APPENDIX D

COWAL GOLD MINE E42 MODIFICATION

FLORA ASSESSMENT

PREPARED BY
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EXECUTIVE SUMMARY

This flora survey and assessment was conducted for a proposed modification to the approved Cowal Gold Mine (CGM). Changes implemented to the approved CGM by the E42 Modification would result in the modified CGM.

The approved CGM is located approximately 38 kilometres (km) north-east of West Wyalong, New South Wales (NSW).

The objectives of the flora survey and assessment were to:

- Identify the vegetation communities present in the study area.
- Map the distribution of each vegetation community.
- Compile lists of flora species in each vegetation community.
- Conduct targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area (including those listed under the schedules of the NSW *Threatened Species Conservation Act, 1995* [TSC Act] and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]).
- Identify the potential impacts of the modified CGM on flora including threatened flora species and ecological communities.

Findings

The following is a summary of the survey and its findings:

- Four vegetation communities were identified and mapped in the study area.
- The survey recorded 87 vascular plant taxa within the study area, of which 75 (86.2%) were native and 12 (13.8%) were introduced. A complete list of plant species is given according to climax vegetation community.
- One threatened ecological community listed as endangered under the TSC Act was identified, *viz*. *Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions* (Myall Woodland EEC).
- No threatened flora species or populations listed under the TSC Act or EPBC Act were identified by the study.
- The condition of the native vegetation in the study area varies according to vegetation community from poor to good. All vegetation communities have been subject to partial or nearly complete land clearing for pastoral purposes, and have been subjected historically to prolonged grazing by livestock.
- Two introduced species listed as noxious weeds for Bland Shire were recorded, namely, the African Boxthorn (*Lycium ferocissimum*) and Bathurst Burr (*Xanthium spinosum*).
- The reduction of grazing in the study area since the commencement of the CGM has seen a substantial recovery of the native understorey in all areas.

Conclusions

In summary the following conclusions were made:

- It is likely that the biodiversity values of the region would be maintained and possibly improved, considering the proposed measures to mitigate and/or offset potential impacts.
- The modified CGM will result in the loss of a local occurrence of the Myall Woodland EEC, however, it is unlikely to lead to the loss of the community in the surrounding area.
- The modified CGM is unlikely to lead to the extinction of any flora species, population or ecological community or place any at risk of extinction.
- The modified CGM will not affect any listed threatened population of a flora species.
- The modified CGM is unlikely to adversely affect critical habitat as no critical habitats are known to occur within the vicinity of the E42 Modification area.
- The modified CGM is very unlikely to adversely affect areas of high conservation value.
- Vegetation that would be removed or changed by the modified CGM is not considered to adversely impact the long-term viability of any flora species, population or ecological community.
- Matters of national environmental significance are not likely to be significantly impacted by the modified CGM.

D1 INTRODUCTION

Barrick Australia Limited (Barrick) is proposing to modify a number of components of the approved Cowal Gold Mine (CGM), located approximately 38 kilometres (km) north-east of West Wyalong, New South Wales (NSW) (Figure D-1). Changes implemented to the approved CGM by the E42 Modification would result in the modified CGM. The modified CGM is scheduled to commence in approximately Year 5 of CGM operations. The main changes to the approved CGM as a result of the E42 Modification would include those presented in Figure D-2, and described below:

- an increase to the operational mine life;
- an increase in total production and maximum ore processing rate;
- an increase in gold production;
- an increase in the total surface area of the open pit;
- an increase in the total volume of waste rock;
- an increase in the height and surface area of the northern and southern waste emplacements;
- a reduction in the height of the perimeter waste emplacement in places;
- an increase in the total volume of tailings produced;
- an increase in the total surface area of low grade ore stockpiles;
- an increase in the height of the northern and southern tailings storage facilities;
- extraction of saline water from a saline groundwater supply borefield located within Mining Lease (ML) 1535; and
- other associated minor changes to infrastructure, plant, equipment and activities

D1.1 SURVEY AND ASSESSMENT OBJECTIVES

The objectives of the flora survey and assessment were to:

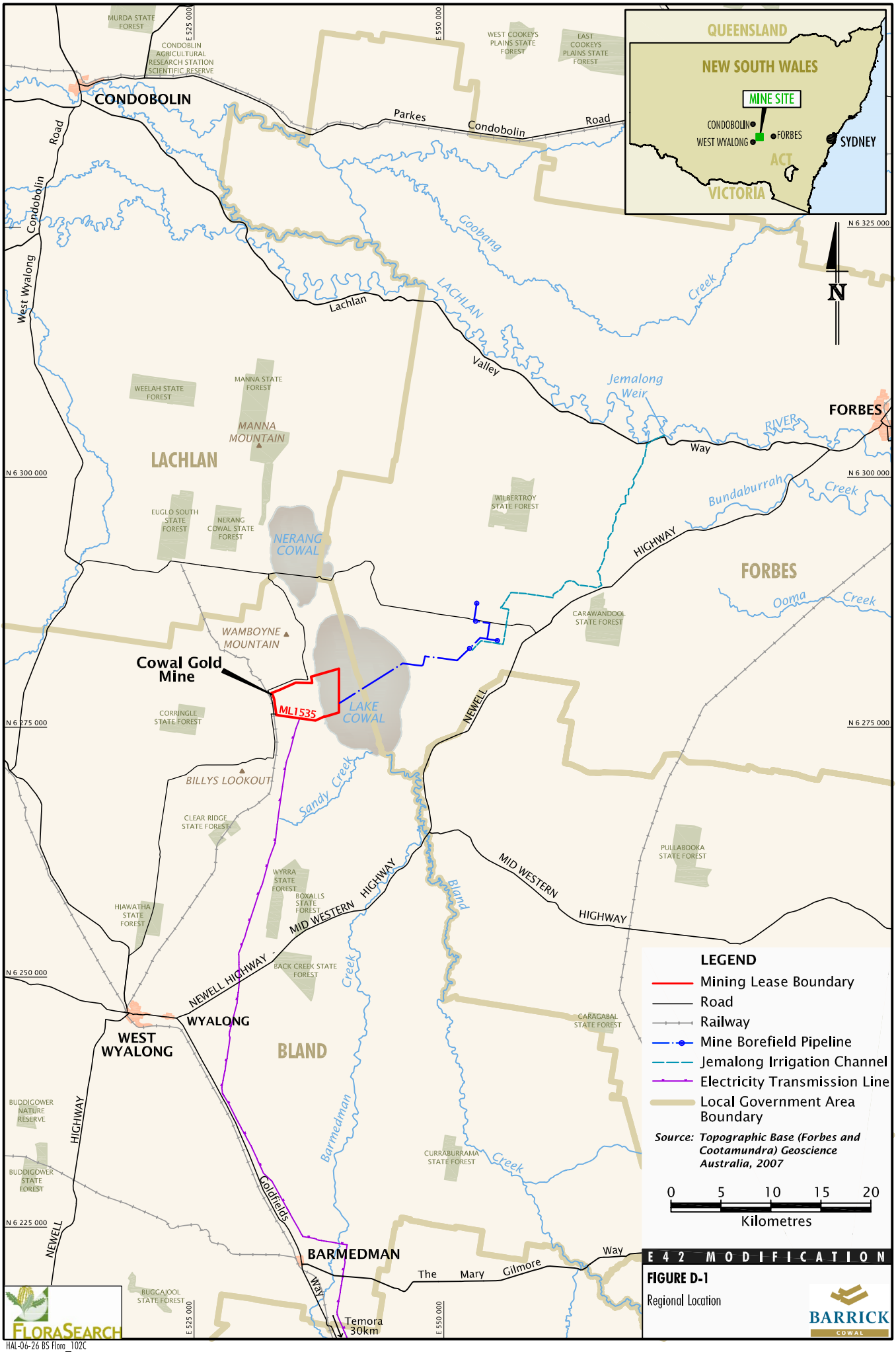
- Identify the vegetation communities present in the study area.
- Map the distribution of each vegetation community.
- Compile lists of flora species in each vegetation community.
- Conduct targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area (including those listed under the schedules of the NSW *Threatened Species Conservation Act, 1995* [TSC Act] and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]).
- Identify the potential impacts of the modified CGM on flora including threatened flora species and ecological communities.

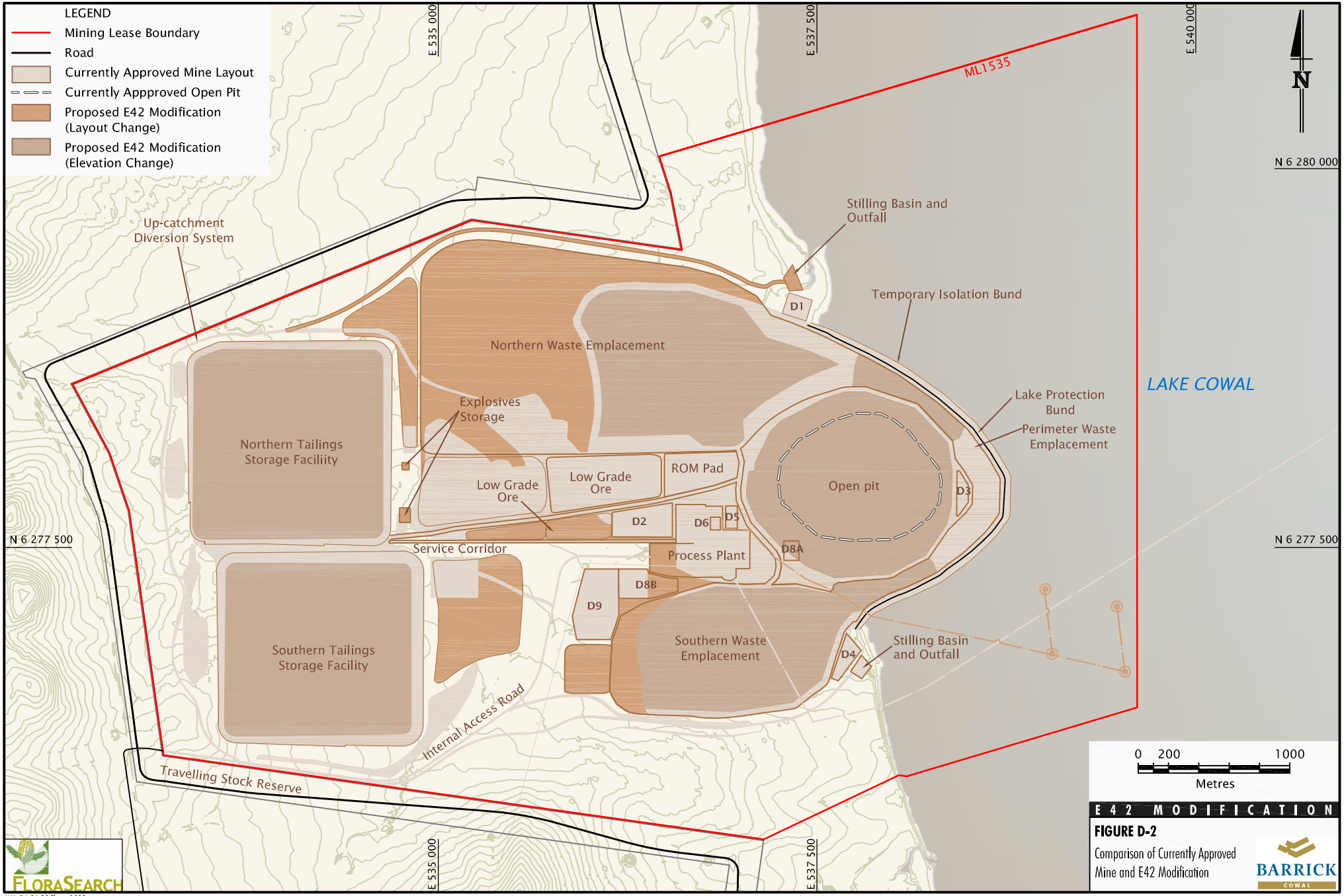
This Flora Assessment was prepared in accordance with the *Draft Guidelines for Threatened Species Assessment* (NSW Department of Environment and Conservation [DEC] and Department of Primary Industries [DPI], 2005).

