whether, or to what degree, *Rutidosis heterogama* is clonal.

Pollinators are native bees and other insects; during the field survey native bees, moths, flies and beetles were observed on flowers. *Rutidosis* are genetically self-incompatible. However it has been shown that in small populations (<200 individuals) self-incompatibility can break down with consequential inbreeding potentially leading to local extinction. Genetic studies have also shown the potential for locally adaptive genotypes in geographically separated populations. This being so, any group of *Rutidosis heterogama* plants existing in genetic isolation from any others would be an important population because of the potential uniqueness of its genotype.

With seed dispersal being limited to such short distances and having a short period of viability, genetic transfer between populations would be restricted to pollen transfer. Genetic isolation would occur at separation distances beyond which pollen would be transferred. This then raises a question as to the structure of the George Booth Drive population as mapped. It is conceivable that George Booth Drive itself has already had a significant fragmenting effect on the original population. It has been demonstrated, for example, that Bumble Bees will not under normal circumstances cross a road (Bhattacharya *et al.* 2003) and these are much larger insects than *Rutidosis* pollinators. However, the possibility exists that, at least on rare occasions, pollen is transferred across the road, thus maintaining genetic heterogeneity between the groups of *Rutidosis heterogama* on either side of George Booth Drive.

Considering the foregoing, when assessing the impact of the Action, a conservative approach would be to consider there being two separate *Rutidosis heterogama* populations, north and south of George Booth Drive. Since the Action would have no impact on the northern population the potential for impact on the southern population is assessed.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of an important population of a species;**

The current southern population totals 4198 subdivided into four groups. The Action would result in the loss of one group of 417 plants or about 10% of this population. Against that loss, a large portion of the remainder of the population will be conserved in perpetuity which should facilitate an increase in numbers. It is unlikely that the Action will result in a long-term decrease in the size of this population.

- **reduce the area of occupancy of an important population;**

The total area of occupancy, being the area in which the species occurs, of the southern population is 2.5 ha of which 0.2 ha or 8% would be lost. However there is adequate habitat available into which the remainder of the population could expand. It is therefore unlikely that the loss of 0.2 ha will effectively reduce the area of occupancy.

- **fragment an existing important population into two or more populations;**

It is probable that the Action, through the construction of a main access from George Booth Drive, will result in fragmentation of the southern population into one component bordering George Booth Drive and two south of the disturbance area.

- **adversely affect habitat critical to the survival of a species;**

This concerns the species as a whole and the Action would not adversely affect habitat critical to its survival, the species is far too widespread.

- **disrupt the breeding cycle of an important population;**

The breeding cycle of the remainder of the southern population would not be disrupted by the proposed Action. Each separate component of this population would remain in its current habitat.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;**

Again this concerns the species as a whole and the Action would not alter the habitat of the remaining southern population in any way that would result in the species declining.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;**

The Action would not result in invasive species becoming established in the southern population habitat.

- **introduce disease that may cause the species to decline; or**

The Action would not result in any disease being introduced that may cause the species to decline.

- **interfere substantially with the recovery of the species.**

The Action would result in the loss of 417 individuals. The remaining 700 individuals within Donaldson Coal land (i.e. 493 individuals to the south and 207 individuals in the north) would not be cleared as a result of the Action and would be conserved when the land is transferred to the NSW Office of Environment and Heritage following completion of the Action. The area has recently been subject to habitat modification and loss as a consequence of four wheel drive and motor bike activity and firewood collection. Following the recent transfer of this land to Donaldson Coal, these activities are now restricted enhancing the prospects of the groups of plants expanding in number.

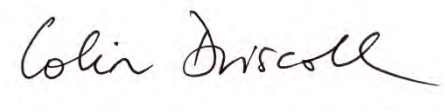
Furthermore, the southern group of 2209 individuals will be conserved in perpetuity by the RTA as part of the compensatory offset package for the Hunter Expressway and the individuals within the George Booth Drive Road reserve are afforded some level of protection.

Conclusion

The loss of 417 *Rutidosis heterogama* plants, 10% of an important population, would not result in the long-term decline of the population or threaten the species as a whole. Habitat conservation and restoration measures associated with the Action should assist with the recovery of the species in the local area.

This assessment has been conducted from the most conservative position that George Booth Drive forms an effective barrier to pollen transfer from the southern to the northern group of plants. As described above, the possibility exists that, at least on rare occasions, pollen is transferred across the road, thus maintaining genetic heterogeneity throughout the entire approximately 11,000 plants. In the circumstance that the groups of *Rutidosis heterogama* on either side of George Booth Drive are a connected population, the potential impacts of the Action would be less than those described above.

Yours Faithfully
HUNTER ECO



Colin Driscoll
Environmental Biologist
NSW OEH Scientific Licence S10565

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Appendix 7 Personnel

Task	Person	Experience
Entire project	Colin Driscoll BSc	>30 years flora and fauna surveys in the Hunter and Central Coast

TERRESTRIAL FLORA ASSESSMENT MINING AREA

Tasman Extension Project

Environmental Impact Statement

APPENDIX F

Resource Strategies

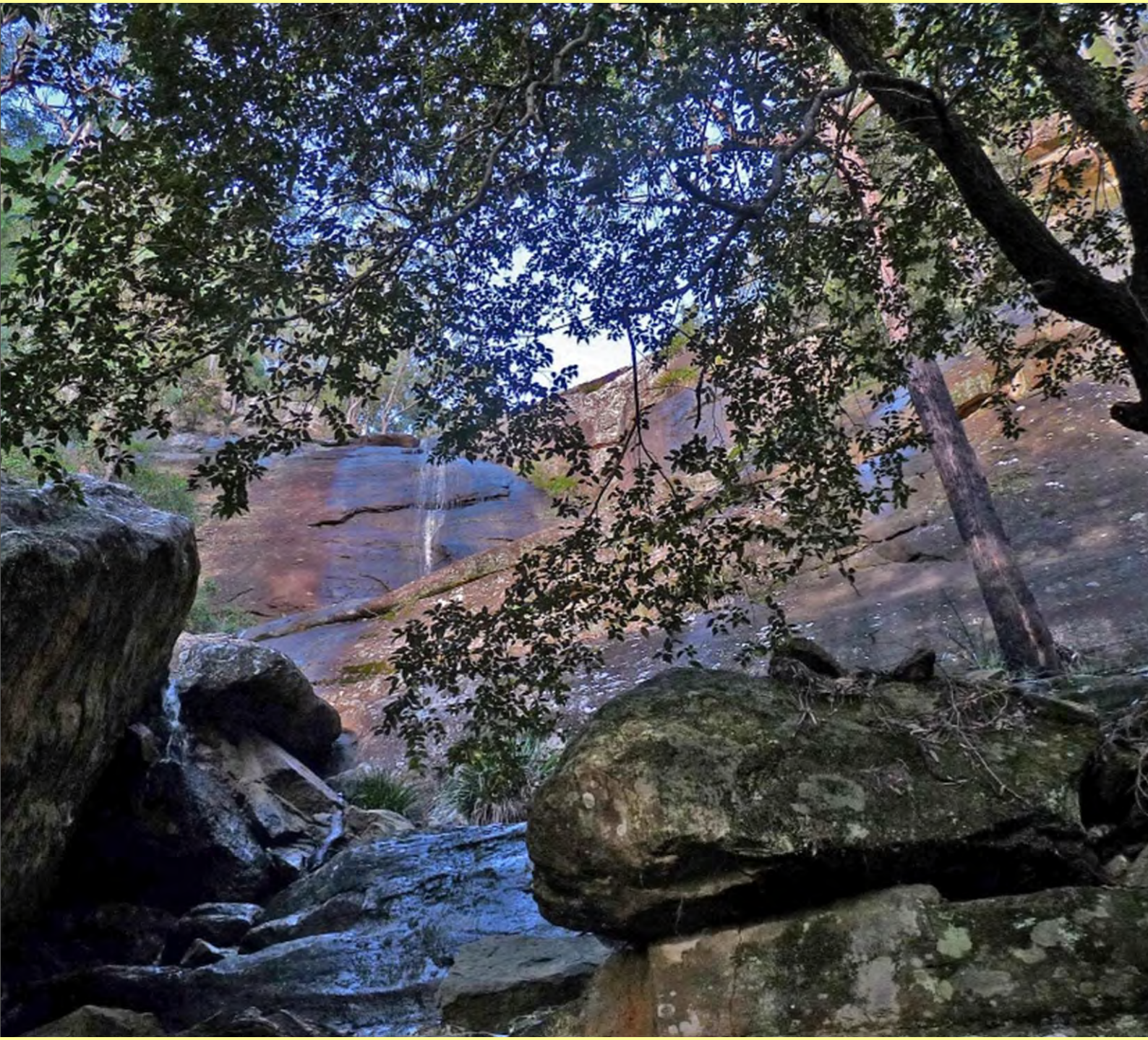
DONALDSON COAL

Part of Gloucester Coal

Tasman Underground Mine – Tasman Extension Project
Mining Area
Vegetation Ecology and Impact Assessment

A report for Donaldson Coal

Colin Driscoll



HUNTER ECO · ABN 25 112 984 240
PO Box 1047, Toronto, NSW 2283

EXECUTIVE SUMMARY

The Tasman Extension Project (the Project) would involve the extension of underground mining operations at the existing Tasman Underground Mine for an additional operational life of 15 years. Coal would be extracted from the West Borehole Seam using bord and pillar partial extraction methods in combination with some full extraction.

Vegetation communities were mapped across an investigation area that included the surface over the proposed new mine. Floristic data were also collected. Species listed as threatened in the schedules of the New South Wales (NSW) *Threatened Species Conservation Act 1995* were a particular target of the investigation. Following formal application, a delegate of the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities declared the Project was "Not a Controlled Action". Therefore the Project does not require assessment and approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.

The vegetation across the investigation area was found to be in as good condition as could be expected having had a history of timber harvesting and with considerable Lantana incursion.

One threatened flora species, *Tetratheca juncea*, was recorded within the bounds of the underground mine. Four endangered communities (EEC) were also recorded: Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions (HLRF); Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (LHSGIF); River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (RFEF); and Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (LRF). Three of these communities were determined to be groundwater dependent ecosystems (GDE).

The mine plan included subsidence control zones that were established in order to protect sensitive communities (EEC and GDE), and potentially unstable topography, from the effects of significant subsidence.

Application of the NSW TSC Act 7-part test concluded that the Project would have no significant impact on threatened flora or endangered communities.

Cover: Escarpment along RF Gully 5

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Tasman Underground Mine – Tasman Extension Project

Mining Area

Vegetation Ecology and Impact Assessment

1 The Project

Donaldson Coal Pty Limited (Donaldson Coal), owns and operates the Tasman Underground Mine. Donaldson Coal is a wholly owned subsidiary of Gloucester Coal Ltd (GCL).

The Tasman Extension Project (the Project) would involve the extension of underground mining operations at the existing Tasman Underground Mine for an additional operational life of 15 years.

The Project is located approximately 20 kilometres (km) west of the Port of Newcastle in New South Wales (NSW) within the Newcastle Coalfield (**Figure 1**). The Project is located approximately 6 km south-southeast from the town of Kurri Kurri within the Cessnock and Lake Macquarie Local Government Areas (LGAs) (**Figure 1**).

The majority of the Project area comprises land reserved as the Sugarloaf State Conservation Area (SCA) and Heaton State Forest (**Figures 1 and 2**). Crown land and privately-owned land occurs within the western and northern portions of the area of the Project.