The study area covers the E42 Modification area shown on Figure D-2.

D1.2 DESCRIPTION OF THE STUDY AREA

The study area is located on the central western plains of NSW towards the western edge of the exposed rocks of the Lachlan Fold Belt geological formation and is close to the western edge of the ephemeral Lake Cowal.


QUEENSLAND
NEW SOUTH WALES
MINE SITE
CONDOBOLIN
WEST WYALONG
FORBES
SYDNEY
ACT
VICTORIA
CONDOBOLIN
Parkes Road
Condobolin Road
West Wyalong Road
Lachlan Valley Way
Goobang Creek
LACHLAN
Jemalong Weir
FORBES
RIVER
Way
Bundaburrah Creek
HIGHWAY
FORBES
Ooma Creek
LACHLAN
MANNA MOUNTAIN
WAMBOYNE MOUNTAIN
NERANG COWAL
LAKE COWAL
Cowal Gold Mine
ML1535
NEWELL HIGHWAY
MID WESTERN HIGHWAY
Sandy Creek
Bland Creek
BILLYS LOOKOUT
WYALONG
WEST WYALONG
BLAND
BARMEDMAN
Barmedman Creek
Goldfields Way
The Mary Gilmore Way
Temora 30km
MURDA STATE FOREST
CONDOBLIN AGRICULTURAL RESEARCH STATION SCIENTIFIC RESERVE
WEST COOKEYS PLAINS STATE FOREST
EAST COOKEYS PLAINS STATE FOREST
WEELAH STATE FOREST
MANNA STATE FOREST
EUGLO SOUTH STATE FOREST
NERANG COWAL STATE FOREST
WILBERTROY STATE FOREST
CARAWANDOOL STATE FOREST
CORRINGLE STATE FOREST
CLEAR RIDGE STATE FOREST
WYRRA STATE FOREST
BOXALLS STATE FOREST
BACK CREEK STATE FOREST
HIAWATHA STATE FOREST
PULLABOOKA STATE FOREST
CARACABAL STATE FOREST
CURRABURRAMA STATE FOREST
BUDDIGOWER NATURE RESERVE
BUDDIGOWER STATE FOREST
BUGGAJOOL STATE FOREST
E 525 000
E 550 000
N 6 325 000
N 6 300 000
N 6 275 000
N 6 250 000
N 6 225 000
N
LEGEND
Mining Lease Boundary
Road
Railway
Mine Borefield Pipeline
Jemalong Irrigation Channel
Electricity Transmission Line
Local Government Area Boundary
Source: Topographic Base (Forbes and Cootamundra) Geoscience Australia, 2007
0 5 10 15 20
Kilometres
E42 MODIFICATION
FIGURE D-1
Regional Location
BARRICK
COWAL
FLORASEARCH
HAL-06-26 BS Flora_102C



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D1.2.1 Landforms

Landforms found on and near the study area are mainly ephemeral lacustrine (e.g. Lake Cowal), extensive gilgai areas, stagnant alluvial plains with ephemeral drainage lines and low hills (e.g. Cowal West Hill). The terrain of the study area is flat to gently undulating, with a local relief of less than Relative Level (RL) 20 meters (m) Australian Height Datum (AHD) between the alluvial plain and Cowal West Hill.

Gilgai landscapes consist of exaggerated unevenness in the soil surface with irregularly spaced low mounds and shallow depressions (Taylor, 1960). Gilgai forms in high clay content soils subject to periods of extreme wetness and drought. The precise mechanism of gilgai formation is unknown but may relate to swelling within the B horizon when it is wetted (Anne Clements and Associates, 1995). This may result in upward pressure and mound formation. There may also be potential effects related to rapid infiltration of water through cracks after drought causing expansion of the B horizon before the A horizon is fully wetted (Taylor, 1960; Beadle, 1981). Another model proposes that depressions are caused by less easily wet, and hence less plastic, blocks of soil sinking relative to less dense, more easily wet surrounding soil (Beadle, 1981). Some gilgai depressions are relatively impermeable with a thick sticky grey mud base and form shallow ponds after heavy rain.

D1.2.2 Geology

The dominant geological feature of the study area is Cowal West Hill an isolated outcrop of remnant Manna Conglomerate laid down in Late Silurian times (ca. 420 Ma) (Lyons *et al.* 2000). Manna Conglomerate comprises mainly rounded quartzite, shale and limestone clasts in a medium to coarse-grained sandstone matrix with sparse clay.

The remainder of the study area is said by Lyons *et al.* (2000) to comprise shallow slope colluvial plains, which are areas of low relief having defined ephemeral drainage lines. However, this is at variance with the work of the NSW Department of Land and Water Conservation (DLWC) (1994) who concluded that the study area is a stagnant alluvial plain after detailed sampling of the soils (see also below).

Two ephemeral drainage lines occur within the study area; one aligned around the north side of Cowal West Hill from the west and the other aligned around the southern side of the southern tailings storage facility and southern waste emplacement.

The stagnant alluvial plains of the region are considered to have developed from as long ago as the end of the Carboniferous (300 Ma) until the end of the Tertiary (2 Ma) (Lyons *et al.,* 2000).

D1.2.3 Soils

King (1998) maps and describes five soil landscapes which cover the study area:

- Reefton Erosional Soil Landscape (Cowal West Hill);
- Marsden Gilgai Soil Landscape (gilgai areas);
- Wah Way Alluvial Soil Landscape (Colluvial Plains);
- Transferral Boxalls Soil Landscape; and
- Alluvial Boxalls Soil Landscape.

There is disagreement between the interpretation of the plains geology in King (1998), who describes the geology as alluvial; Lyons *et al.* (2000), who treat it as colluvial; and DLWC (1994) who consider it to be a stagnant alluvial soil landscape. Since DLWC (1994) examined the soil on the study area in detail, it is considered here to be a stagnant alluvial soil landscape. As such, the later soil descriptions (Wah Way Soil Landscape) applied by King (1998) to the study area are likely to be incorrect, as is the assertion by Lyons *et al.* (2000) that the landscape is colluvial.

The topsoils on Cowal West Hill are reported to be a very shallow (<10 centimetres [cm]) dark reddish brown, gravelly sandy loam, often over bedrock. Where developed, the subsoils are a reddish brown, gravelly sandy clay loam. The soils are very strongly acid and of very low fertility.

In accordance with the DLWC (1994), it is considered that the Euglo Stagnant Alluvial Soil Landscape (King, 1998) is a better fit for the study area than the Wah Way Alluvial Soil Landscape indicated by King (1998). This is due to the elevation of the terrain above the active floodplain and the dominant tree species present, which include Wilga (*Geijera parviflora*) and Rosewood (*Alectryon oleifolius*). The dominant soils of the Euglo Soil Landscape are red earths and red podzolic soils. The red earth A1 horizon is a dark reddish brown sandy clay loam about 10 cm deep (pH 5.5) above a weakly differentiated similar A2 horizon about 15 cm deep with a weakly pedal B2 horizon of dark reddish brown sandy clay loam more than 60 cm deep (pH 7.5). The red podzolic soil has a similar sandy loam topsoil (PH 6.0) to the red earth, but with a reddish brown medium clay moderately pedal subsoil (pH 5.5) extending beyond 80 cm deep.

The gilgai soils include red, brown and grey clays (King, 1998). The DLWC (1994) describe the gilgai soils as follows:

> *The surface soil is typically 5-10 cm deep, moderately to strongly structured and has medium clay texture. Colour varies from greyish olive to dark reddish brown. There is a clear to gradual change to the underlying strongly pedal, medium to heavy clay textured subsoil. The colour of the upper subsoil is typically greyish olive (grey clays), brown (brown clays) or dark reddish brown (red clays). These clays extend to at least 2 metres depth.*
>
> *Surface soils are moderately acid to moderately alkaline (pHw 5.8-8.3). Subsoils shallower than about 1 metre depth are neutral to very strongly alkaline (pHw 6.9-9.3). Below about 1 metre the soil varies from extremely acid to very strongly alkaline (pHw 4.4-9.6).*

D1.2.4 Landuse

The study area is former cleared and semi-cleared farmland that was used for grazing of predominantly native pastures by livestock. The original native tree cover has largely been removed except for scattered individual trees, often Wilga or Rosewood, or small stands of Belah (*Casuarina cristata*) and Bimble Box (*Eucalyptus populnea*). The exception is Cowal West Hill which retains a higher proportion of its original tree cover, due to its shallow soils and poorer grazing potential. The tree cover on Cowal West Hill has been thinned by logging of White Cypress Pine (*Callitris glaucophylla*) in the past. The main landuse within ML 1535 is now mining.

D1.2.5 Climate

The study area lies in the 'temperate – no dry season (hot summer)' zone defined by Stern *et al.* (2000).

There are two Commonwealth Bureau of Meteorology weather stations near the study area at similar altitudes; Wyalong (RL 245 m AHD, 36 km south-west) and Quandialla (RL 250 m AHD, 54 km south-east). The mean annual rainfall at Wyalong and Quandialla is 476 and 524 millimetres (mm), respectively (Table D-1) and on average is distributed fairly evenly through the year. The lowest mean monthly rainfall figures are zero for all but three and four months, respectively, at Wyalong and Quandialla, indicating that months without any rainfall are common (Table D-1). Nevertheless, the highest mean monthly rainfalls indicate that both locations may experience periods of very high rainfall, emphasising high rainfall variability.

Table D-1
Average Monthly Maximum and Minimum Daily Temperatures, Rainfall and Relative Humidity for Wyalong and Quandialla

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Average or Total
Wyalong													
Mean daily max temp (°C)	32.6	31.9	28.8	23.6	18.6	14.9	14.0	15.9	19.4	23.3	27.0	30.6	23.4
Mean daily min temp (°C)	17.4	17.4	14.5	10.0	6.8	4.0	3.0	3.9	6.1	9.3	12.3	15.3	10.0
Mean rainfall (mm)	42.6	37.3	36.0	35.7	39.3	42.5	41.9	39.4	36.9	46.0	36.2	42.7	476.4
Highest rainfall (mm)	317.3	235.5	180.3	195.3	157.6	165.3	147.8	98.1	128.6	145.1	168.8	176.8	851.2
Lowest rainfall (mm)	0.0	0.0	0.0	0.0	0.0	1.6	3.1	0.5	0.0	0.0	0.0	0.0	180.8
Mean RH (9.00 am)	55	61	63	67	79	87	88	79	70	59	58	55	68
Mean RH (3.00 pm)	33	36	37	43	52	62	62	53	48	40	36	35	45
Quandialla													
Mean daily max temp (°C)	32.9	32.1	29.0	24.1	19.1	15.1	14.3	16.2	19.4	23.6	27.4	31.4	23.7
Mean daily min temp (°C)	17.1	16.9	13.8	9.6	6.4	3.9	2.8	3.6	5.5	8.7	11.8	14.9	9.6
Mean rainfall (mm)	49.6	42.1	43.3	42.0	43.7	40.3	44.1	42.9	40.5	51.0	41.2	42.8	523.7
Highest rainfall (mm)	297.2	139.7	265.7	240.2	159.3	113.4	170.6	127.8	148.8	182.8	122.9	168.3	972.3
Lowest rainfall (mm)	0.0	0.0	0.0	0.0	0.0	0.6	2.0	4.4	1.8	0.0	0.0	0.0	140.4
Mean RH (9.00 am)	57	63	66	68	80	86	86	81	73	65	62	58	70
Mean RH (3.00 pm)	31	33	35	40	53	64	62	57	52	41	37	33	45

Source: Bureau of Meteorology (2008a; 2008b). Climate Statistics current as at 3 July 2008.

°C: degrees Celsius
RH: Relative Humidity

The temperature data (Table D-1) indicates that the study area experiences a Mediterranean seasonal climate of cool to mild winters, hot summers and warm spring and autumn weather. As would be expected from the moderate rainfall and high temperatures, the mean monthly relative humidity levels at 3.00 pm are low, below 50% in all months except May to August at Wyalong and May to September at Quandialla (Table D-1).

D1.3 BOTANICAL/BIOGEOGRAPHICAL REGIONS

The study area is located in the Central Western Slopes Botanical Division of NSW (Anderson, 1968; Harden, 1990-2002). It is also located within the NSW South Western Slopes Biogeographic Region as defined by the *Interim Biogeographic Regionalisation for Australia* (IBRA) (Thackway and Cresswell, 1995; Department of the Environment, Water, Heritage and the Arts [DEWHA], 2008a). The South Western Slopes Bioregion is based within the southern half of the inland slopes of the Great Dividing Range, approximately between altitudes of RL 200 m AHD and RL 500 m AHD. The South Western Slopes Bioregion comprises 80,017 square kilometres (km^2) in NSW.

D1.4 PREVIOUS VEGETATION STUDIES

Previous vegetation studies are described in the following sections.

D1.4.1 Vegetation Classification and Mapping

A vegetation survey of ML 1535 and surrounds was conducted by Anne Clements and Associates (1995) and Charles Sturt University (1997). Vegetation mapping for the *Cowal Gold Project Environmental Impact Statement* (EIS) (North Limited, 1998) and *Cowal Gold Project Species Impact Statement* (SIS) (Resource Strategies, *et al.* 1997) was produced from studies by Charles Sturt University (1997). Bower mapped vegetation along the pipeline route to the approved CGM borefield on the eastern side of Lake Cowal (Figure D-1) (Bower, 2003a) and along the access road from West Wyalong to the approved CGM (Figure D-1) (Bower, 2003b). In 2005, a botanical assessment of remnant vegetation in the Lake Cowal area was undertaken by the Lake Cowal Foundation (2005).

Broader vegetation studies covering the study area have been conducted by Sivertson and Metcalfe (1995) and Austin *et al.* (2000). Sivertson and Metcalfe (1995) described the vegetation on the Forbes 1:250,000 map sheet and Austin *et al.* (2000) analysed the vegetation of the Central Lachlan Region. The study of Sivertson and Metcalf (1995) mapped only three vegetation communities in the Lake Cowal area and is not considered further here.

A number of distinct vegetation associations were identified for the region around Lake Cowal in the definitive study by Austin *et al.* (2000). Table D-2 compares the regional associations identified by Austin *et al.* (2000) with the equivalent Lake Cowal communities distinguished by North Limited (1998).

The EIS (North Limited, 1998) described a Eucalypt Woodland vegetation community that contained Dwyers Red Gum (*E. dwyeri*), Bimble Box (*E. populnea*), Inland Grey Box (*E. microcarpa*), White Cypress (*C. glaucophylla*) and Belah (*C. cristata*). However, it is considered that this community is actually an amalgamation of multiple community types recognised by Austin *et al.* (2000), including a Dwyers Red Gum (*E. dwyeri*) and White Cypress (*C. glaucophylla*) community which is likely to occur on Cowal West Hill and Poplar Box community which is likely to have occurred on the flatter landscapes.

Table D-2
Vegetation Communities in the Wider Area Surrounding ML1535

Austin *et al.* (2000)			EIS (North Limited, 1998)
No.	**Common Name**	**Scientific Name**	
19	Poplar Box	*E. populnea*	Part of Eucalypt Woodland *(E. dwyeri/E. populnea/E. microcarpa/ C. glaucophylla/C. cristata*). (Only *E. populnea* is a dominant species within the equivalent Austin *et. al.,* [2000] community).
22	Wilga/Belah/Poplar Box	*G. parviflora/C. cristata/E. populnea*	Wilga Woodland (G. *parviflora/C. cristata*).
			Belah Woodland (*C. cristata*).
			Predominantly Cleared Agricultural Land with Scattered Bimble Box Woodland (E. populnea).
64	Dwyer's Mallee Gum/White Cypress Pine/Currawang	*E. dwyeri/C. glaucophylla/A. doratoxylon*	Remnant Woodland (*E. dwyeri/ A. doratoxylon/ Callitris* sp.). Part of Eucalypt Woodland *(E. dwyeri/E. populnea/E. microcarpa/ C. glaucophylla/C. cristata*). (Only *E. dwyeri* and *C. glaucophylla* are dominant within the equivalent Austin *et. al.,* [2000] community).
68	Myall	*Acacia pendula*	Mixed Woodland (*A. pendula/C. cristata*).
71	River Red Gum	*E. camaldulensis*	Fringing River Red Gum Woodland (*E. camaldulensis*).
72	Lignum/River Red Gum/River Cooba	*M. florulenta/E. camaldulensis/Acacia stenophylla*	*M. florulenta.*
			Eragrostis australasica.

D1.4.2 Targeted Searches

Since 1998, Bower (Orchid Research and FloraSearch) has conducted a number of targeted threatened species searches in the study area and surrounds. Targeted threatened species searches were conducted at the approved CGM and pipeline (Bower, 1997; 1998a; 1998b; 2003a; Barrick 2003a), along the Temora to Cowal Electricity Transmission Line (Bower, 2003c; Country Energy, 2004) and along the approved CGM access road upgrade (Bower, 2003b; 2003c; Barrick, 2003b).

These previous targeted threatened species searches were conducted for all threatened flora species likely to occur within the study area (Section D1.5.3).

The following sections discuss the occurrence of threatened flora found during the previous targeted threatened species searches. Of the threatened species found, only the Austral Pillwort was recorded within ML 1535.

Austral Pillwort (Pilularia novae-hollandiae)

In 1995, the Austral Pillwort was recorded during surveys of the Lake Cowal region by Anne Clements and Associates (1995), approximately 12 km south-east of ML 1535 (North Limited, 1998). At the time of the survey, these findings represented an extension of the known range of Austral Pillwort in the Central Western Slopes of NSW (Bower, 1997).

In 1998, a targeted survey for the Austral Pillwort was conducted by Bower (1998a) in ML 1535 and wider area. The survey indicated that the Austral Pillwort is a relatively common inhabitant of gilgai depressions not only in ML 1535 but also in much of the gilgai habitat that is found on the western side of Lake Cowal both to the north and south of ML 1535 (Bower, 1998a).

In 2003, an additional targeted survey for the Austral Pillwort was conducted by Bower (2003d). The survey again located the Austral Pillwort within ML 1535.

Tricolor Diuris (Diuris tricolor syn. Diuris sheaffiana)

During a targeted search conducted along the approved CGM access road upgrade in 2004 (Figure D-1) (Bower, 2004a), the Tricolor Diuris was identified within the road reserve and adjoining private properties, as well as several other large populations in the wider region.

The identification of several large populations of this species in a short two day survey suggests that the Tricolor Diuris is almost certainly more widespread in the region.

Spiny Peppercress (Lepidium aschersonii)

During targeted searches conducted in 2004 along the Temora to Cowal Electricity Transmission Line (Figure D-1), the Spiny Peppercress was found in multiple locations from south of Barmedman to north of West Wyalong (Bower, 2004b). The number of individuals located was estimated to be over 10,000 (Bower, 2004b).

The Spiny Peppercress was found in a diverse range of habitats (Bower, 2004b). Most populations occurred in Belah (*Casuarina cristata*) woodland on gilgai soils however others occurred in mallee dominated by Bull Mallee (*Eucalyptus behriana*) as well as Grey Box (*E. microcarpa*)/Buloke (*Allocasuarina luehmannii*) woodland (Bower, 2004b).

The habitats in which the Spiny Peppercress were found differ markedly from those recorded in the literature, almost all of which relate to Victorian populations (Leigh *et al.*, 1984; Harris and Smith, 2000). In Victoria, the Spiny Peppercress occurs in saline situations bordering lakes or in salt marshes (Leigh *et al.,* 1984) on 'heavy black or clay soil' in areas experiencing 'seasonal waterlogging or inundation' (Harris and Smith, 2000).

Aromatic Pepper-cress (Lepidium hyssopifolium)

The Aromatic Pepper-cress is a perennial herb to 50 cm in height (Retter and Harden, 2000). This species was reported to occur in the Lake Cowal area by Vestjens (1977). Bower, (1998b) conducted a targeted search for the Aromatic Pepper-cress within ML 1535, however, no specimens were found. As a result of the survey, it was considered by Bower (1998b) that the species recorded by Vestjens (1977) was likely to have been *Lepidium pseudohyssopifolium*, a common species of peppercress similar to *L. hyssopifolium*, but which was not been recognised as distinct until later studies by Hewson (1982). *L. hyssopifolium sensu stricto* is confined to grassy eucalypt woodlands on the tablelands in NSW (Retter and Harden 2000).

Potential habitat for the Aromatic Pepper-cress is not considered to occur within the E42 Modification area or immediate surrounds. This species is not considered further in this report.

Silky Swainson-pea (Swainsona sericea)

The Silky Swainson-pea was found during targeted searches conducted in 2004 along the approved CGM access road upgrade (Figure D-1) (Bower, 2004c). Following the identification of this species along the access road upgrade, further surveys were conducted to determine whether the species occurs more widely in the region.

The abundance of the Silky Swainson-pea in NSW is largely unknown (NSW Scientific Committee, 1999), although the NSW Scientific Committee (1999) states that the known populations vary in size from 50 to 1000 plants and that it is likely that less than 10,000 mature individuals remain in nature in NSW. While the population of this species along the access road upgrade is within the size range of known populations, that on the Ungarie/Condobolin Road (30 km north-northwest of the access road upgrade) greatly exceeds the previous total population estimate of this species in NSW. The Ungarie/Condobolin Road population is very large comprising at least 100,000 individuals and possibly many more.

D1.5 THREATENED ECOLOGICAL COMMUNITIES, POPULATIONS AND SPECIES

A desktop assessment was undertaken to determine the threatened ecological communities, populations and species that occur within the wider region.

D1.5.1 Threatened Ecological Communities

Five threatened ecological communities listed under the TSC Act are known to occur in the South Western Slopes Bioregion, one of which is also listed under the EPBC Act (Table D-3). However, only two of the five listed communities, the Myall Woodland Endangered Ecological Community (Myall Woodland EEC) and the Inland Grey Box Woodland EEC, have potential to occur in the study area (Table D-3). Table D-3 justifies the exclusion of the other three communities from further consideration. Threatened ecological communities can be 'endangered' or 'critically endangered' ecological communities under the TSC Act and EPBC Act (Table D-3).