The main activities associated with the development of the Project would include:

- continued underground mining of the Fassifern Seam using a combination of total and partial pillar extraction methods within Mining Lease (ML) 1555;
- underground mining of the West Borehole Seam using a combination of total and partial pillar extraction methods;
- production of run of mine (ROM) coal up to 1.5 million tonnes per annum;
- development of a new pit top facility, associated ROM coal handling infrastructure and intersection with George Booth Drive (**Figure 2**);
- development of ventilation surface infrastructure;
- continued transport of Fassifern Seam ROM coal from the existing Tasman Underground Mine pit top to the Bloomfield Coal Handling and Preparation Plant (CHPP) via truck on public and private roads to approximately 2015 (inclusive);
- transport of West Borehole Seam ROM coal from the new pit top to the Bloomfield CHPP via truck on public and private roads;
- progressive development of sumps, pumps, pipelines, water storages and other water management equipment and structures;

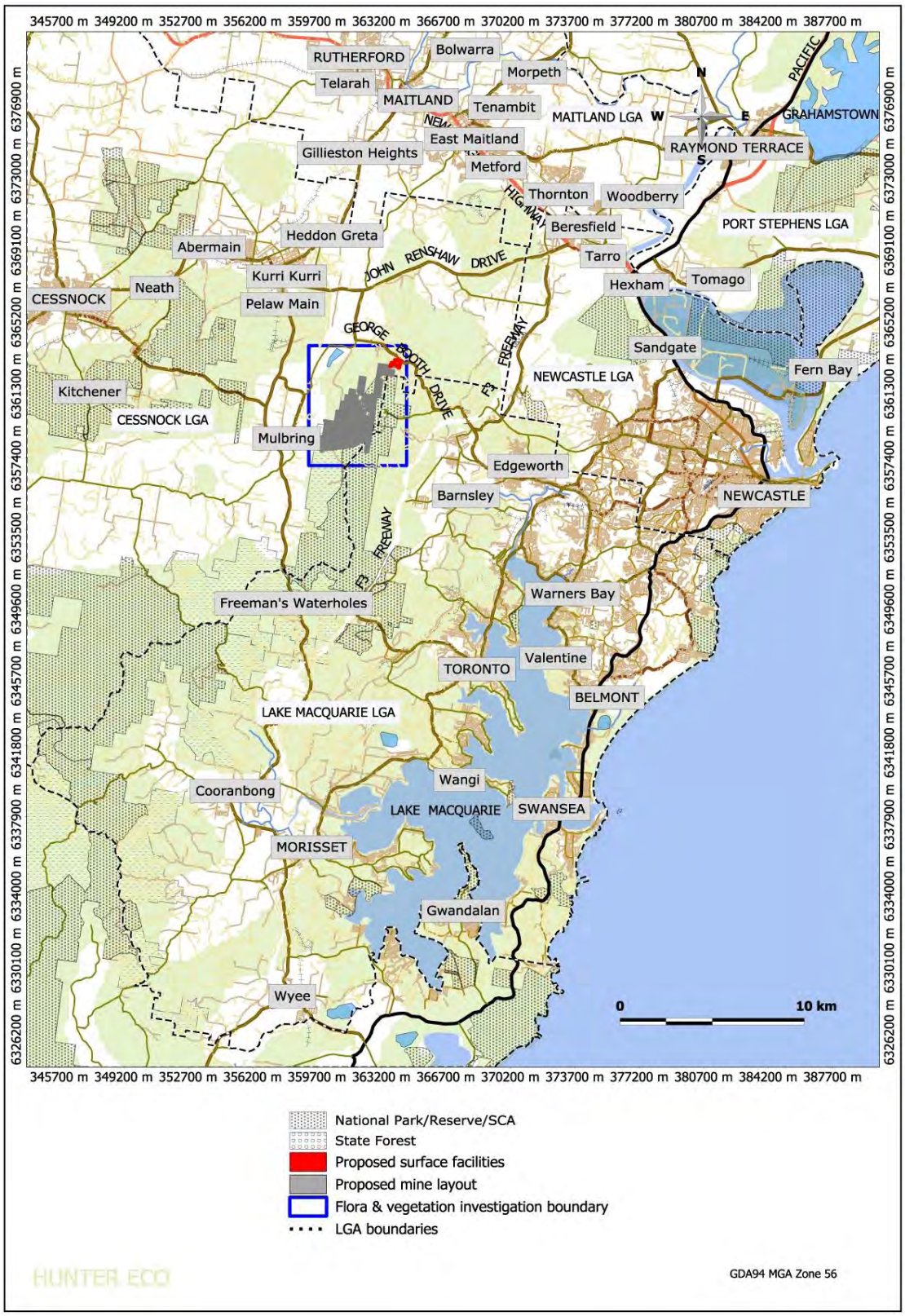

Figure 1 The mining and investigation areas in a regional context

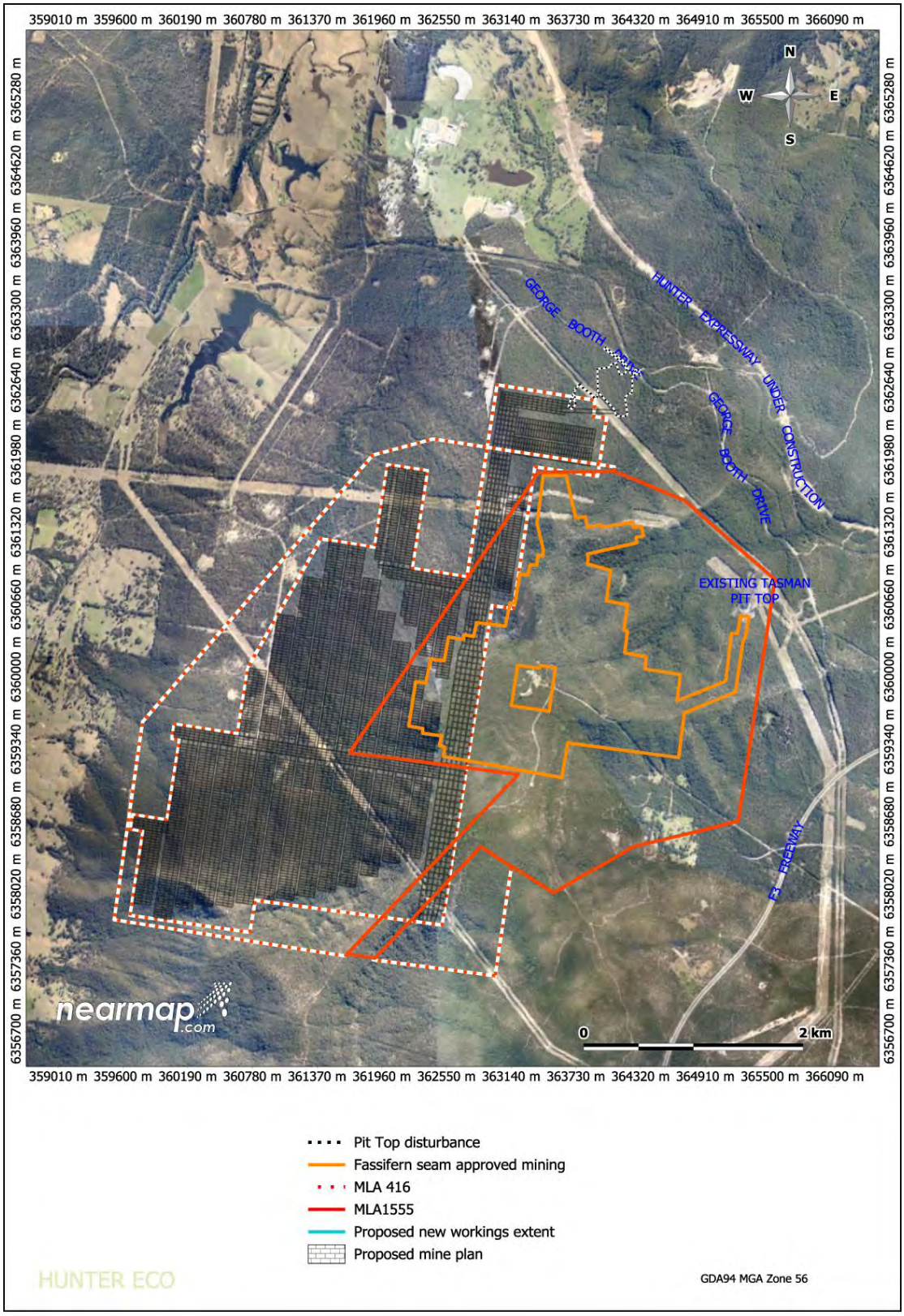

Figure 2 The general arrangement of the Project

- ongoing exploration activities;
- ongoing surface monitoring, rehabilitation and remediation of subsidence effects; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the Project is shown on **Figure 2**, including extents of underground mining in the West Borehole Seam and the extent of surface disturbance within the pit top boundary.

The Project would involve mining of the West Borehole Seam using bord and pillar mining methods with secondary extraction. Bord and pillar mining is an underground mining method which involves the extraction of coal using 'first workings' from a network of underground roadways (known as 'panels'), leaving behind pillars of coal to support the roof of the mine. Secondary extraction from the remaining pillars of coal would be conducted using a combination of partial and total extraction. Partial extraction involves the removal of coal either in the form of partial removal of remaining coal pillars or the removal of alternate pillars. Total pillar extraction is an extension of partial extraction whereby as much coal as can safely and economically be mined is removed from each panel.

The Project is a proposed extension of underground mining operations at the Tasman Underground Mine for an additional operational life of approximately 15 years.

Extraction of coal by bord and pillar mining methods results in the vertical and horizontal movement of the land surface. The land surface movements are generally referred to as subsidence effects. The type and magnitude of subsidence effects is dependent on a range of variables which include the mine geometry and topography, the layout of unmined pillars, the number of seams mined, the coal recovery from each seam, the nature of the superincumbent strata and other geological factors.

A combination of total and partial pillar extraction methods maximise the efficiency and recovery of the coal resource while allowing for adjustment of extraction to manage subsidence impacts. The bord and pillar mining method facilitates minimisation and management of potential subsidence impacts on significant surface features. The indicative underground mining area within the West Borehole Seam is shown on **Figure 2**.

The West Borehole seam is the basal coal unit of the Newcastle Coal Measures and is located approximately 175 metres (m) below the Fassifern Seam currently mined at the approved Tasman Underground Mine. The depth of the West Borehole Seam below the surface ranges from approximately 50 m to over 400 m.

The existing Tasman Underground Mine was declared "Not a Controlled Action" on 9 May 2002 (2001/253).

The Project was referred to the Commonwealth Department of Sustainability, Environment, Water Population and Community (SEWPaC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 5 December 2011.

On 10 January 2012, a delegate of the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities declared the Project was "Not a Controlled Action" (2011/6211). Therefore the Project does not require assessment and approval under the EPBC Act.

2 Locality and Environment

The Project is located at the northern edge of the Wyong sub-region in the Sydney Basin Bioregion; at the northern edge of the Wyong sub-region of the Hunter – Central Rivers Catchment Management Authority (CMA); and at the southern end of the North Coast Botanical Division.

Data interpolated from regional historical records indicates that rainfall in the Project area is 900-1000 millimetres (mm) per year (Driscoll unpub.).

The land under which mining is proposed varies in elevation from just less than 50 m to 370 m AHD. It is bordered on the east, south and west by the main Sugarloaf range and ridges, with the land falling into a wide central valley through which the majority of the catchment flows (**Figure 3**), ultimately into Wallis Creek, some 14 km downstream, and finally into the Hunter River. Slope varies from flat to very steep (**Figure 4**) and includes bands of exposed, often precipitous, sandstone escarpment.

Overall, geology across the underground mining area consists of the Sydney Basin Newcastle Sequence. The main Sugarloaf range and ridges are Triassic age, Narrabeen Group, sedimentary sandstone, shale and tuff. The remainder of the area is Permian age, Singleton Supergroup, Newcastle Coal Measures and Adamstown, Moon Island Beach or Boolaroo subgroups. Adamstown and Moon Island Beach are conglomerate and Boolaroo is sedimentary (NSW Department of Mineral Resources [DMR] 1999).

Soil is Beresfield residual, Awaba associated and Killingworth erosional landscapes on the side slopes and lower areas. These are acidic soils of low fertility and generally highly erodible. Sugarloaf colluvial landscape comprising shallow soils with rocky outcrops occurs on the upper rugged escarpments and ridgetops (Matthie 1995).

The majority of the land over the proposed mining area is well vegetated and, as will be shown later in this report, includes open heath, dry sclerophyll forest, wet sclerophyll forest and mesic rainforest.

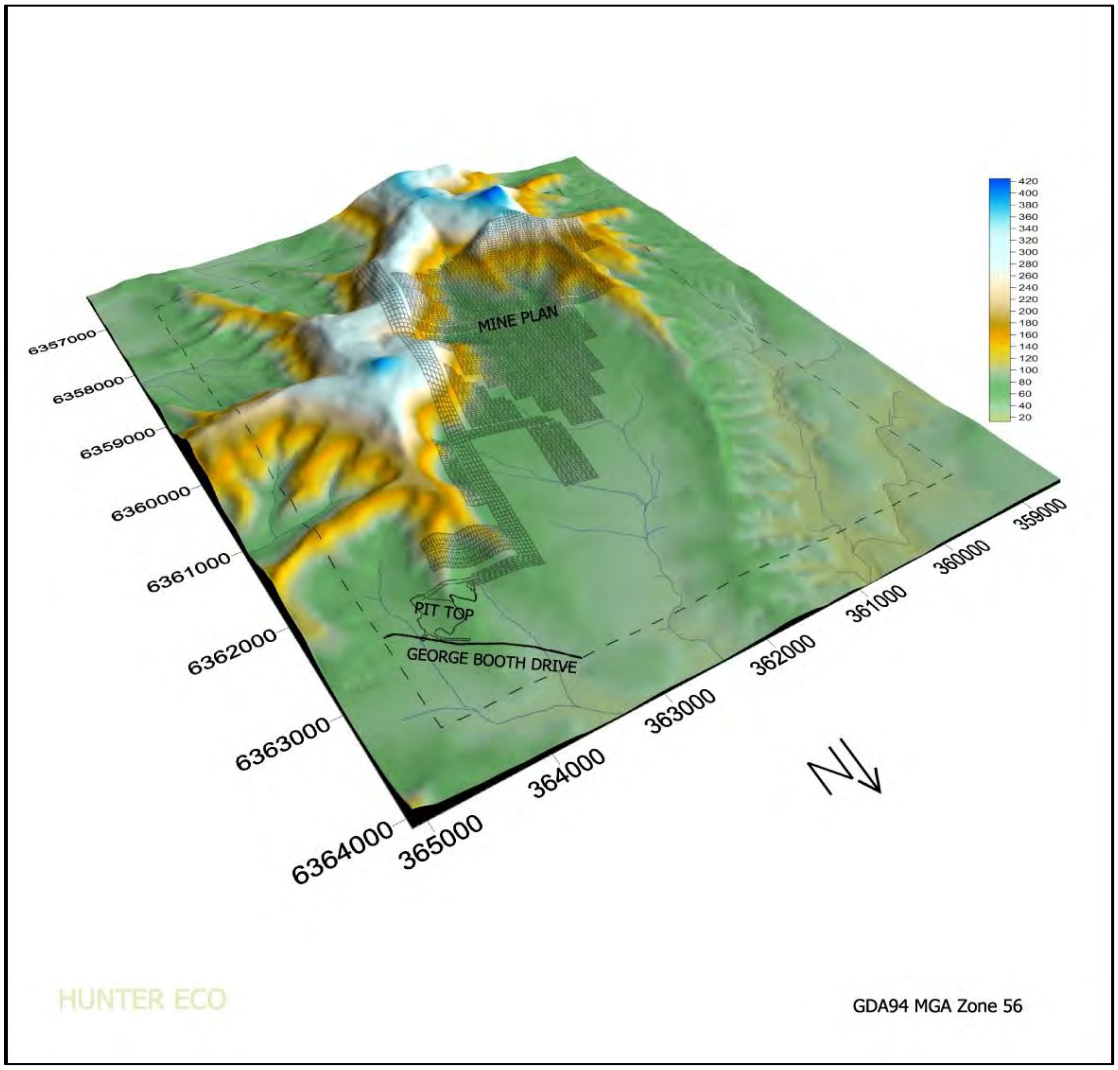

Figure 3 Topography, flora and vegetation investigation boundary, mine plan and main streamlines

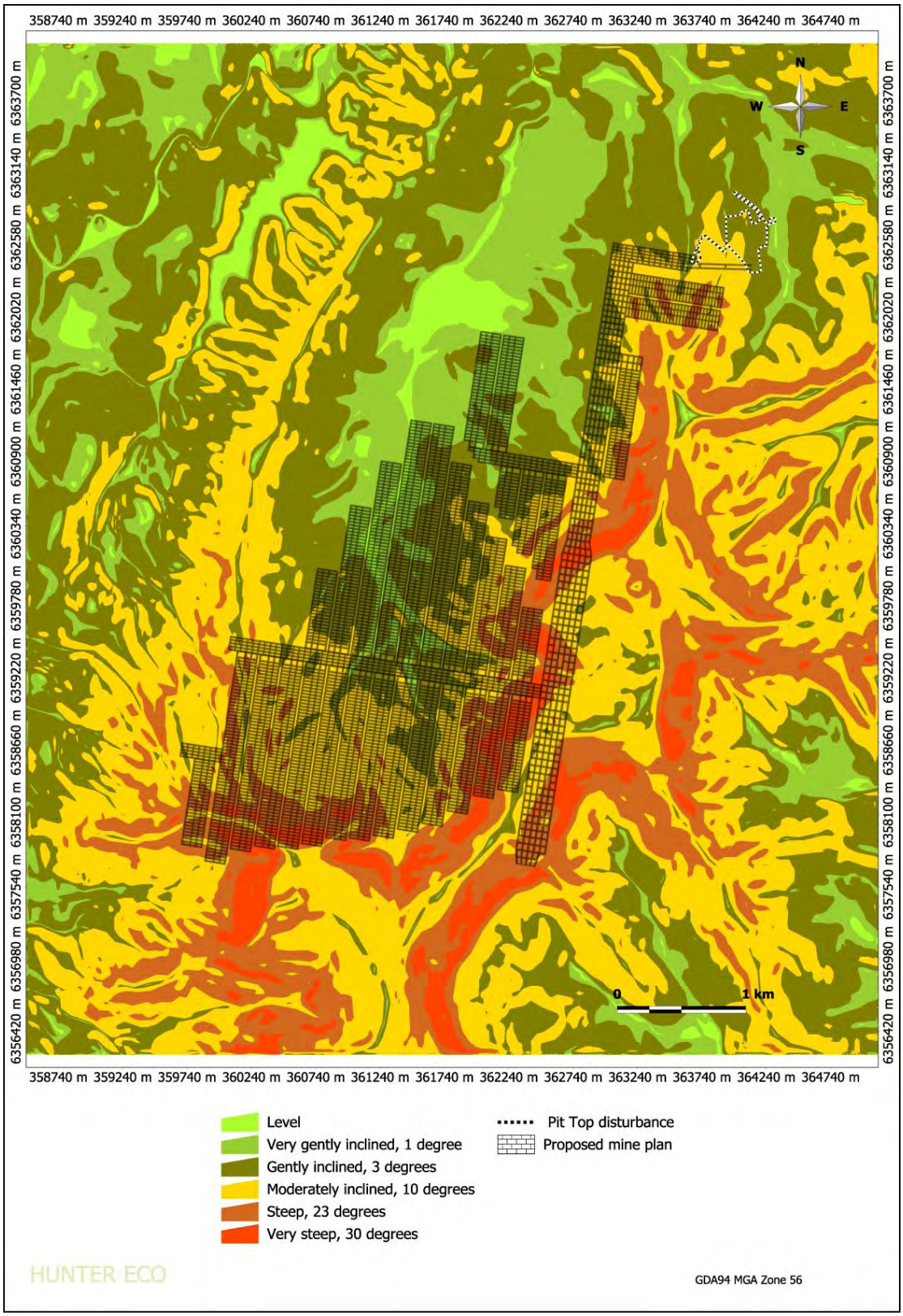

Figure 4 Slope across the mining area and surrounds

Slope classes are from McDonald *et al.* (1998) with mean slopes shown for each class.

3 Previous Studies

A broad regional vegetation classification and mapping report (NSW National Parks and Wildlife Service [NPWS] 2000) included the current Project area. The vegetation community classification from this study has become the reference classification for most subsequent local vegetation studies. Mapping in NPWS (2000) was modelled and determined to be suitable for broad scale assessment at a scale of 1:25,000 (Nicholls *et al.* 2002).

Bell and Driscoll (2009) mapped the vegetation of Sugarloaf SCA, the northern end of which was within the Project flora and vegetation investigation area (**Figures 1 and 3**). Raw field data from Bell and Driscoll (2009) was included in the data used to generate the final vegetation map for the Project.

Other studies of areas adjacent to, but not including, the Project flora and vegetation investigation area have been Gunninah Environmental Consultants (2002) assessing flora and fauna for the existing Tasman Underground Mine and Ecobiological (2005, 2006a, 2006b, 2007a, 2007b, 2008a, 2008b, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b) annual monitoring of the Tasman Underground Mine surface disturbance, compensatory habitat areas, and reporting on the ecological values of two parcels for a land swap for establishing the proposed new surface facilities for the Project.

4 Survey Aims and Methods

This survey was directed at determining the vegetative habitat types and floristic content across the investigation area shown on **Figures 1 and 3**. Because no vegetation clearing is proposed across the mining surface area (apart from very minor clearing/lopping associated with monitoring) the primary, and probably only, potential for impact would be from subsidence. Subsidence has the potential to create cracks in the underlying strata. This can have a significant impact on groundwater dependent ecosystems (GDE) through downward diversion of subsurface water, thus depriving these specialised ecosystems of water. Consequently GDE were a particular target for this investigation.

Flora species and ecological communities listed as threatened in the NSW *Threatened Species Conservation Act 1995* (TSC Act) were a primary survey target. Threatened flora species were recorded opportunistically and threatened vegetation communities were mapped as part of the overall vegetation mapping process.

A vegetation map was prepared from ground-truthed point data, floristic plot data and ground-truthed community boundary determination, applying methods developed in part by the author, as published in Bell and Driscoll (2008). Vegetation community types were determined by matching floristic content to data from the NPWS (2000) regional classification. High resolution aerial photography was used to identify areas of potential GDE and these areas were closely investigated.

The first step in preparing the vegetation map was to collect ground-truth data referred to as rapid data points (RDP). These point locations contain a presence only record of the dominant species in the canopy, shrub and ground structural layers. All available roads and tracks were traversed by vehicle or on foot and at intervals RDP data were recorded against waypoints using a handheld GPS (Garmin Map60CSx) fitted with an antenna booster. The targeted GDE areas, mainly gullies and drainage lines, were walked, as were large trackless areas, with RDP being recorded.