Table D-3
Threatened Ecological Communities Known to Occur within the Wider Region

Community Name	Conservation Status		Comment
	TSC Act[1]	EPBC Act[2]	
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain , Murray Darling Depression, Riverina and NSW South Western Slopes Bioregions	E	-	Myall Woodland occurs in the Lake Cowal region (Table D-2) on stagnant alluvial plains, especially on gilgai landscapes that are very wet in average winters. It is frequently associated with Belah (*Casuarina cristata*).
Inland Grey Box Woodland in the Riverina, South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.	E	-	Inland Grey Box trees are present in the region surrounding Lake Cowal (Table D-2) and includes communities 8, 10, 11, 12, 13 of Austin *et al.* (2000).
White Box Yellow Box Blakely's Red Woodland	E	CE	White Box Yellow Box Blakely's Red Woodland occurs in the eastern areas of the South Western Slopes Bioregion and is absent from the vicinity of Lake Cowal. Predictive mapping by Austin *et al.* (2000) shows that communities including Yellow Box generally do not occur further west than the Jemalong Range. East of the Jemalong Range, Yellow Box associates mainly with Inland Grey Box (Austin *et al.* 2000). Blakely's Red Gum and White Box generally occur much further to the east. Similarly, Anne Clements and Associates (1995) reported Yellow Box from only one ridge in Nerang Cowal State Forest in the Lake Cowal region, stating that it was at its western range limit.
Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	E	-	Fuzzy Box Woodland occurs mainly in the Dubbo-Narromine-Parkes-Forbes area (DEC, 2004) and is absent from the Lake Cowal region (Austin *et al.* 2000).
Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western slopes bioregions	E	-	Sandhill Pine Woodland is largely restricted to the south-western parts of the South Western Slopes Bioregion in the catchments of the Murray and Murrumbidgee Rivers (NSW Department of Environment and Climate Change [DECC], 2008a). It does not appear to occur in the Lachlan catchment. Sandy soils suitable for this community are not known to occur in the Lake Cowal region.

[1] Threatened Species Status under the TSC Act.

[2] Threatened Species Status under the EPBC Act.
E Endangered
CE Critically Endangered

D1.5.2 Threatened Populations

Twenty three plant populations are listed as endangered in Schedule 1, Part 2 of the TSC Act (DECC, 2008b). None occur in the South Western Slopes Bioregion.

D1.5.3 Threatened Species

Threatened species are considered likely to occur within the study area. A desktop assessment was undertaken to determine the threatened species which occur within the wider region.

Table D-4 provides a list of threatened flora species which was compiled based on searches of the following databases for a 400 km^2 search area surrounding the E42 Modification area:

- DECC (2008c) Atlas of NSW Wildlife;
- Sydney Royal Botanic Gardens (SRBG) database (2008a).

- EPBC Act Protected Matters Search (DEWHA, 2008b); and
- BioNet (2008) database.

Table D-4
Threatened Species Recorded or Predicted within the Wider Area

Scientific Name	Common Name	Conservation Status		Source of Record			
		TSC Act[1]	EPBC Act[2]	DECC Atlas of NSW Wildlife[3]	SRBG[4]	EPBC Act Protected Matters Search[5]	BioNet[6]
Lepidium aschersonii	Spiny Pepper-cress	V	V	-	✓	-	✓
Pilularia novae-hollandiae	Austral Pillwort	E	-	-	✓	-	✓
Swainsona sericea	Silky Swainson-pea	V	-	-	✓	-	✓
Diuris tricolor syn. *Diuris sheaffiana*	Tricolour Diuris	V	V	-	-	Predicted	-
Austrostipa wakoolica	A Speargrass	E	E	✓	-	Predicted	✓
Austrostipa metatoris	A Speargrass	V	V	-	-	Predicted	-
Swainsona murrayana	Slender Darling-pea	V	V	-	-	Predicted	-

[1] Threatened Species Status under the TSC Act.

[2] Threatened Species Status under the EPBC Act.

V Vulnerable E Endangered

[3] DECC (2008c).

[4] SRBG (2008a).

[5] DEWHA (2008b).

[6] BioNet (2008).

In addition to the threatened flora species listed in Table D-4, the Winged Peppercress (*Lepidium monoplocoides*) is considered to potentially occur in the study area, given the occurrence of potential habitat resources (e.g. Poplar Box woodland).

The Austral Pillwort (*Pilularia novae-hollandiae*) is the only threatened flora species to have been previously recorded within ML 1535 as discussed in Section D1.4.

The species discussed in this section were the subject of targeted searches in the study area (Section D2) and evaluation of potential impacts provided in Section D4.5.

D2 METHODS

The survey was used to:

- confirm the distribution of vegetation communities in the study area;
- confirm flora species present in each vegetation community; and
- identify any threatened flora species and ecological communities within the E42 Modification area (including those listed under the schedules of the TSC Act and the EPBC Act).

Targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area were conducted. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

D2.1 SURVEY TIMING

Field work for the survey was conducted on 4 and 5 March 2008.

D2.2 WEATHER

Although drought conditions prevailed across the study area for most of the six years prior to 2008, the four months leading up to the survey had average to above average rainfall (Table D-5). The rain stimulated germination of many grass and herbaceous species, which were well developed at the time of the survey.

Table D-5
Monthly Rainfall Prior to the Survey

Location	Rainfall (mm)			
	November	December	January	February
Wyalong	65.4	85.2	35.0	37.8
Quandialla	76.2	108.0	54.8	42.6

Source: Bureau of Meteorology (2008)

D2.3 VEGETATION SAMPLING

The vegetation was surveyed by a combination of quadrat sampling and random meander searches.

D2.3.1 Quadrat Sampling

Seven 20 × 20 m quadrat samples were surveyed. These were distributed in two areas containing remnant natural tree and/or shrub cover in order to sample all plant communities and to record the full range of native plant species. The Australian Map Grid (AMG) coordinates were recorded for each quadrat using a hand-held Global Positioning System (GPS). Each quadrat was thoroughly searched to compile a complete list of vascular plant species.

D2.3.2 Random Meander Searches for Threatened Species

Targeted searches for threatened flora species considered possible occurrences within the study area (Table D-4) were conducted by three random meander searches, each of approximately 30 minutes duration. The searches were conducted in all habitat types.

D2.3.3 Species Listing

All observed plant species were recorded, whether or not they were identified on formal sample sites. Where plants could not be quickly identified in the field, a sample was taken back to the laboratory for identification using a binocular microscope and flora keys. The principal reference was the *Flora of NSW* (Harden, 1990-2002) and any updates on the PlantNet website (SRGB, 2008b). These sources are used as the primary basis for nomenclature in this report. However, updated taxonomy from published research is used for some groups that have been revised more recently.

D2.3.4 Defining Vegetation Communities

Vegetation communities were defined by the dominant plant species in each vegetation stratum and were interpreted in accordance with the vegetation community definitions in Austin *et al.* (2000). Natural vegetation communities are groups of plant species that commonly associate with each other, through a shared ability to survive and reproduce on certain physical sites under specific climatic conditions. One of the vegetation communities in the study area is a secondary or derived assemblage resulting from land clearing by landholders. Large parts of the study area have had the upper vegetation stratum removed, so that the current dominant vegetation comprises components of the former ground layer.

Vegetation communities identified from the field surveys were mapped in the field onto aerial photographs of the study area.

D2.4 HABITAT CONDITION ASSESSMENT

The condition of the native vegetation was assessed at each of the vegetation quadrat sites using the following parameters:

- **Native plant species diversity:** - the number of native plant species in the 20 × 20 quadrat.
- **Native overstorey cover:** – mean percent (%) cover of ground by the foliage of the uppermost vegetation layer; trees or tall shrubs (>1 m) estimated at 10 points along a 50 m transect.
- **Native midstorey cover:** – mean % cover of ground by the foliage of the middle vegetation layer; tall shrubs (>1 m), low trees and regeneration estimated at 10 points along a 50 m transect.
- **Native groundcover – grasses:** – Average of visual estimates of groundcover by native grasses estimated at 1 m intervals along a 50 m transect.
- **Native groundcover – shrubs:** – Average of visual estimates of groundcover by native shrubs less than 1 m high estimated at 10 points along a 50 m transect.
- **Native groundcover – other:** – Average of visual estimates of groundcover by native herbs, ferns etc. (less than 1 m high) estimated at 1 m intervals along a 50 m transect.
- **Exotic plant cover:** – Average of visual estimates of groundcover by exotic plant species estimated at 1 m intervals along a 50 m transect.
- **Number of trees with hollows:** – All living and dead standing trees with their centres in a 50 × 20 m area at each quadrat were examined for hollows capable of harbouring wildlife. Hollows are defined as tree holes > 5 cm diameter, having depth, and > 1 m above the ground.
- **Regeneration:** – Whether overstorey trees species on the quadrat are regenerating.
- **Total length of fallen logs:** – The length of fallen logs > 10 cm diameter and > 0.5 m long in a 50 × 20 m area at each quadrat.

D3 RESULTS AND DISCUSSION

D3.1 VEGETATION COMMUNITIES

Four plant communities were identified in the study area (Table D-6 and Figure D-3), two of which represent the original native climax vegetation of the study area (Communities 1 and 2). Community 3 is secondary native grassland resulting from extensive clearing for previous agricultural purposes and Community 4 occurs within Lake Cowal. The vegetation communities of the study area are described below.

Table D-6
Vegetation Communities within the E42 Modification Area

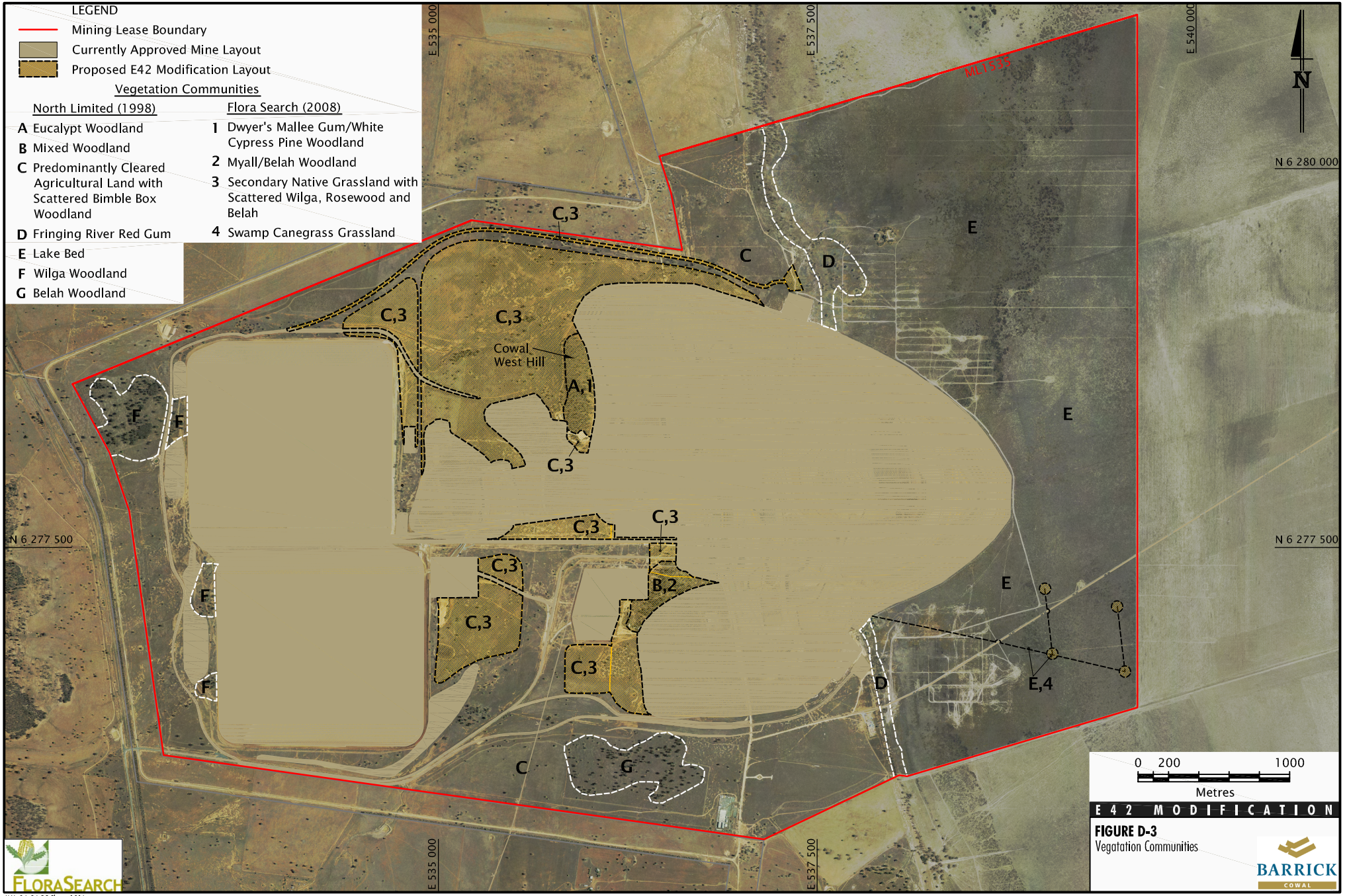
Community Number		Common Name	Scientific Names	Landscape Position
Modified CGM	Austin *et al*. (2000)			
1	64	Dwyer's Mallee Gum/ White Cypress Pine Woodland	*Eucalyptus dwyeri/ Callitris glaucophylla*	Cowal West Hill.[1]
2	68	Myall / Belah Woodland	*Acacia pendula / Casuarina cristata*	Gilgai areas.
3	-	Secondary Native Grassland with Scattered Wilga, Rosewood and Belah	*Geijera parviflora / Alectryon oleifolius / Casuarina cristata*	Gently sloping stagnant alluvial plain.
4	-	Swamp Canegrass Grassland	*Eragrostis australasica*	Lake Cowal.

[1] *Acacia doratoxylon*, which is a dominant species in community 64 of Austin *et al.* (2000), is absent from this community on Cowal West Hill.

Vegetation Community 1 – Dwyer's Mallee Gum/White Cypress Pine Woodland

This community is a component of the Eucalypt Woodland (*E. dwyeri/E. populnea/E. microcarpa/ C. glaucophylla/C. cristata*) community identified in the EIS and mapped on Figure D-3.

This community occurred only on the middle and upper slopes, and summit of Cowal West Hill on shallow soils derived from Silurian conglomerate rocks. The dominant tree is Dwyer's Red Gum (*Eucalyptus dwyeri*) in association with smaller occurrences of White Cypress Pine (*Callitris glaucophylla*) (Attachment DA). The lower slopes also support some Inland Grey Box (*E. microcarpa*) and Poplar Box (*E. populnea*) individual trees (Attachment DA). Tall shrubs (>1m) are absent, including Currawang (*Acacia doratoxylon*), that occurs in this community elsewhere in the region. Low shrubs and woody herbs (<1m) are mainly chenopods including Black Rolypoly (*Sclerolaena muricata*), Mallee Goosefoot (*Chenopodium desertorum* subsp. *anidiophyllum*) and Spiny-fruit Saltbush (*Atriplex spinibractea*) (Attachment DA). The groundcover comprises mainly various native grasses and herbs, the most common of which are Small Crumbweed (*Chenopodium pumilio*), Winged Fissure-weed (*Maireana enchylaenoides*), Buckbush (*Salsola kali*), Caustic Weed (*Chamaesyce drummondii*), Blue Storksbill (*Erodium crinitum*), Tarvine (*Boerhavia dominii*), Speargrass (*Austrostipa scabra*), Windmill Grass (*Enteropogon acicularis*) and Slender Panic (*Paspalidium gracile*). Introduced species were relatively uncommon, the most prominent being Paterson's Curse (*Echium plantagineum*), Paddy Melon (*Cucumis myriocarpus*) and Bathurst Burr (*Xanthium spinosum*).



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Vegetation Community 2 – Myall/Belah Woodland

This community is equivalent to the Mixed Woodland (*A. pendula/C. cristata*) community identified in the EIS and mapped on Figure D-3.

Community 2 occupies a small area of semi-cleared gilgai landscape in the proposed E42 Modification area near the southern waste emplacement. The dominant overstorey species is the tall shrub Weeping Myall (*Acacia pendula*) interspersed with stands of Belah (*Casuarina pendula*). Tall shrubs (>1m), other than Myall, are absent (Attachment DA). Low shrubs (<1m) include Ruby Saltbush (*Enchylaena tomentosa*), *Maireana microphylla*, Black Cotton Bush (*Maireana decalvans*), Spiny Saltbush (*Rhagodia spinescens*), Black Rolypoly (*Sclerolaena muricata*) and Lignum (*Muehlenbeckia florulenta*). The main groundcover herb and low shrub species are Tall Mulla Mulla (*Ptilotus exaltatus* subsp. *exaltatus*), *Maireana enchylaenoides*, Grey Copperburr (*Sclerolaena diacantha*), Caustic Weed (*Chamaesyce drummondii*), Corrugated Sida (*Sida corrugata*) and Pin Sida (*Sida fibulifera*). The dominant grasses are Windmill Grass (*Enteropogon acicularis*) and Fairy Grass (*Sporobolus caroli*). Introduced species were not prominent and included mainly the noxious shrub African Boxthorn (*Lycium ferocissimum*) and Prickly Sowthistle (*Sonchus asper*).

Vegetation Community 3 – Secondary Native Grassland with Scattered Wilga, Rosewood and Belah

This community is equivalent to the Predominantly Cleared Agricultural Land with Scattered Bimble Box (*E. populnea*) community identified in the EIS and mapped on Figure D-3.

Community 3 occurs on cleared grazing land with remnant scattered trees to the west of Cowal West Hill. The dominant remaining tree species are Wilga (*Geijera parviflora*) with occasional Rosewood (*Alectryon oleifolius*) and a patch of Belah (*Casuarina cristata*) and Bimble Box (*E. populnea*). The dominant trees indicate the original native vegetation was Community 22 of Austin *et al.* (2000) - the Wilga/Belah/Poplar Box (*Geijera parviflora/Casuarina cristata/Eucalyptus populnea*) community. The understorey is currently dominated by native grasses including *Austrostipa nitida*, Windmill Grass (*Enteropogon acicularis*), Weeping Lovegrass (*Eragrostis parviflora*), Purple Lovegrass (*Eragrostis lacunaria*), Yadbila Grass (*Panicum queenslandicum*), Jericho Wiregrass (*Aristida jerichoensis*) and Slender Panic (*Paspilidium gracile*). A watercourse traversing the northern side of the area supports an array of native grasses, sedges, rushes and herbs adapted to wet conditions, including Warrego Grass (*Paspilidium jubiflorum*), Rat's Tail Couch (*Sporobolus mitchellii*), Pepper Grass (*Paspilidium laevinode*), Early Spring Grass (*Eriochloa pseudoacrotricha*), Pale Spike-sedge (*Eleocharis pallens*), Flat Spike-sedge (*Eleocharis plana*), Field Woodrush (*Eleocharis pusilla*), Trim Flat-sedge (*Cyperus concinnus*), Poison Pratia (*Pratia concolor*), Shiny Dock (*Rumex tenax*), Common Nardoo (*Marsilea drummondii*) and *Juncus* species. Some introduced weeds were present, including large infestations of Bathurst Burr (*Xanthium spinosum*) along the watercourse that had recently been sprayed with herbicide.

Vegetation Community 4 – Swamp Canegrass Woodland

The Swamp Canegrass Grassland is equivalent to the Lakebed (*Eragrostis australasica*/*Medicago polymorpha*) community identified in the EIS and mapped on Figure D-3.

Trees are absent from this vegetation community.

The shrub species, Burr Medic (*Medicago polymorpha*) is an introduced, now naturalised, species that is now widespread throughout Australia.

Other grass species which commonly occur in this grassland include Blown Grass (*Lachnagrostis filiformis*) as well as introduced pasture grasses Perennial Ryegrass (*Lolium perenne*) and Barley Grass (*Hordeum leporinum*).

D3.2 FLORA SPECIES

Attachment DA lists the vascular flora species recorded in the survey for each quadrat and the random meanders. A total of 87 plant species was identified within the study area, of which 75 (86.2%) are native and 12 (13.8%) are introduced. The most prominent families of native plants in descending order were the Poaceae (Grasses) – 22 species, Chenopodiaceae (Saltbushes) – 16 species, Asteraceae (Daisies) – 6 species and Cyperaceae (Sedges) – 5 species. The dominant families of introduced species were the Asteraceae (Daisies) – 3 species, Boraginaceae (Heliotropes) - 2 species and Cucurbitaceae (Melons) – 2 species (Attachment DA).

The total number of plant species found during the survey is relatively low, despite having been conducted after good rain in preceding months (Table D-5) with subsequent high germination levels and growth of some herbaceous and grass species. The relatively low plant diversity can be attributed to a number of factors including:

- the relatively small survey area and low number of plant communities present;
- prolonged grazing of the entire study area by sheep over the last 150+ years, which would have removed many of the shrub and herb species that are most palatable to stock;
- past clearing of the area west of Cowal West Hill, and thinning out of the tree cover on Cowal West Hill and the gilgai area by previous pastoral landholders; and
- the autumn timing of the survey which did not allow spring flowering annual species to be recorded in the samples.

D3.3 THREATENED FLORA SPECIES

No species listed as threatened under the TSC Act or the EPBC Act were identified during this study. However, the survey timing was appropriate for the detection of *Lepidium aschersonii, Lepidium monoplocoides, Austrostipa wakoolica* and *Austrostipa metatoris*. None of these species, or potential habitat for them was detected by the survey and hence they are not subjected to full assessments of impact below (section D4.5). However, the survey timing was unsuitable for *Pilularia novae-hollandiae*, *Diuris tricolor*, *Swainsona sericea* and *Swainsona murrayana*, which are only positively identifiable when flowering or actively growing in spring. Potentially suitable habitat for *P. novae-hollandiae, D. tricolor* and *S. sericea* was found by the survey, however, no habitat for *S. murrayana* was identified. Accordingly, the potential impacts of the modified CGM on *P. novae-hollandiae, D. tricolor* and *S. sericea* are assessed in section D4.5.

D3.4 THREATENED ECOLOGICAL COMMUNITIES

Myall Woodland Endangered Ecological Community

One threatened ecological community listed under the TSC Act was found, *viz. Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions*. The Myall Woodland EEC equates to Community 2 recorded in this study (Table D-6; Figure D-3).