RDP were uploaded into a GIS and were given a preliminary classification according to the NPWS (2000) regional classification, based on floristic content. The point data were then used to create polygons representing the different vegetation communities. The vegetation map was refined with the assistance of aerial photograph interpretation where different patterns could be reasonably interpreted as different vegetation types.

4.1 Survey effort

Field data were collected over the month of August 2011. *Tetratheca juncea* was in flower and recorded at this time, as was *Rutidosis heterogama*. The other likely threatened flora species were not cryptic and could be recorded at any time of the year.

5 Threatened Flora and Endangered Communities

A desktop analysis was conducted by drawing from the Atlas of NSW Wildlife data base for an area within 5 km of the investigation boundary (**Table 1**).

Table 1 Threatened flora species from the Atlas of NSW Wildlife

Family	Scientific Name	Common Name	Status[1]
Asteraceae	***Rutidosis heterogama***	**Heath Wrinklewort**	V
Elaeocarpaceae	***Tetratheca juncea***	**Black-eyed Susan**	V
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	E1
Myrtaceae	*Eucalyptus parramattensis* subsp. *decadens*	Earp's Gum	V
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V
Myrtaceae	*Angophora inopina*	Charmhaven Apple	V
Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum	V
Proteaceae	***Grevillea parviflora* subsp. *parviflora***	**Small-flower Grevillea**	V

Note:

Data were extracted September 2011 for an area within 5 km of the investigation area. Species in **bold** have been reported from within the investigation area.

[1] Threatened species status under the TSC Act (current as at 21 March 2012).
V = Vulnerable E = Endangered

Endangered Ecological Communities (EEC) possibly occurring within the investigation area were determined from the detailed vegetation community classification and mapping of Bell and Driscoll (2008) for the Cessnock-Kurri area. This mapping overlapped the north west corner of the current investigation area.

There were nine probable EEC:

- 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;
- Kurri Sand Swamp Woodland in the Sydney Basin Bioregion;
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions;
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions;
- Lower Hunter Spotted Gum - Ironbark Forest 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;
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; and
- Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion.

6 Results

Overall, the vegetation was in very good condition. Exceptions were in the lowland riparian habitat and some elevated rainforest areas where Lantana was prolific. In most areas there was evidence of past timber harvesting such as old logging trails, remnant stumps and timber on the ground, and the predominance of relatively young (<50 yr) trees.

6.1 Floristics

Appendix 1 lists the 230 flora species, from 63 families, recorded across the investigation area, and the vegetation communities in which they occurred. Only one weed species was recorded. **Appendix 2** lists the 78 rainforest species and the gullies where these were recorded. A few Red Cedar (*Toona ciliata*) were found, indicating that these areas would have been logged in the past.

6.2 Threatened Flora Species

Three threatened flora species were recorded within the investigation area: *Grevillea parviflora* subsp. *parviflora*, *Rutidosis heterogama* and *Tetratheca juncea* (**Figure 5)**. These three species are listed as vulnerable in both the TSC Act and the EPBC Act. Only *Tetratheca juncea* was present within the limits of the mining area.

A comprehensive floristic search was not conducted across the investigation area. To assess the likelihood that other threatened flora species were present, the habitat preferences of the species listed in **Table 1** above were examined. **Table 2** provides information on the likelihood of these species occurring in the mapped habitat types.

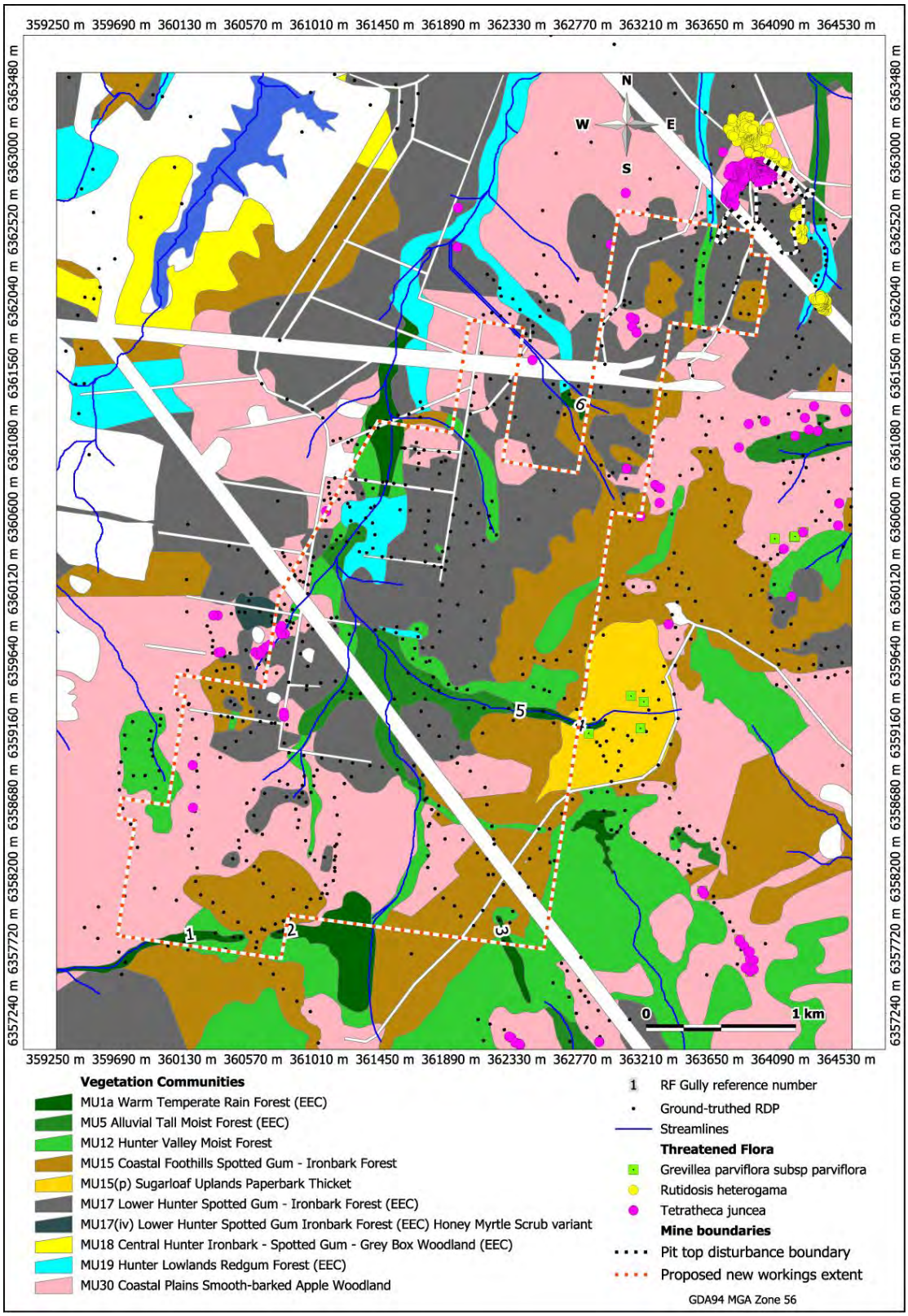

Figure 5 Vegetation communities and threatened species

Table 2 The likelihood of threatened flora species occurring within the investigation area (source Table 1)

Scientific Name	Distribution and habitat	Likelihood of occurring
Rutidosis heterogama	Recorded from Warnervale to Kurri and far northern NSW. Grows in heath, open forest and grasslands.	Recorded within the investigation area.
Tetratheca juncea	Recorded from Wyong to Bulahdelah. Grows in heath, open woodland and coastal sands.	Recorded within the investigation area.
Acacia bynoeana	Recorded from the Nowra region to the Lower Hunter Valley. Grows in heath, open forest and grasslands. Generally in sandy or lateritic soils.	Unlikely as suitable habitat was not present.
Angophora inopina	Recorded from Wyong to Karuah. Grows in open dry woodland in sandy and often lateritic soil. Generally in association with Scribbly Gums and Red Bloodwood.	Unlikely as suitable habitat was not present.
Eucalyptus parramattensis subsp. *decadens*	In the local area this species is a characteristic species in the EEC *Kurri Sand Swamp Woodland in the Sydney Basin Bioregion*.	Unlikely as suitable habitat was not present.
Callistemon linearifolius	Recorded from Sydney to Nelson Bay. Grows in dry sclerophyll forest.	Suitable habitat present.
Eucalyptus glaucina	Recorded from Maitland to Casino. Grows on deep, well-watered soils.	Suitable habitat in the areas where Forest Redgums were growing. Community MU19.
Grevillea parviflora subsp. parviflora	Recorded from Sydney to Kurri. Grows in sandy or light clay soils in heath, woodland or forest.	Recorded within the investigation area.

Habitat preference information was drawn from the following online resources:

- http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx
- http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl
- http://plantnet.rbgsyd.nsw.gov.au/

6.3 Vegetation Communities

As described in Section 3, the vegetation map was developed from ground-truthed data points coded according to their species content to match communities in the NPWS (2000) classification. **Table 3** lists the species that were common to both the NPWS (2000) community profiles and the RDP.

Just over 1000 ground-truthed RDP contributed to the final vegetation map (**Figure 5** above).

Table 3 Community indicator species used to classify RDP

Community (NPWS 2000)	Canopy	Mid layer and shrubs	Ground and vines
MU1a	*Eucalyptus saligna, Acmena smithii, Guioa semiglauca, Backhousia myrtifolia*	*Synoum glandulosum, Neolitsea dealbata, Trochocarpa laurina, Gymnostachys anceps*	*Doodia aspera, Adiantum formosum, Cissus antarctica, Ripogonum fawcettianum*
MU5	*Eucalyptus saligna, Eucalyptus acmenoides, Syncarpia glomulifera*	*Glochidion ferdinandi, Melaleuca styphelioides, Alphitonia excelsa, Backhousia myrtifolia*	*Cissus antarctica, Oplismenus imbecilus, Lomandra longifolia, Calochlaena dubia*
MU12	*Corymbia maculata, Eucalyptus punctata, Angophora floribunda, Eucalyptus siderophloia*	*Allocasuarina torulosa, Melaleuca styphelioides, Myrsine variabilis*	*Adiantum aethiopicum, Themeda australis, Oplismenus imbecilus, Microlaena stipoides, Dichondra repens*
MU15	*Corymbia maculata, Eucalyptus umbra, Eucalyptus siderophloia*	*Allocasuarina torulosa, Persoonia linearis, Daviesia ulicifolia, Melaleuca nodosa*	*Imperata cylindrica, Entolasia stricta, Themeda australis*
MU15(p)*	*Corymbia maculata*	*Melaleuca nodosa*	-
MU17	*Eucalyptus fibrosa, Corymbia maculata, Eucalyptus punctata, Eucalyptus sparsifolia*	*Daviesia ulicifolia, Acacia parvipinnula, Melaleuca nodosa, Lissanthe strigosa, Persoonia linearis*	*Entolasia stricta, Themeda australis, Lepidosperma laterale*
MU17(iv)*	*Eucalyptus fibrosa, Corymbia maculata,*	*Melaleuca erubescens*	*Entolasia stricta, Microlaena stipoides, Ptilothryx deusta, Themeda australis*
MU 18	*Eucalyptus crebra, Corymbia maculata, Eucalyptus moluccana*	*Daviesia ulicifolia*	No ground species recorded
MU19	*Eucalyptus tereticornis, Eucalyptus amplifolia, Eucalyptus globoidea, Eucalyptus punctata*	No shrub species in common between RDP and the profile for this community	*Microlaena stipoides, Imperata cylindrica, Themeda australis,* *Entolasia stricta, Lomandra longifolia,*
MU30	*Angophora costata, Corymbia gummifera, Eucalyptus umbra, Eucalyptus resinifera, Eucalyptus piperita*	*Allocasuarina littoralis, Banksia spinulosa, Acacia myrtifolia, Dodonaea triquetra, Lambertia formosa, Dillwynia retorta, Xanthorrhoea latifolia*	*Entolasia stricta, Themeda australis, Lomandra obliqua, Pteridium esculentum, Pimelea linifolia, Gonocarpus tetragynus, Mirbelia rubiifolia*

* These communities were not described in NPWS (2000).