The potential impacts from the modified CGM on this ecological community are assessed in Section D4.6.

Inland Grey Box Woodland Endangered Ecological Community

As discussed in Section D1.4.1, the EIS (North Limited, 1998) described a Eucalypt Woodland vegetation community that contained Dwyers Red Gum (*E. dwyeri*), Bimble Box (*E. populnea*), Inland Grey Box (*E. microcarpa*), White Cypress (*C. glaucophylla*) and Belah (*C. cristata*).

Despite the occurrence of individual Inland Grey Box trees on the lower slopes of Cowal West Hill, the Inland Grey Box Woodland EEC does not occur within the E42 Modification area or the remainder of ML 1535. It is considered that the community described in the EIS (North Limited, 1998) is actually an amalgamation of multiple community types. It was confirmed during this study that the community that occurs on Cowal West Hill is Dwyers Red Gum/White Cypress Pine Woodland. Hence the Inland Grey Box Woodland EEC is not considered further.

D3.5 INTRODUCED AND NOXIOUS WEEDS

Twelve species of introduced plants were recorded in the study area (Attachment DA) comprising 13.8% of the total species observed. The number and abundance of introduced species was low despite the high levels of grazing to which the land had been subjected by previous pastoral owners, which tends to favour many introduced weeds. The relative lack of introduced species is largely due to the mid-autumn timing of the survey, since in western NSW most introduced species are annuals that germinate and grow in late autumn and winter, with flowering in early spring before they die back in late spring. By contrast, much of the native flora comprises perennial species that tend to grow and flower later and remain in evidence throughout the year.

Two species, African Boxthorn (*Lycium ferocissimum*) and Bathurst Burr (*Xanthium spinosum*), listed as Class 4 noxious weeds (*the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority*) in the Bland Shire (DPI, 2008), were recorded in Community 2 and all communities, respectively (Attachment DA). Barrick currently manage weeds at the approved CGM in accordance with measures described in the Land Management Plan (Barrick, 2003c).

D3.6 VEGETATION AND HABITAT CONDITION ASSESSMENT

The condition of the vegetation in the study area is influenced by a number of factors including land clearing, former prolonged grazing by livestock and the potential effects of recent drought conditions. Vegetation condition was assessed using ten variables. The data for each variable is summarised in Attachment DB. This data is used to assess the condition of each vegetation community below.

Vegetation Community 1 (Dwyers Mallee Gum / White Cypress Pine Woodland)

Vegetation Community 1 occurs on Cowal West Hill (Figure D-3). While the original pre-clearing state of the vegetation on Cowal West Hill is unknown, it is likely to have been similar to other examples of vegetation Community 1 in the nearby region. The trees on Cowal West Hill have been thinned historically by 75% or more to densities much lower than the original in order to promote the growth of groundcover species for grazing. This has resulted in generally low overstorey cover ratings (Attachment DB). In addition the health of many trees was poor at the time of the survey due largely to drought conditions over most of the previous six years. A large number of mature White Cypress Pines had died and many of the Dwyers Mallee Gum had undergone severe dieback of twigs and branches. Trees with dieback were resprouting from epicormic buds on the trunk and major branches. Tree regeneration was virtually absent (Attachment DB).

No midstorey or low shrub cover remains on Cowal West Hill due to past clearing and suppression of regeneration by grazing (Attachment DB). The former midstorey is likely to have included Currawang (*Acacia doratoxylon*) and Cough Bush (*Cassinia laevis*) among other species. By contrast with the midstorey, the understorey was in relatively good condition at the time of the survey. Native grass cover averaged 16.5% and other native groundcovers averaged 17.5% coverage (Attachment DB). The presence of relatively high levels of groundcover is the result of reduced grazing in the area since the commencement of mining. In addition, few introduced species were present and their groundcover percentages were below the level of detection with the methods used (Attachment DB). It is likely that weed levels would be higher in spring following germination and growth after autumn and winter rains. Nevertheless, the current condition of the groundcover suggests that withdrawal of grazing can result in considerable recovery of natural vegetation communities in the Lake Cowal area.

Overall, the condition of Community 1 is considered to be moderate.

Vegetation Community 2 (Myall/Belah Woodland)

Vegetation Community 2 occurs in a small area adjacent to the former 'Cowal West' homestead west of the current extent of the southern waste emplacement (Figure D-3). The community comprises scattered patches of Myall (*Acacia pendula*) and Belah (*Casuarina cristata*) on a gilgai landscape. Overstorey cover was sparse, averaging 14.2% (Attachment DB). Tree health of the Myall was generally poor. Most specimens are overmature and in decline, with multiple broken limbs and dieback. Prior constant grazing has suppressed regeneration over many decades, such that younger healthy Myall trees are generally absent. Like most acacias, Myall is relatively short-lived and populations need regular natural regeneration events to survive. The Belah was in better condition as the trees tend to be longer lived and the seedlings seem more resistant to grazing. The low shrub layer was sparse, averaging 2.7% cover (Attachment DB) and in poor condition owing to prolonged heavy grazing and several years of drought. The groundcover grasses were very patchy and tended to be best developed in openings where trees were absent. However, other native groundcover species were well represented, averaging 31% cover (Attachment DB). Overall, the groundcover diversity of native grasses and shrubs was high. Introduced plants were few in numbers of species and low in abundance (Attachment DB).

As with Community 1, there was evidence of recovery in Community 2 since the reduction of grazing following the commencement of mining. Juvenile plants of both Myall and Belah were present (Attachment DA) and recovery was evident in sub-shrubs such as Spiny Saltbush (*Rhagodia spinescens*), Eastern Cotton Bush (*Maireana microphylla*) and Lignum (*Muehlenbeckia florulenta*). Groundcover species were ungrazed and growing and reproducing rapidly. It is clear that this community would have a good capacity for recovery if grazing pressure were lifted.

Overall, the floristic condition of Community 2 is considered to be good, although the tree health of the Myall was generally poor and prior grazing has suppressed regeneration in past decades.

Vegetation Community 3 (Secondary Native Grassland with Scattered Wilga, Rosewood and Belah)

Vegetation Community 3 predominantly occurs to the west of Cowal West Hill. This area is dominated by native grasses with scattered remnant native Wilga, Rosewood, Belah and Poplar Box trees (Figure D-3). Although this area has been grazed for many decades, it does not appear to have been ploughed, cropped or pasture improved, at least in recent years. The dominance by native grasses suggests it has been managed as native pasture, which remains in reasonably good condition with relatively few introduced weeds. Past management and grazing have eliminated the former midstorey which would have featured a high diversity of native shrubs in the undisturbed condition. The health of the remnant trees is generally good despite some limb dieback due to past stress. However, the trees are becoming overmature and regeneration was absent. No plot assessments were conducted in this community due to its derived nature.

Overall, the floristic condition of vegetation Community 3 is considered to be poor.

Vegetation Community 4 – Swamp Canegrass Woodland

Vegetation Community 4 occurs within the lakebed and is adapted to the irregular wetting and drying cycle (Figure D-3). Historically throughout its drying cycle the lakebed has been subject to livestock grazing and, in some areas, cropping.

D4 EVALUATION OF POTENTIAL IMPACTS

The EIS (North Limited, 1998) and SIS (Resource Strategies, *et. al.,* 1997) assessed the short-term and long-term potential impacts of the approved CGM on flora. The modified CGM potential impact pathways would be largely the same as identified in the EIS (North Limited, 1998) and SIS (Resource Strategies, *et. al.,* 1997), the difference due to a small increase in the area proposed to be cleared.

The following sections evaluate the potential impacts of the modified CGM on flora species, populations and ecological communities, and their habitats in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). The magnitude, extent and significance of potential impacts are identified in the following sub-sections.

D4.1 VEGETATION CLEARANCE

The E42 Modification disturbance area covers approximately 290 hectares (ha) of land (Figure D-3). Climax vegetation communities that would be cleared or modified include:

- approximately 15 ha of Dwyers Mallee Gum/White Cypress Pine Woodland; and
- approximately 15 ha of Myall/Belah Woodland (equivalent to the Myall Woodland EEC which is assessed in Section D4.6.1).

Approximately 10 ha of Swamp Canegrass Grassland would also be cleared for the saline groundwater supply borefield (including the associated pipeline).

Approximately 250 ha of the Secondary Native Grassland with Scattered Wilga, Rosewood and Belah would also be cleared for the modified CGM.

Clearing native vegetation is a key threatening process listed under the TSC Act and the EPBC Act, however, the vegetation clearance required for the modified CGM is unlikely to significantly impact any vegetation communities, given:

- the relatively small areas of climax vegetation required to be cleared;
- all vegetation communities have been subject to partial or nearly complete land clearing (i.e. the condition of the Dwyers Mallee Gum/White Cypress Pine Woodland is moderate, the condition of the Myall/Belah Woodland is good and the condition of the Secondary Native Grassland with Scattered Wilga, Rosewood and Belah is poor); and
- the disjunct nature of the vegetation patches that are located adjacent to existing approved Mine infrastructure.

Potential indirect effects of vegetation clearance include weed and pest proliferation as discussed in Sections D4.2 and D4.3, respectively.

Measures to mitigate and offset potential vegetation clearance impacts are provided in Sections D5 and D6.

D4.2 INTRODUCED FLORA SPECIES

Twelve introduced flora species were recorded during the survey (Attachment DA). Two of these species are listed as noxious weeds for the Bland Shire, namely, the African Boxthorn (*Lycium ferocissimum*) and Bathurst Burr (*Xanthium spinosum*). Barrick currently manage weeds at the approved CGM in accordance with measures described in the Land Management Plan (Barrick, 2003c).

Disturbance can act as a catalyst for weed incursion and if management initiatives are not implemented, proliferation of weeds can occur.

The modified CGM is not considered to significantly increase the potential for weed incursion, given the weed control measures which would continue to be implemented (Section D5).

D4.3 INTRODUCED FAUNA SPECIES

Competition and grazing by the Feral European Rabbit (*Oryctolagus cuniculus*) is a key threatening process listed under the TSC Act (NSW Scientific Committee, 2002). The Feral European Rabbit and other introduced fauna can result in erosion problems as well as reduce recruitment and survival of native plants.

Introduced fauna have the potential to increase or become concentrated in the vicinity of the mine without the appropriate measures. However, given the pest control measures currently implemented at the approved CGM (Section D5), the modified CGM is unlikely to significantly increase the potential introduced fauna impacts on flora.

D4.4 VEGETATION AND DUST

Studies have shown that excessive dust can impact on the health and viability of vegetation. Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and allow penetration of phytotoxic gaseous pollutants (Farmer, 1993; Eller, 1977).

A study on the effect of dust on photosynthesis and its significance for plants (Thompson *et al.*, 1984) found that photosynthesis and leaf diffusion resistance was reduced at 5 to 10 grams (g) of dust per square metre (m^2) leaf surface.

An assessment of the potential generation and dispersion of atmospheric dust resulting from the modified CGM was carried out by Holmes Air Sciences (2008).

Given that predicted dust deposition contours (Holmes Air Sciences, 2008) indicate that levels of approximately 0.4 grams per square metre per month (g/m^2/month) or less are predicted to be contributed from the modified CGM or a total of 3.2 g/m^2/month or less with background contributions, vegetation species diversity and abundance in areas outside the ML are unlikely to be deleteriously affected. Further, the approach used by Holmes Air Sciences for predicting dust concentrations provides for a conservative assessment because the background levels are likely to include some contribution from the approved CGM (Holmes Air Sciences, 2008).

Measures to avoid and mitigate potential impacts from dust are provided in Section D5.

D4.5 THREATENED FLORA SPECIES

No threatened flora species were recorded during the survey. However, potential habitat for the Austral Pillwort (*Pilularia novae-hollandiae*), Tricolour Diuris (*Diuris tricolor*) and Silky Swainson-pea (*Swainsona sericea*) were found by the survey. (Section D3.3). The potential impacts from the modified CGM on these three species are assessed in Section D4.5.1 to D4.5.3, based on the questions in the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

The potential impacts from the modified CGM on other threatened flora species, which are less likely to be affected, are assessed in Section D4.5.4.

D4.5.1 Austral Pillwort (*Pilularia novae-hollandiae*)

Background

The Austral Pillwort is a widespread, small semi-aquatic perennial fern that grows in seasonally dry depressions, margins of marshes and gilgai country when wet (Bower, 1997). The growth cycle begins when gilgai depressions fill with water in wet winters and is completed before the mud dries out in summer (Bower, 1998a). Austral Pillwort consist of long, slender creeping rhizomes just below the mud surface from which arise the filiform bright green fronds in groups of two or three at intervals of about 1 cm (Harden, 1990-2002; Bower, 1998a).

As discussed in Section D1.4.2, a number of targeted searches have been conducted for the Austral Pillwort across ML 1535 and surrounding areas.

The surveys indicated that the Austral Pillwort is a relatively common inhabitant of saturated gilgai depressions not only in ML 1535 but also in much of the gilgai habitat that is found along the western margin of Lake Cowal both to the north and south of ML 1535 (Bower, 1998a). Table D-7 provides the distribution and abundance of the Austral Pillwort recorded during the survey of E42 Modification area.

Table D-7
Distribution and Abundance of the Austral Pillwort in the Lake Cowal Area

Number	Location	Approximate Distance from ML 1535	Number of Gilgai Depressions with Austral Pillwort	Abundance within Gilgai
1	536402 6281265	0.9 km north	3	rare
			4	common
			1	moderately common
			2	abundant
2	536660 6282289	1.9 km north	1	moderately common
			2	common
			2	abundant
3	536126 6283986	3.7 km north	3	rare
			1	common
			1	abundant
4	535969 6285173	6.6 km north	2	moderately common
			5	abundant
5	539237 6272458	5.3 km south-southeast	4	rare
			1	moderately common
			13	abundant

Source adapted from Bower (1998a).

Bower (1998a) noted that the Austral Pillwort grew most commonly in gilgai depressions with a sticky grey mud base and was absent from depressions with friable or stony soils. The gilgai depressions in the E42 Modification area occur on gravelly red cracking clay soils that are not favoured by *P. novae-hollandiae*. In addition, the depressions did not have the sealed grey clay bases usually associated with Austral Pillwort (Bower 1998a), all had basal holes to the substrate below. Austral Pillwort also favours sunlit depressions without tree cover or heavy growth of introduced grasses and other weeds (Bower, 1998a). Most of the depressions in the E42 Modification area are either too heavily vegetated to support Austral Pillwort or are strongly shaded by stands of Myall and Belah trees. It is concluded the depressions on the E42 Modification area are unlikely to support populations of the Austral Pillwort.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Although the Austral Pillwort has been recorded widely within ML 1535, it is considered the types of gilgai in the E42 Modification area are unlikely to support it. Therefore, it is unlikely that the modified CGM would cause the loss of a local population of the Austral Pillwort.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Although gilgai depressions occur in the E42 Modification area, they are considered to be unsuitable as habitat for the Austral Pillwort (see above). It is considered the modified CGM is unlikely to affect habitat for the Austral Pillwort.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This species is not at its limit of known distribution within the study area. This species has been recorded from the Central Coast, Southern Tablelands, and South Western Slopes of NSW (Harden, 1990-2002), and is also known to occur in Victoria, Australian Capital Territory, South Australia, Western Australia and Tasmania (DECC, 2008c).

4. How is the proposal likely to affect current disturbance regimes?

The modified CGM would positively reduce a current disturbance regime applicable to this species, namely livestock grazing. The offset area to the north of ML 1535 would result in the removal of intensive grazing from a significant area of gilgai habitat known to support the Austral Pillwort. The removal of grazing is likely to eliminate 'pugging' of wet gilgai soils by stock potentially providing a more stable environment for Austral Pillwort. However, the potential effects of stock removal on the Austral Pillwort cannot easily be predicted. Certain potential long-term negative impacts are also possible, such as domination of gilgais by perennial grasses and large rushes, and shading by regenerating Myall and Belah. It will be important to monitor population trends in the Austral Pillwort as the management of the offset area changes.

5. How is the proposal likely to affect habitat connectivity?

The Austral Pillwort is known to occur to the north and south of the E42 Modification area. These populations are already bisected by ML1535. The modified CGM may further reduce physical connectivity. However, this is unlikely to be biologically significant given the probable dispersal of the species sporocarps by water birds. Austral Pillwort is known to be eaten by herbivorous water fowl (Mark Clayton, CSIRO Division of Sustainable Ecosystems, pers. comms.) and its sporocarps are likely to be dispersed in their droppings. Hence, physical habitat connectivity is unlikely to be necessary for the exchange of genetic material between the northern and southern populations of Austral Pillwort on the western side of Lake Cowal

6. How is the proposal likely to affect critical habitat?

No critical habitat has been identified for the Austral Pillwort in the Register of Critical Habitat held by the Commonwealth Minister of the DEWHA (DEWHA, 2008c), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008d) or within the Bland Local Environment Plan (Bland Shire Council, 2008).

D4.5.2 Tricolour Diuris (*Diuris tricolor* syn. *Diuris sheaffiana*)

Background

The Tricolour Diuris (*Diuris tricolor*) is a small terrestrial orchid. It has one to three erect green linear leaves to 30 cm long and a single flower stem arising from the base of the plant with one to six yellow flowers with maroon, purple and white markings. The plant is dormant in summer, shoots its leaves after the first soaking autumn-winter rains and flowers from September to November. The Tricolour Diuris occurs in Box/Pine woodlands, usually in habitats with White Cypress Pine (*Callitris glaucophylla*) as one of the dominant species (Burrows, 1999, Bishop, 2000, DLWC, 2002).

A taxonomic revision in 1989 reduced *D. sheaffiana* to a synonym of *D. tricolor* (Clements, 1989). However, it remains listed as *D. sheaffiana* in the schedule of the EPBC Act.

As discussed in Section D1.4.2, the Tricolour Diuris was detected in targeted surveys on the route of the access road to the approved CGM and in the nearby region (Bower, 2004a). It was found on coarse sandy granitic soils in communities dominated by *Eucalyptus dwyeri*, *E. populnea* and *Callitris glaucophylla*. Potential habitat for the Tricolour Diuris occurs on Cowal West Hill, which supports a community dominated by *E. dwyeri* and *C. glaucophylla* (Figure D-3). Although Cowal West Hill has been subject to past semi-clearing, logging and regular grazing, the lack of cultivation, and the rocky habitat which protects subterranean tubers from rabbits, provides a potential refuge for the Tricolour Diuris. However, the inconspicuous nature of the Tricolour Diuris when not in flower means it can easily be missed in targeted surveys carried out in seasons other than spring.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

If the Tricolour Diuris were to occur on Cowal West Hill, the proposal would result in the loss of a local population of the species, since Cowal West Hill is an isolated patch of potential habitat amid a large area of unsuitable habitat. However, a substantial area of similar grassy woodland habitat dominated by Dwyer's Mallee Gum, with and without White Cypress Pine, occurs in the hill remnant vegetation in the southern offset area (Figure D-4). This area is also potential habitat for the Tricolour Diuris. Withdrawal of grazing from this area is expected to result in recovery of the habitat and possibly the recovery of the Tricolour Diuris from suppression by grazing.

One threatened population of a large flowered form of the Tricolour Diuris has been listed for the Muswellbrook Shire (NSW Scientific Committee, 2007), however, this population does not occur within the E42 Modification area.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

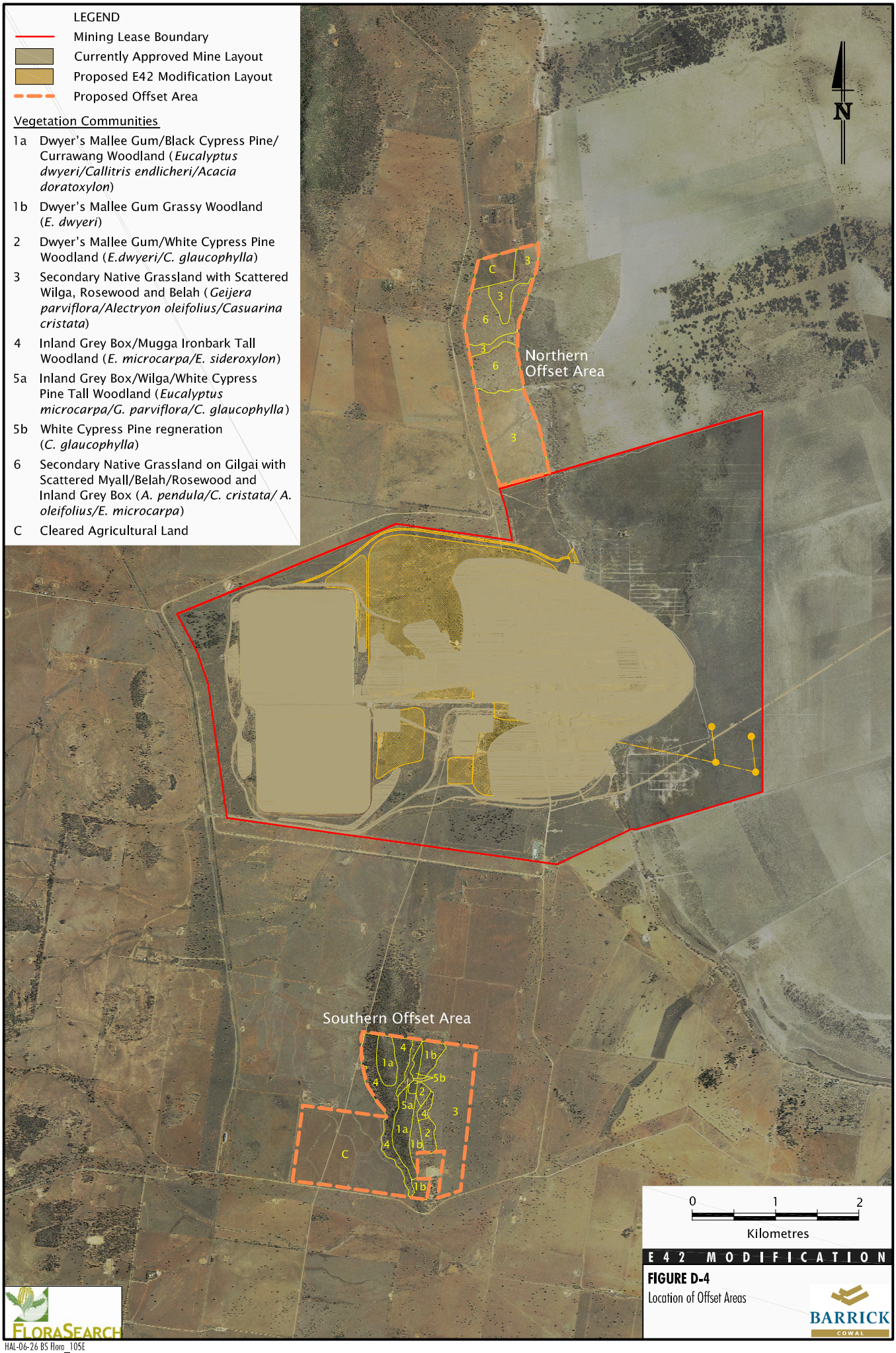
The proposal would result in the loss of potential habitat for the Tricolour Diuris. However, a substantial area of similar habitat exists in the hill remnant vegetation in the southern offset area (Figure D-4).