Reliability of the final vegetation map was tested using a confusion matrix (**Table 4**). This analysis tests how many RDP lie within the vegetation polygon matching the community code. It is the equivalent of randomly choosing a location and shows the likelihood that the vegetation at that location would be what was mapped for there. For example, of the 24 RDP coded as MU1a, 11 are located within MU1a polygons, five within MU5 and seven within MU12. These three communities are moist and the analysis demonstrates ambiguity in determining which community is represented by RDP from within these. By contrast, of the 277 RDP coded as MU17, 97% lie within polygons mapped as MU17.

Table 4 Confusion matrix vegetation map reliability test

	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30	Total RDP	% correct
MU1a	**11**	5	7	0	0	0	0	0	**24**	**48**
MU5	2	**27**	4	1	0	0	1	4	**44**	**69**
MU12	0	2	**72**	2	0	0	0	0	**88**	**95**
MU15	0	0	2	**211**	2	0	1	13	**244**	**92**
MU17	0	1	0	6	**251**	0	2	0	**277**	**97**
MU18	0	0	0	0	1	**11**	0	0	**30**	**92**
MU19	0	0	2	0	0	0	**41**	0	**62**	**95**
MU30	0	0	8	4	2	1	1	**367**	**413**	**96**

Note:

Community codes embedded in the RDP data are in the left hand column and those in the vegetation map polygons are in the top row. The right hand column shows the percentage of RDP that lie within the correctly matching vegetation polygon. See main text for more details.

MU15 includes MU15(p) and MU17 includes MU17(iv).

Approximately 3000 ha of the 3500 ha investigation area were vegetated and consisted of 10 vegetation communities (**Tables 3 and 5**) of which six were determined to be EEC's. Detailed floristic content of each community is presented in **Appendix 1** and community profiles are presented in **Appendix 3**.

The proposed mining area covers just under 940 ha of vegetated and cleared land. **Table 5** includes the 878 ha of vegetation communities within that area. These are the communities that would be subject to varying amounts of subsidence.

Table 5 Vegetation communities extant over the investigation area (IA) and mining areas (MA)

Community (NPWS 2000)	EEC	IA (ha)	MA (ha)
MU1a Coastal Warm Temperate –Sub Tropical Rainforest (EEC)	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	57	19
MU5 Alluvial Tall Moist Forest (EEC)	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	73	43
MU12 Hunter Valley Moist Forest	Not an EEC	345	85
MU15 Coastal Foothills Spotted Gum - Ironbark Forest	Not an EEC	550	191
MU15(p) Sugarloaf Uplands Paperbark Thicket	Not an EEC	65	7
MU17 Lower Hunter Spotted Gum - Ironbark Forest (EEC)	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	724	285
MU17(iv) Lower Hunter Spotted Gum Ironbark Forest (EEC) Honey Myrtle Scrub variant	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	5	<1
MU 18 Central Hunter Ironbark - Spotted Gum - Grey Box Woodland (EEC)	Central Hunter Ironbark – Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	102	0
MU19 Hunter Lowlands Redgum Forest (EEC)	Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	113	17
MU30 Coastal Plains Smooth-barked Apple Woodland	Not an EEC	978	231
Total		**3012**	**878**

6.4 Lowland Rainforest

The vegetation community mapped as MU1a, *Coastal Warm Temperate – Sub Tropical Rainforest* is generally consistent with the NSW Scientific Committee (2006) determination for the EEC Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions. This habitat was highly restricted in the upper reaches of sheltered gullies (**Figure 5** above). These areas meet the condition described by Floyd (1990) as being at the limits of Lowland Rainforest with low moisture and soil nutrient status. The floristic content of these gullies (**Appendix 2**) was consistent with the Floyd (1990) Dry Rainforest suballiance *30. Backhousia myrtifolia – Acmena smithii* and the Warm Temperate Rainforest *Ceratopetalum apetalum* Alliance. For example Gully 5 contained a small number of *Ceratopetalum apetalum* and *Schizomeria ovata* along with *Tristaniopsis laurina*. These Floyd (1990) alliances and suballiances are referenced in NSW Scientific Committee (2006).

6.5 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDE) are ecosystems which are dependent in whole or in part on water reserves held in the ground. These water reserves form the saturated part of the aquifer soil matrix that sits below the 'water table' or 'phreatic surface', and are differentiated from water bound in the soil matrix in the unsaturated zone above the water table. A common source of water for GDE is base flow which originates with rainfall that soaks into the soil. In areas such as the Sugarloaf Range complex with its ridges and valleys, this subsurface water flows to the valley centre where it can continue downstream both under ground (groundwater) or on the surface depending on the amount of impervious rock present. This groundwater continues to flow, often well after rain events and is the source of water for the species that make up a GDE. Depending on the topography, GDE can be confined to narrow enclosed gullies or expand across wide areas. At lower, flatter areas, unconstrained alluvial aquifers can form.

The GDE in the investigation area consisted of MU1a *Coastal Warm Temperate – Sub Tropical Rainforest*, MU5 *Alluvial Tall Moist Forest* and possibly MU15(p) *Sugarloaf Uplands Paperbark Thicket*. The area mapped as MU15(p) in **Figure 5** featured skeletal soil over sandstone which means that rainfall soaking into the soil quickly meets the underlying impervious rock. This results in a larger amount of flow into the main drainage line than would be the case for deeper soil. The drainage line (Rainforest Gully 5 on **Figure 5**) being fed by this area consisted of a series of rock pools, riffs and cascades at the upper elevation, truncated by a near vertical escarpment about 30 m high that the water flowed over. Below this, the stream continued as a series of rocky ponds until it met alluvium. The vegetation along this stream was typical of the mesic vegetation in the other drainage lines surveyed with the exception of Water Gum (*Tristaniopsis laurina*) growing in the upper reaches below the escarpment. This species does not occur elsewhere in the elevated gullies of the investigation area and is an indication that this stream had almost permanent water.

The rainforest in gully 5 transitioned into a wide area of riparian MU5 *Alluvial Tall Moist Forest* dominated by Sydney Bluegum (*Eucalyptus saligna*) with an open ferny ground cover. Further downstream, the same community developed a dense mesic midstorey (see **Appendix 1** for overall floristic content).

7 Impact Assessment

The main potential for impact on flora species and vegetation communities would be from subsidence. Impacts to GDE and riparian vegetation can occur if stream flow is altered through bed-cracking or ponding. Streamflow and aquifers can also be impacted away from their immediate location if surface and/or sub-surface flow into these areas is diverted underground by deep cracking. *Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands* is a key threatening process listed in schedule 3 of the NSW TSC Act.

Localised destruction of vegetation is also possible where subsidence results in destabilisation of exposed rocky escarpments resulting in major rock falls.

The mine plan has been specifically designed to avoid having direct impact on these potentially unstable areas as well as the main areas occupied by GDE. Subsidence control zones have been established where barrier pillars are left to add support to the overburden and minimise subsidence (**Figure 6**).

However, potential exists for water inflow to be diverted underground and away from supplying the riparian communities and GDE (refer to paragraphs below for further discussion and clarification). **Figure 7** shows the location of the areas of greatest subsidence in relation to the catchments feeding the central streamline along which the GDE and riparian vegetation are located. The total catchment area for the main stream is about 1560 ha and the area of catchment potentially effected by major subsidence is about 700 ha, close to 45%.

Ditton Geotechnical Services (DGS 2012) have provided a subsidence report for the Project. The amount of subsidence is expected to be at maximum over areas of total panel extraction with the level of subsidence varying with depth of cover. The anticipated range is 0.58 m to 1.27 m over the flatter areas of the mining lease where cover depth ranges from 55 to 185 m. DGS (2012) report that similar mining methods in similar conditions used in the Abel underground mine have resulted in about the same levels of subsidence.

There would be a wave pattern to subsidence along a transect at right angles to the mined panels with the greatest subsidence in the centre of a panel reducing across the barrier pillar and increasing to the centre of the next panel. **Figure 7** suggests that this pattern could result in changes to water flow down the hillside to the small ephemeral drainage lines and finally into the main creek. The severity of the impact on water availability to the GDE would depend on how much diversion into underground workings occurred. Table 21 in DGS (2012) indicates that at cover depths of < 50 m it is *likely* that connective cracking will occur, at cover depths of 50 – 80 m it is *possible*, at cover depths of 80 – 100 m it is *unlikely* and at cover depths of >100 m it is *very unlikely*.

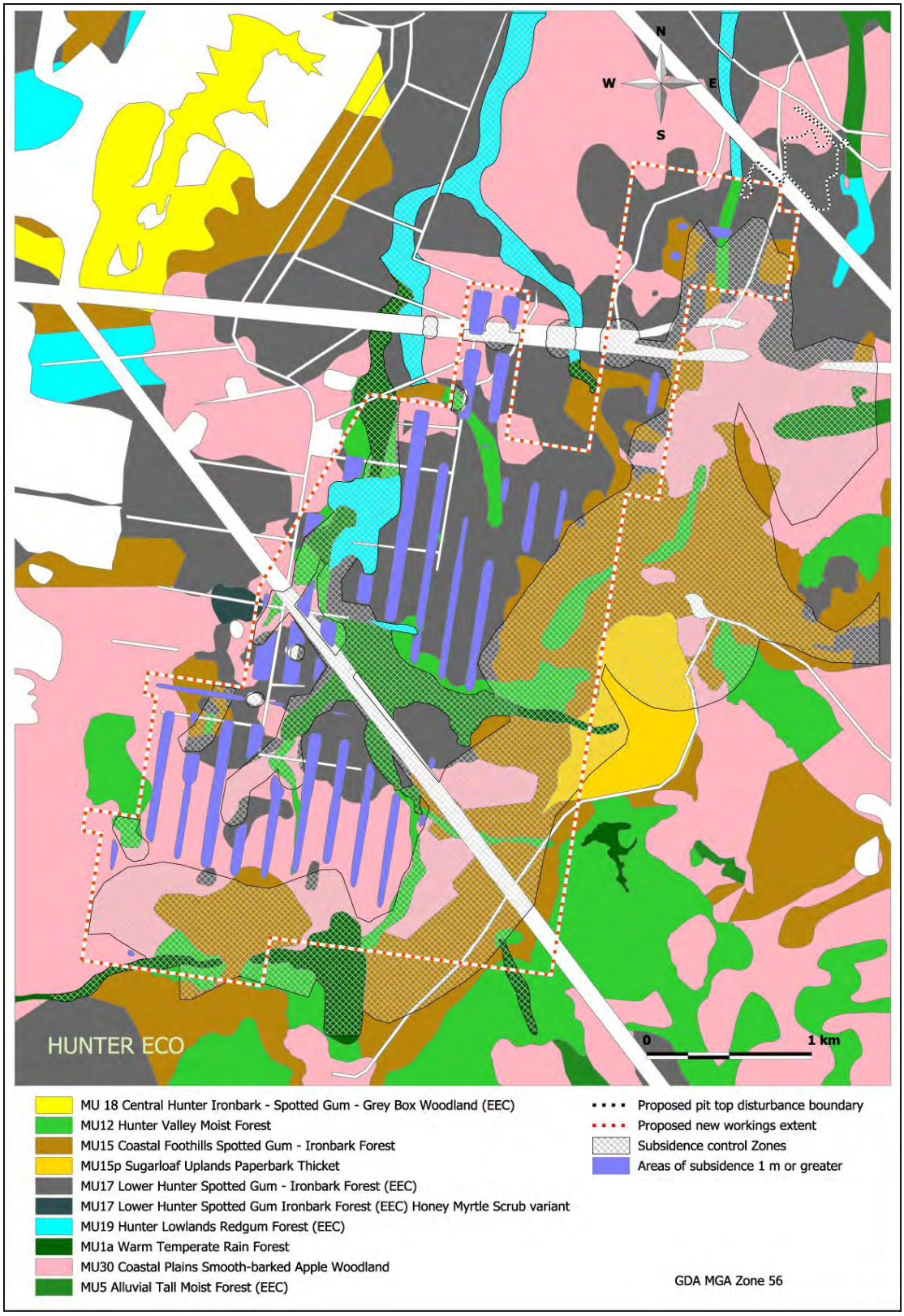

Figure 6 Proposed subsidence control zones and maximum subsidence zones

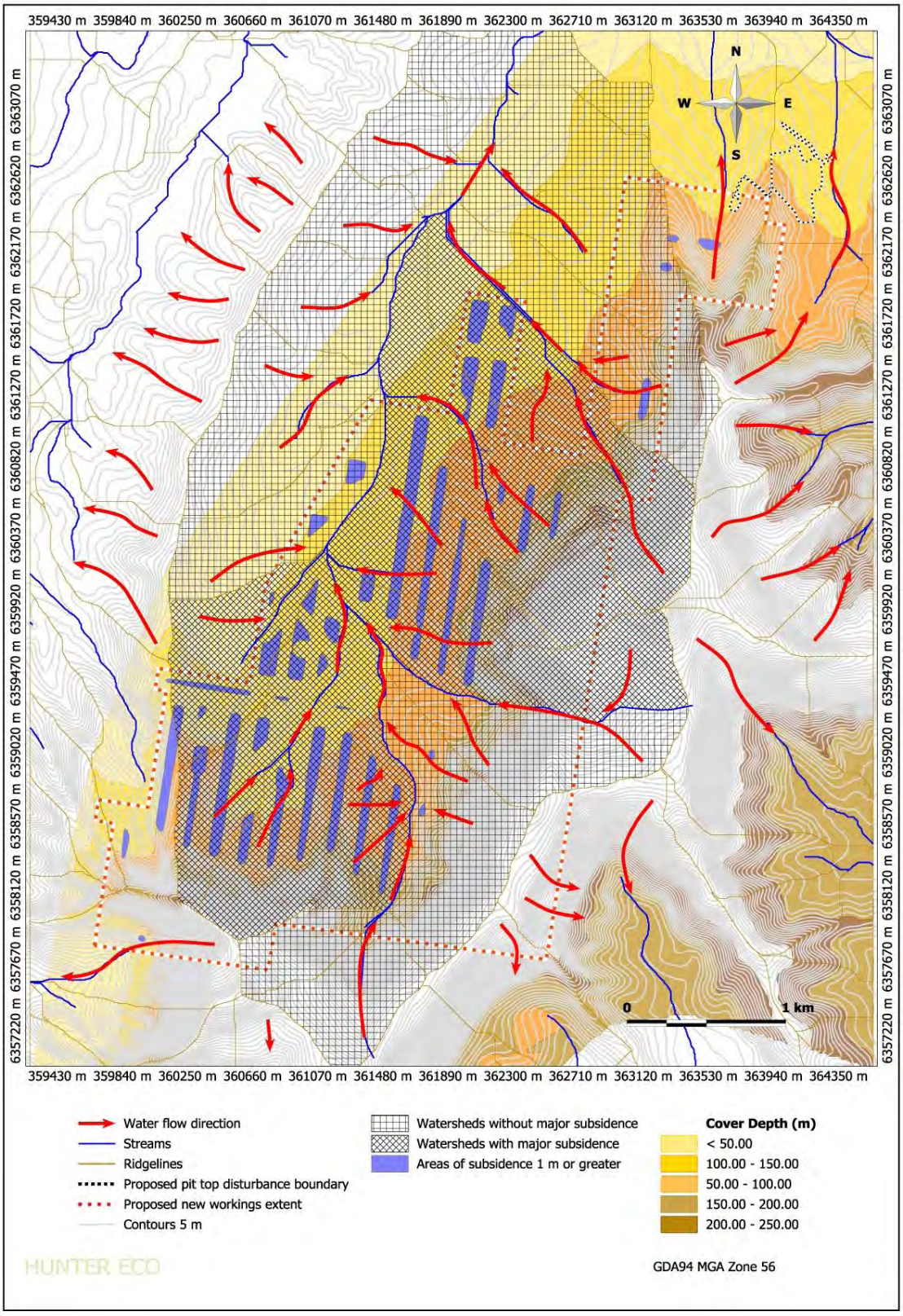

Figure 7 Catchments subjected to subsidence and cover depth

Ponding within existing creek channels is another potential outcome from subsidence with a worst-case scenario of 0.5 – 1.0 m depth ponds being formed above the centre of some of the full extraction panels. Out-of-channel depressions may also become ponded. However, DGS (2012) notes that the most likely outcome would in-channel ponded depressions in drainage lines feeding the main creek.

The impact of this altered hydrology on the associated vegetation would vary depending on the severity of the subsidence event, and the remedies available. Referring back to **Figure 6**, it can be seen that the majority of the vegetation over full extraction panels is MU17 *Lower Hunter Spotted Gum – Ironbark Forest* and MU30 *Coastal Plains Smooth-barked Apple Woodland*. Empirical observation suggests that both these communities can tolerate a range of conditions as expressed in their varying composition. They can present as dry open forest or moist shrubby forest. They are not GDE, so as with a lot of Australian vegetation, they have adapted to a wide range of water availability. Changes in topography from subsidence are not all going to be permanent. Over time subterranean cracks will seal with a combination of siltation and vegetation detritus. Even surface ponded depressions will silt up to varying degrees. Plant species, adapted to high water availability will establish in the same way that happens in naturally eroded depressions in streamlines.

For a long-term detrimental impact to occur to local populations of threatened flora species, changes to habitat would need to be widespread and themselves long-term. There is no recorded experience of this occurring as a consequence of the mining methods chosen for the Project. The worst that might happen would be localised loss of individual plants, an event that would be unlikely to place a local population at risk of extinction.

There would be no clearing associated with the underground mining that would lead to habitat fragmentation or isolation. Consequently, the corridor values of the ecology investigation area would be maintained.

A formal impact assessment applying the 7-part test of the NSW *Threatened Species Conservation Act 1995* to threatened flora species and endangered ecological communities is provided in **Appendix 4**. The assessment was applied to species known to occur or considered likely to occur within the mining limits (**Table 2**). All mapped EEC were assessed.

8 Conclusion and Recommendations

In conclusion, this impact assessment has shown that no lasting damage is likely to be caused by the Project to any threatened flora species or EEC. This includes those species and habitat that lie within the Sugarloaf SCA and State Forest.

However, it is recommended that the current Tasman Flora and Fauna Monitoring Plan (Ecobiological 2007) is extended to include monitoring the condition of the rainforest, riparian and LHSGIF communities that occur over the Project mining area. Baseline data, collected for as long as possible prior to mining and subsidence, should be obtained so that post-subsidence comparisons can be made.

Management plans should also include awareness of the threat of infection by Myrtle Rust, and measures to minimise the risk of transfer from infected areas. See OEH (2011) for detailed management of this pathogen.

9 References

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Appendix 1 Vegetation Community Floristic Lists

MU15 includes species recorded in the variant MU15p and MU17 includes species recorded in MU17(iv)

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Adiantaceae								
Adiantum aethiopicum	✓		✓					
Adiantum diaphanum	✓							
Adiantum formosum	✓	✓	✓					
Adiantum hispidulum	✓							
Pellaea falcata			✓					
Pellaea paradoxa			✓					
Apocynaceae								
Parsonsia straminea	✓							
Araceae								
Gymnostachys anceps	✓		✓					✓
Araliaceae								
Astrotricha latifolia	✓	✓	✓	✓				
Astrotricha obovata			✓	✓	✓			✓
Polyscias murrayi	✓							
Arecaceae								
Livistona australis	✓							
Aspleniaceae								
Asplenium australasicum	✓							
Asteliaceae								
Cordyline stricta	✓							
Asteraceae								
Cassinia quinquefaria					✓			
Olearia elliptica					✓			
Athyriaceae								
Lunathyrium petersenii	✓							
Blechnaceae								
Blechnum cartilagineum	✓	✓						✓
Doodia aspera	✓	✓	✓					
Casuarinaceae								
Allocasuarina littoralis			✓	✓				✓
Allocasuarina torulosa	✓	✓	✓	✓	✓			✓
Celastraceae								
Elaeodendron australe	✓							
Convolvulaceae								
Dichondra repens			✓					✓
Cunoniaceae								
Aphanopetalum resinosum	✓							
Callicoma serratifolia			✓					
Ceratopetalum apetalum	✓							
Schizomeria ovata	✓							

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Cyperaceae								
Carex gaudichaudiana	✓							
Carex sp.			✓					
Gahnia clarkei			✓					✓
Gahnia melanocarpa			✓					
Gahnia radula								✓
Gahnia sieberiana		✓						
Lepidosperma elatius			✓	✓				
Lepidosperma laterale					✓			
Ptilothrix deusta				✓	✓			✓
Schoenus apogon								✓
Dennstaedtiaceae								
Hypolepis muelleri		✓	✓					
Pteridium esculentum			✓	✓	✓		✓	✓
Dicksoniaceae								
Calochlaena dubia	✓	✓	✓					
Dilleniaceae								
Hibbertia aspera			✓					✓
Hibbertia empetrifolia subsp. empetrifolia			✓		✓		✓	
Hibbertia obtusifolia								✓
Hibbertia scandens	✓							
Dioscoreaceae								
Dioscorea transversa	✓							
Doryanthaceae								
Doryanthes excelsa			✓	✓	✓			✓
Ebenaceae								
Diospyros australis	✓		✓					
Elaeocarpaceae								
Elaeocarpus obovatus	✓	✓						
Tetratheca juncea								✓
Tetratheca thymifolia								✓
Epacridaceae								
Acrotriche divaricata			✓	✓				✓
Epacris pulchella								✓
Lissanthe strigosa				✓	✓			✓
Monotoca scoparia								✓
Trochocarpa laurina	✓							
Euphorbiaceae								
Breynia oblongifolia			✓					✓
Claoxylon australe	✓	✓						
Croton verreauxii		✓	✓					
Glochidion ferdinandi	✓	✓	✓	✓				✓
Omalanthus populifolius	✓							
Poranthera ericifolia					✓			
Eupomatiaceae								
Eupomatia laurina	✓	✓	✓					

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Fabaceae (Faboideae)								
Bossiaea obcordata								✓
Bossiaea rhombifolia								✓
Daviesia squarrosa				✓	✓			✓
Daviesia ulicifolia			✓	✓	✓	✓		✓
Daviesia umbellulata					✓			✓
Dillwynia retorta					✓			✓
Gompholobium latifolium								✓
Indigofera australis			✓	✓				
Jacksonia scoparia			✓	✓	✓			✓
Mirbelia rubiifolia								✓
Podolobium aciculiferum				✓	✓			✓
Podolobium ilicifolium			✓	✓	✓			✓
Pultenaea euchila				✓	✓			✓
Pultenaea retusa				✓				
Pultenaea spinosa								✓
Pultenaea villosa			✓	✓	✓			✓
Swainsona galegifolia			✓	✓				
Fabaceae (Mimosoideae)								
Acacia elongata					✓			✓
Acacia falcata				✓	✓			
Acacia fimbriata	✓	✓	✓	✓	✓		✓	✓
Acacia implexa	✓		✓					
Acacia irrorata				✓				
Acacia linifolia			✓	✓	✓			✓
Acacia longifolia			✓	✓			✓	✓
Acacia maidenii			✓					
Acacia myrtifolia								✓
Acacia parvipinnula			✓	✓	✓		✓	✓
Acacia stricta				✓	✓			
Acacia ulicifolia			✓	✓	✓			✓
Pararchidendron pruinosum var. pruinosum	✓							
Flacourtiaceae								
Scolopia braunii	✓	✓						
Goodeniaceae								
Goodenia ovata			✓					
Haloragaceae								
Gonocarpus tetragynus				✓				✓
Lamiaceae								
Prostanthera incisa	✓		✓					
Lauraceae								
Cryptocarya glaucescens		✓						
Cryptocarya microneura	✓	✓	✓					
Cryptocarya rigida	✓							
Neolitsea dealbata	✓							

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Lomandraceae								
Lomandra confertifolia					✓			✓
Lomandra filiformis					✓			
Lomandra glauca								✓
Lomandra longifolia	✓	✓	✓	✓			✓	
Lomandra multiflora subsp. multiflora								✓
Lomandra obliqua					✓			✓
Luzuriagaceae								
Geitonoplesium cymosum	✓							
Malvaceae								
Hibiscus heterophyllus	✓							
Meliaceae								
Synoum glandulosum subsp. glandulosum	✓		✓					
Toona ciliata	✓							
Menispermaceae								
Stephania japonica	✓							
Monimiaceae								
Wilkiea huegeliana	✓							
Moraceae								
Ficus coronata	✓	✓		✓				
Ficus rubiginosa	✓							
Myrsinaceae								
Myrsine variabilis	✓		✓					
Myrtaceae								
Acmena smithii	✓	✓						
Angophora bakeri								✓
Angophora costata	✓	✓	✓	✓	✓			✓
Angophora floribunda	✓	✓	✓	✓	✓	✓	✓	✓
Backhousia myrtifolia	✓	✓	✓	✓				
Callistemon linearis					✓			✓
Callistemon pinifolius					✓			✓
Callistemon salignus	✓	✓	✓	✓			✓	✓
Callistemon shiressii			✓					
Corymbia gummifera			✓	✓	✓			✓
Corymbia maculata	✓	✓	✓	✓	✓	✓	✓	✓
Eucalyptus acmenoides	✓	✓	✓	✓	✓		✓	✓
Eucalyptus amplifolia						✓	✓	
Eucalyptus capitellata								✓
Eucalyptus crebra				✓	✓	✓		
Eucalyptus eugenioides							✓	
Eucalyptus fergusonii	✓	✓	✓	✓	✓			✓
Eucalyptus fibrosa			✓	✓	✓		✓	✓
Eucalyptus globoidea		✓	✓		✓		✓	✓
Eucalyptus moluccana				✓	✓	✓	✓	

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Eucalyptus paniculata		✓	✓	✓	✓		✓	✓
Eucalyptus piperita				✓				✓
Eucalyptus placita			✓	✓	✓			
Eucalyptus punctata	✓	✓	✓	✓	✓		✓	✓
Eucalyptus resinifera			✓	✓	✓		✓	✓
Eucalyptus saligna	✓	✓	✓	✓	✓		✓	
Eucalyptus siderophloia		✓	✓	✓	✓		✓	
Eucalyptus sp. aff. agglomerata								✓
Eucalyptus sparsifolia			✓	✓	✓			✓
Eucalyptus tereticornis		✓	✓	✓	✓	✓	✓	
Eucalyptus umbra			✓	✓	✓			✓
Leptospermum juniperinum			✓	✓				
Leptospermum polyanthum			✓	✓	✓		✓	✓
Leptospermum trinervium			✓	✓	✓			✓
Melaleuca decora		✓		✓	✓		✓	✓
Melaleuca erubescens				✓	✓			
Melaleuca linariifolia		✓	✓		✓		✓	✓
Melaleuca nodosa		✓	✓	✓	✓		✓	✓
Melaleuca sieberi				✓	✓			✓
Melaleuca styphelioides	✓	✓	✓	✓	✓	✓	✓	✓
Melaleuca thymifolia				✓	✓			
Rhodamnia rubescens	✓	✓	✓					✓
Syncarpia glomulifera	✓	✓	✓	✓	✓			✓
Syzygium australe	✓							
Syzygium oleosum	✓	✓						
Tristaniopsis laurina	✓	✓	✓					
Oleaceae								
Notelaea longifolia	✓							
Notelaea venosa	✓		✓					
Orchidaceae								
Cestichis reflexa	✓							
Dendrobium aemulum			✓					
Dendrobium speciosum	✓			✓				
Sarcochilus hillii	✓							
Pittosporaceae								
Bursaria spinosa			✓	✓	✓	✓		✓
Hymenosporum flavum	✓	✓						
Pittosporum revolutum	✓							
Pittosporum undulatum	✓							
Poaceae								
Anisopogon avenaceus								✓
Aristida vagans				✓	✓			✓
Cleistochloa rigida		✓	✓	✓	✓			✓
Cymbopogon refractus			✓		✓			
Dichelachne sieberiana								✓
Echinopogon ovatus			✓	✓				

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Entolasia stricta			✓	✓	✓		✓	✓
Imperata cylindrica var. major	✓	✓	✓	✓	✓		✓	✓
Joycea pallida			✓	✓	✓			✓
Microlaena stipoides		✓	✓	✓	✓		✓	✓
Notodanthonia longifolia			✓					
Oplismenus imbecillis		✓	✓	✓				
Panicum simile					✓			✓
Poa affinis			✓	✓				
Poa labillardierei var. labillardierei			✓	✓	✓		✓	✓
Tetrarrhena juncea								✓
Themeda australis		✓	✓	✓	✓		✓	✓
Polypodiaceae								
Platycerium superbum	✓							
Pyrrosia confluens var. confluens	✓							
Pyrrosia rupestris	✓							
Proteaceae								
Banksia spinulosa				✓	✓			✓
Grevillea montana				✓				✓
Grevillea parviflora subsp. parviflora				✓				✓
Hakea bakeriana								✓
Hakea sericea								✓
Isopogon anemonifolius								✓
Lambertia formosa								✓
Lomatia silaifolia								✓
Persoonia lanceolata				✓				✓
Persoonia levis								✓
Persoonia linearis			✓	✓	✓			✓
Rhamnaceae								
Alphitonia excelsa	✓	✓	✓					
Pomaderris intermedia								✓
Ripogonaceae								
Ripogonum album	✓							
Ripogonum fawcettianum	✓							
Rosaceae								
Rubus moluccanus			✓					
Rubiaceae								
Cyclophyllum longipetalum	✓							
Morinda jasminoides	✓							
Rutaceae								
Acronychia oblongifolia	✓							
Melicope micrococca	✓		✓					
Phebalium squamulosum			✓					
Santalaceae								
Exocarpos strictus				✓				

Family and Species	MU1a	MU5	MU12	MU15	MU17	MU18	MU19	MU30
Sapindaceae								
Dodonaea triquetra			✓	✓	✓		✓	✓
Guioa semiglauca	✓		✓					
Smilacaceae								
Smilax glyciphylla	✓							
Sterculiaceae								
Brachychiton populneus		✓		✓				
Lasiopetalum parviflorum								✓
Thymelaeaceae								
Pimelea linifolia				✓	✓			✓
Tremandraceae								
Tetratheca juncea								✓
Tetratheca thymifolia								✓
Verbenaceae								
**Lantana camara*	✓	✓	✓				✓	
Clerodendrum tomentosum	✓		✓					
Vitaceae								
Cissus antarctica	✓	✓	✓					
Cissus hypoglauca	✓							
Xanthorrhoeaceae								
Xanthorrhoea glauca								✓
Xanthorrhoea latifolia			✓		✓			✓
Xanthorrhoea malacophylla	✓		✓	✓	✓			✓
Zamiaceae								
Macrozamia reducta			✓	✓	✓			✓
Zingiberaceae								
Alpinia caerulea		✓						

Appendix 2 Rainforest Gullies Floristic List

Family and Species	Rainforest Gully					
	1	2	3	4	5	6
Adiantaceae						
Adiantum aethiopicum				✓		
Adiantum diaphanum					✓	
Adiantum formosum		✓	✓	✓		✓
Adiantum hispidulum		✓				
Araceae						
Gymnostachys anceps	✓		✓			
Araliaceae						
Astrotricha latifolia	✓					
Arecaceae						
Livistona australis			✓			
Aspleniaceae						
Asplenium australasicum	✓		✓			
Asteliaceae						
Cordyline stricta	✓		✓		✓	✓
Athyriaceae						
Lunathyrium petersenii			✓	✓		
Blechnaceae						
Blechnum cartilagineum					✓	
Doodia aspera	✓	✓	✓	✓		✓
Celastraceae						
Elaeodendron australe			✓			
Cunoniaceae						
Aphanopetalum resinosum	✓	✓	✓	✓		✓
Ceratopetalum apetalum					✓	
Schizomeria ovata					✓	
Cyperaceae						
Carex gaudichaudiana						✓
Dicksoniaceae						
Calochlaena dubia	✓					
Dilleniaceae						
Hibbertia scandens	✓					
Dioscoreaceae						
Dioscorea transversa	✓	✓	✓	✓		
Ebenaceae						
Diospyros australis	✓		✓	✓	✓	
Elaeocarpaceae						
Elaeocarpus obovatus	✓				✓	
Epacridaceae						
Trochocarpa laurina			✓	✓	✓	
Euphorbiaceae						
Claoxylon australe						✓
Glochidion ferdinandi	✓			✓		✓
Omalanthus populifolius		✓				

Family and Species	Rainforest Gully					
	1	2	3	4	5	6
Eupomatiaceae						
Eupomatia laurina	✓	✓				
Fabaceae (Mimosoideae)						
Acacia fimbriata						✓
Acacia implexa						✓
Pararchidendron pruinosum var. pruinosum	✓					
Flacourtiaceae						
Scolopia braunii	✓	✓	✓	✓	✓	
Lamiaceae						
Prostanthera incisa	✓					
Lauraceae						
Cryptocarya microneura	✓	✓	✓			✓
Cryptocarya rigida			✓			
Neolitsea dealbata	✓		✓	✓	✓	
Lomandraceae						
Lomandra longifolia	✓					
Luzuriagaceae						
Geitonoplesium cymosum	✓					
Malvaceae						
Hibiscus heterophyllus	✓					
Meliaceae						
Synoum glandulosum	✓					
Toona ciliata	✓	✓		✓		
Menispermaceae						
Stephania japonica	✓					
Monimiaceae						
Wilkiea huegeliana	✓		✓			
Moraceae						
Ficus coronata	✓	✓	✓	✓	✓	✓
Ficus rubiginosa			✓	✓	✓	
Myrsinaceae						
Myrsine variabilis	✓			✓		
Myrtaceae						
Acmena smithii			✓		✓	✓
Backhousia myrtifolia				✓	✓	✓
Callistemon salignus						✓
Melaleuca styphelioides				✓		✓
Rhodamnia rubescens	✓					✓
Syncarpia glomulifera				✓		
Syzygium australe						✓
Syzygium oleosum				✓		
Oleaceae						
Notelaea longifolia					✓	
Notelaea venosa				✓		
Orchidaceae						
Cestichis reflexa			✓			

Family and Species	Rainforest Gully					
	1	2	3	4	5	6
Dendrobium speciosum			✓			
Sarcochilus hillii				✓		
Pittosporaceae						
Hymenosporum flavum			✓			✓
Pittosporum revolutum	✓					
Pittosporum undulatum		✓	✓	✓	✓	
Polypodiaceae						
Platycerium superbum	✓					
Pyrrosia confluens var. confluens					✓	
Pyrrosia rupestris	✓	✓	✓			
Rhamnaceae						
Alphitonia excelsa						✓
Ripogonaceae						
Ripogonum album	✓		✓	✓	✓	✓
Ripogonum fawcettianum			✓		✓	
Rubiaceae						
Cyclophyllum longipetalum		✓				
Morinda jasminoides			✓	✓	✓	✓
Rutaceae						
Acronychia oblongifolia						✓
Melicope micrococca						✓
Sapindaceae						
Guioa semiglauca				✓	✓	
Smilacaceae						
Smilax glyciphylla					✓	
Verbenaceae						
**Lantana camara*	✓	✓				✓
Clerodendrum tomentosum			✓			✓
Vitaceae						
Cissus antarctica	✓		✓			✓
Cissus hypoglauca	✓			✓	✓	✓
Xanthorrhoeaceae						
Xanthorrhoea malacophylla	✓					

Appendix 3 Vegetation Community Profiles

MAP UNIT	MU1a
MAP NAME	Coastal Warm Temperate – Sub Tropical Rainforest
CONSERVATION STATUS	EEC, Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions

AREAS	
Investigation Area	**Mining Area**
57 ha	19 ha

DESCRIPTION	
Canopy	*Eucalyptus saligna, Acmena smithii, Guioa semiglauca, Backhousia myrtifolia*
Shrubs	*Synoum glandulosum, Neolitsea dealbata, Trochocarpa laurina, Gymnostachys anceps*
Ground	*Doodia aspera, Adiantum formosum, Cissus antarctica, Ripogonum fawcettianum*
Significant Species	None recorded

MAP UNIT	MU5
MAP NAME	Alluvial Tall Moist Forest
CONSERVATION STATUS	EEC, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

AREAS	
Investigation Area	**Subsidence Area**
73 ha	43 ha

DESCRIPTION	
Canopy	*Eucalyptus saligna, Eucalyptus acmenoides, Syncarpia glomulifera*
Shrubs	*Glochidion ferdinandi, Melaleuca styphelioides, Alphitonia excelsa, Backhousia myrtifolia*
Ground	*Cissus antarctica, Oplismenus imbecilus, Lomandra longifolia, Calochlaena dubia*
Significant Species	None recorded

MAP UNIT	MU12
MAP NAME	Hunter Valley Moist Forest
CONSERVATION STATUS	Not listed as threatened
AREAS	
Investigation Area	**Subsidence Area**
345 ha	85 ha

DESCRIPTION	
Canopy	*Corymbia maculata, Eucalyptus punctata, Angophora floribunda, Eucalyptus siderophloia*
Shrubs	*Allocasuarina torulosa, Persoonia linearis, Daviesia ulicifolia, Melaleuca nodosa*
Ground	*Adiantum aethiopicum, Themeda australis, Oplismenus imbecilus, Microlaena stipoides, Dichondra repens*
Significant Species	None recorded

MAP UNIT	MU15
MAP NAME	Coastal Foothills Spotted Gum - Ironbark Forest
CONSERVATION STATUS	Not listed as threatened
AREAS	
Investigation Area	**Subsidence Area**
550 ha	191 ha

DESCRIPTION	
Canopy	*Corymbia maculata, Eucalyptus umbra, Eucalyptus siderophloia*
Shrubs	*Allocasuarina torulosa, Persoonia linearis, Daviesia ulicifolia, Melaleuca nodosa*
Ground	*Imperata cylindrica, Entolasia stricta, Themeda australis*
Significant Species	None recorded

MAP UNIT	MU15(p)
MAP NAME	Sugarloaf Uplands Paperbark Thicket
CONSERVATION STATUS	Not listed as threatened

AREAS	
Investigation Area	**Subsidence Area**
65 ha	7 ha

DESCRIPTION	
Canopy	*Corymbia maculata, Eucalyptus sparsifolia, Eucalyptus punctata, Melaleuca decora,*
Shrubs	*Melaleuca nodosa, Epacris pulchella, Melaleuca thymifolia, Mirbelia rubiifolia, Acacia ulicifolia,*
Ground	*Themeda australis, Panicum simile, Entolasia stricta, Pseuderanthemum variabile, Phyllanthus hirtellus*
Significant Species	*Grevillea parviflora* subsp. *parviflora*

MAP UNIT	MU17
MAP NAME	Lower Hunter Spotted Gum - Ironbark Forest
CONSERVATION STATUS	EEC, Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion

AREAS	
Investigation Area	**Subsidence Area**
724 ha	285 ha

DESCRIPTION	
Canopy	*Eucalyptus fibrosa, Corymbia maculata, Eucalyptus punctata, Eucalyptus sparsifolia*
Shrubs	*Daviesia ulicifolia, Acacia parvipinnula, Melaleuca nodosa, Lissanthe strigosa, Persoonia linearis*
Ground	*Entolasia stricta, Themeda australis, Lepidosperma laterale*
Significant Species	*Rutidosis heterogama*

MAP UNIT	MU17(iv)
MAP NAME	Lower Hunter Spotted Gum Ironbark Forest Honey Myrtle Scrub variant
CONSERVATION STATUS	EEC, Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion

AREAS	
Investigation Area	**Subsidence Area**
5 ha	< 1 ha

DESCRIPTION	
Canopy	*Eucalyptus fibrosa, Corymbia maculata,*
Shrubs	*Melaleuca erubescens*
Ground	*Entolasia stricta, Microlaena stipoides, Ptilothryx deusta, Themeda australis*
Significant Species	None recorded

MAP UNIT	MU18
MAP NAME	Central Hunter Ironbark - Spotted Gum - Grey Box Woodland
CONSERVATION STATUS	EEC, Central Hunter Ironbark - Spotted Gum- Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions

AREAS	
Investigation Area	**Subsidence Area**
102 ha	0 ha

DESCRIPTION	
Canopy	*Eucalyptus crebra, Corymbia maculata, Eucalyptus moluccana*
Shrubs	*Daviesia ulicifolia*
Ground	None recorded
Significant Species	None recorded

MAP UNIT	MU19
MAP NAME	Hunter Lowlands Redgum Forest
CONSERVATION STATUS	EEC, Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions

AREAS	
Investigation Area	**Subsidence Area**
113 ha	17 ha

DESCRIPTION	
Canopy	*Eucalyptus tereticornis, Eucalyptus amplifolia, Eucalyptus globoidea, Eucalyptus punctata*
Shrubs	*Bursaria spinosa, Acacia fimbriata, Dodonaea triquetra, Melaleuca styphelioides*
Ground	*Microlaena stipoides, Imperata cylindrica, Themeda australis, Entolasia stricta, Lomandra longifolia*
Significant Species	None recorded

MAP UNIT	MU30
MAP NAME	Coastal Plains Smooth-barked Apple Woodland
CONSERVATION STATUS	Not listed as threatened
AREAS	
Investigation Area	**Subsidence Area**
978 ha	231 ha

DESCRIPTION	
Canopy	*Angophora costata, Corymbia gummifera, Eucalyptus umbra, Eucalyptus resinifera, Eucalyptus piperita*
Shrubs	*Allocasuarina littoralis, Banksia spinulosa, Acacia myrtifolia, Dodonaea triquetra, Lambertia formosa, Dillwynia retorta, Xanthorrhoea latifolia*
Ground	*Entolasia stricta, Themeda australis, Lomandra obliqua, Pteridium esculentum, Pimelea linifolia, Gonocarpus tetragynus, Mirbelia rubiifolia*
Significant Species	*Tetratheca juncea*

Appendix 4 Impact assessment, the 7-part test

Threatened Flora

This test assesses the impact of the Project on the following species:

- *Callistemon linearifolius*
- *Grevillea parviflora* subsp. *parviflora*
- *Rutidosis heterogama*
- *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,

The only threatened flora species known to occur within the mining subsidence limits was *Tetratheca juncea* (**Figure 5**), although the other three species could not be confidently discounted. The viable local population of *Tetratheca juncea* would take in a wider area than those records within the subsidence limits. Subsidence is not likely to impact on this local population of *Tetratheca juncea* in a way that would place it at risk of extinction. Similarly, subsidence is unlikely to place local populations of *Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora* or *Rutidosis heterogama* at risk of extinction.

(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,

No endangered population of these species has been listed.

(c) in the case of an 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

Not applicable

(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,

Not applicable

(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,

No habitat would be modified to the extent that isolation or fragmentation would result. Subsidence would not have this outcome directly and even where remediation of significantly cracked areas was required, this would not result in fragmentation or isolation of habitat.

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

No critical habitat was present.

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

In that there would be no impact on any of the threatened flora species that are known to occur, or are considered likely to occur, the action is consistent with recovery and threat abatement plans.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is a key threatening process which could be an outcome where cracking resulted in diversion of surface water into mine workings. The potential for this to occur is recognised, and monitoring (both surface and underground) would ensure that such an occurrence was identified. Remediation measures would be undertaken where deemed appropriate.

Endangered Ecological Communities

This is a test assessing impact of the project on the following EEC's:

- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions (HLRF);
- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (LHSGIF);
- River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner (RFEF); and
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (LRF).

(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,

Not applicable to the consideration of an EEC.

(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,

Not applicable to the consideration of an EEC.

(c) in the case of an 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,

HLRF, RFEF and LRF are groundwater dependent ecosystems (GDE) and are to be protected from significant direct subsidence effects through the provision of subsidence control zones (**Figure 6**). Indirect impact could occur if cracking in subsided areas across the catchments supplying these communities (**Figure 7**) diverted sufficient water underground that they came under chronic water stress. This outcome is highly unlikely in that only about 45% of the area of these catchments would potentially be affected, and a smaller amount within that area. Remediation measures would also be available. It is likely that the action would not have an impact on these communities such that their local occurrence would be placed at risk of extinction.

The lower part of the area of total extraction east of the central creekline is dominated by LHSGIF (**Figure 6**). This is a dry forest community that would not be impacted as a whole, even by cracking connected to the underground workings. It is likely that the action would not have an impact on this community such that the local occurrence would be placed at risk of extinction.

(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,

No habitat would be modified to the extent that isolation or fragmentation would result. Subsidence would not have this outcome directly and even where remediation of significantly cracked areas was required, this would not result in fragmentation or isolation of habitat.

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

No critical habitat was present.

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

The action is consistent with recovery and threat abatement plans in that there would be no impact on the community.

(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.

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is a key threatening process which could be an outcome where cracking resulted in diversion of surface water. Such diversion might occur over a short length of stream as a result of near-surface cracking, or longer if cracking were deeper. The potential for this to occur is recognised, and monitoring (both surface and underground) would ensure that such an occurrence was identified. Remediation measures would be undertaken where deemed appropriate.

Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae is a key threatening process with the potential to impact on Myrtaceous species within the EEC under consideration. These fungi are generically referred to as 'Myrtle Rust'. None was found during the field surveys for this assessment. Dispersal vectors for Myrtle Rust appear to include wind and direct physical transfer by humans or animals having had contact with infected plants. Management plans should include awareness of this threat and measures to minimise the risk of transfer from infected areas.

Appendix 5 Personnel

Task	Person	Experience
Entire project	Colin Driscoll BSc	>30 years flora and fauna surveys in the Hunter and Central Coast