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This species is not at its limit of known distribution within the study area. A widespread and formerly abundant species, it is known on the NSW western slopes and plains from Gillenbah near Narrandera in the south to the far north (Bishop, 2000). There is one record from Lake Rowan in north-east Victoria (Jeanes and Backhouse, 2000) and it extends to the Moreton and Darling Downs districts in Queensland, where it is said to be common (Stanley and Ross, 1989).

4. How is the proposal likely to affect current disturbance regimes?

The proposed mitigation measures and offset strategy for the modified CGM has potentially positive outcomes for current disturbance regimes applicable to this species. A large area of habitat considered to be suitable for the Tricolour Diuris occurs in the hill remnant vegetation in the southern offset area. Under offset management, grazing would be permanently withdrawn from this area, potentially allowing the recovery of any Tricolour Diuris populations occurring there.



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5. How is the proposal likely to affect habitat connectivity?

Should the Tricolour Diuris occur in the E42 Modification area, it is unlikely the modified CGM would reduce the connectivity of its habitat because Cowal West Hill is an isolated outcrop surrounded by dissimilar vegetation communities and is therefore not connected physically to similar habitat nearby. In common with most orchids, the Tricolour Diuris has tiny wind blown seeds, such that habitat connectivity is not critical for long distance dispersal.

6. How is the proposal likely to affect critical habitat?

No critical habitat has been identified for the Tricolour Diuris in the Register of Critical Habitat held by the Commonwealth Minister of the DEWHA (DEWHA, 2008c), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008d) or within the Bland Local Environment Plan (Bland Shire Council, 2008).

D4.5.3 Silky Swainson-pea (*Swainsona sericea*)

Background

The Silky Swainson-pea is a low growing perennial herb to 10 cm high that was formerly widely distributed and common, but has declined due to habitat clearing, farming, and grazing by domestic stock and rabbits. The stems and foliage are densely covered by medifixed hairs. Erect stems carry a raceme of 2 to 8 purple flowers to 11 mm long in spring. Silky Swainson-pea is a renascent perennial that resprouts when sufficient soil moisture becomes available in autumn and winter (Earl *et al.,* 2003). The species occurs in grassland, eucalypt woodlands and Cypress Pine woodlands (Thompson and James, 2002).

As discussed in Section D1.4.2, a roadside population of Silky Swainson-pea was discovered on a granite outcrop near Billys Lookout some 9.5 km south-west of the E42 Modification area in 2004 (Bower 2004c). A second much larger population numbering many tens of thousands of plants was found beside the Ungarie-Condobolin Road about 30 km north-west of Billys Lookout, also in 2004 (Bower, 2004c). There appear to be no other known populations in the region.

Given the former wide distribution of this species, it is possible that it once occurred on Cowal West Hill (Figure D-3), which has a similar vegetation community to that on Billys Lookout. It was not detectable during the survey in March 2008, when the plants would have been dormant.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

If the Silky Swainson-pea were to occur on Cowal West Hill (Figure D-3), the proposal would result in the loss of a local population of the species, since Cowal West Hill is an isolated patch of potential habitat amid a large area of unsuitable habitat. However, a substantial area of similar grassy woodland habitat dominated by Dwyer's Mallee Gum, with and without White Cypress Pine, occurs in the hill remnant vegetation in the southern offset area (Figure D-4). This area is also potential habitat for the Silky Swainson-pea. Withdrawal of grazing from this area is expected to result in recovery of the habitat and possibly the recovery of any surviving Silky Swainson-pea populations from suppression by grazing.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would result in the loss of potential habitat for the Silky Swainson-pea. However, a substantial area of similar habitat exists within the hill remnant vegetation in the southern offset area (Figure D-4).

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This species is not at its limit of known distribution within the study area. The Silky Swainson-pea occurs in NSW, Victoria and South Australia (NSW Scientific Committee, 1999). In NSW, this species is distributed on the northern tablelands to the southern tablelands and Monaro region and further inland on the slopes and plains (*ibid*.).

4. How is the proposal likely to affect current disturbance regimes?

The proposed mitigation measures and offset strategy for the modified CGM has potentially positive outcomes for current disturbance regimes applicable to the Silky Swainson-pea. A large area of habitat considered to be suitable for this species occurs in the hill remnant vegetation in the southern offset area. Under offset management, grazing would be permanently withdrawn from this area, potentially allowing the recovery of any Silky Swainson-pea populations occurring there.

5. How is the proposal likely to affect habitat connectivity?

Potential habitat for the Silky Swainson-pea in the E42 Modification area is an isolated rocky outcrop. Therefore, it is unlikely the modified CGM would reduce the connectivity of habitat for the Silky Swainson-pea.

6. How is the proposal likely to affect critical habitat?

No critical habitat has been identified for the Silky Swainson-pea in the Register of Critical Habitat held by the Commonwealth Minister of the DEWHA (DEWHA, 2008c), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008d) or within the Bland Local Environment Plan (Bland Shire Council, 2008).

D4.5.4 Other Threatened Flora Species

This section provides justification for considering that the following threatened flora species are unlikely to occur in the E42 Modification area:

- A Speargrass (*Austrostipa wakoolica*);
- A Speargrass (*Austrostipa metatoris*);
- Winged Peppercress (*Lepidium monoplocoides*);
- Spiny Peppercress (*Lepidium aschersonii*); and
- Slender Darling-pea (*Swainsona murrayana*).

No critical habitat has been identified for any of these species (DEWHA, 2008c; DECC, 2008d; Bland Shire Council, 2008).

A Speargrass (Austrostipa wakoolica)

Austrostipa wakoolica is a densely tufted grass which grows to 1 m in height. *Austrostipa wakoolica* occurs on grey clay floodplain soils of the Murray River and tributaries (Vickery *et. al*., 1986, Jacobs and Hastings 1993). There is one record validated by a herbarium specimen in the nearby region, located some 22 km north-northwest of ML 1535.

Limited potential floodplain habitat resources for *Austrostipa wakoolica* occur within the E42 Modification area, and it is considered unlikely that *Austrostipa wakoolica* occurs within the E42 Modification area given it has not been previously recorded at Lake Cowal. Since it is a large conspicuous species, it is unlikely to have been overlooked in the targeted survey, which identified two other *Austrostipa* species.

The modified CGM would not adversely affect any current disturbance regimes applicable to possible occurrences of *Austrostipa wakoolica* in the surrounds.

Since limited habitat for *Austrostipa wakoolica* occurs in the E42 Modification area, it is unlikely the modified CGM would reduce the connectivity of habitat for *Austrostipa wakoolica*.

A Speargrass (Austrostipa metatoris)

Austrostipa metatoris occurs in mallee habitats on red brown sands to sandy loam (Everett and Jacobs, 1983; Ayers et al., 1996). There are two centres of distribution in NSW; in a triangle between Euston, Swan Hill and Moulamein, and in the Mount Hope to Cobar area. There are no records close to ML 1535.

Potential habitat for this species (i.e. suitable mallee habitat) does not occur within the E42 Modification area. For this reason, it is unlikely that the modified CGM would significantly impact this species.

The modified CGM would not adversely affect any current disturbance regimes applicable to possible occurrences of *Austrostipa metatoris* in the surrounds as the disturbance regimes are largely human-induced (e.g. grazing).

Since habitat for *Austrostipa metatoris* does not occur in the E42 Modification area, it is unlikely the modified CGM would reduce the connectivity of habitat for *Austrostipa metatoris*.

Peppercress (Lepidium monoplocoides)

The most recent records of the Winged Peppercress are from alluvial soils, although many records from the late 1800s refer to mallee scrub on sandhills (Leigh *et. al*., 1984). Cunningham *et. al*. (1981) note its occurrence in Poplar Box, *Eucalyptus populnea*, communities. Early records suggest it was widespread and common in western NSW (Leigh *et al*., 1984). The nearest historical published record is Lake Cargelligo 100 km from ML1535 (Leigh *et. al*., 1984; Entwistle, 1996; Retter and Harden, 2000). The closest recent published records are from the shore of Lake Urana (National Parks and Wildlife Service [NPWS], 2001) to the south and Narran Lake to the north (NPWS, 2000) of the E42 Modification area.

Given the records in lakes to the north and south of the E42 Modification area, this species may have formerly occurred at Lake Cowal. However, given the limited potential habitat resources within the E42 Modification area, and this species has not been previously recorded at Lake Cowal it is unlikely that the modified CGM would significantly impact this species.

The modified CGM would not adversely affect any current disturbance regimes applicable to possible occurrences of the Winged Peppercress in the surrounds.

Since limited habitat for the Winged Peppercress occurs in the E42 Modification area, it is unlikely the modified CGM would reduce the connectivity of habitat for the Winged Peppercress.

Spiny Peppercress (Lepidium aschersonii)

Prior to 2004, little was known about the occurrence of the Spiny Peppercress in Central Western NSW. The main extant populations were thought to occur in Victoria (Leigh *et al*., 1984; Entwistle, 1996; Harris and Smith, 2001; Retter and Harden, 2000) on heavy clay soils near salt lakes and swamps, usually with seasonal inundation or waterlogging. Three historic records from 1915, 1931 and 1943 exist for the wider Lake Cowal region (DECC, 2008c; SRBG, 2008a). It was recorded in 1993 at Narrabri, but not at former locations at Temora, West Wyalong or Barmedman (Harris and Smith, 2000).

In 1999 it was located approximately 6 km west of the approved CGM access road (DECC, 2008c; SRBG, 2008a).

As discussed in Section D1.4.2, targeted searches for the Spiny Peppercress in January 2004 found it at nine locations in the West Wyalong – Barmedman area in a diverse range of habitats (Bower, 2004b). Most populations occurred in Belah (*Casuarina cristata*) woodland on gilgai soils, however the species was also recorded in mallee dominated by Bull Mallee (*Eucalyptus behriana*) as well as Grey Box (*E. microcarpa*)/Bull Oak (*Allocasuarina luehmannii*) woodland. The number of individuals estimated at each site ranged from approximately 20 to over several thousand and totalled well in excess of 10,000 plants (Bower, 2004b).

Potential habitat resources for the Spiny Peppercress occur within the E42 Modification area, i.e. Belah (*Casuarina cristata*) communities, although this species has not been recorded within ML 1535, despite several flora surveys. *Lepidium aschersonii* was targeted in March 2008 in appropriate habitats and no plants were found. As such it is unlikely that the modified CGM would significantly impact this species.

The modified CGM would not adversely affect any current disturbance regimes applicable to possible occurrences of the Spiny Peppercress in the surrounds.

The modified CGM would not reduce the connectivity of habitat for the Spiny Peppercress as potential habitat areas are already disjunct from similar habitat in the nearby region due to past clearing by farmers.

Slender Darling-pea (Swainsona murrayana)

The Slender Darling-pea inhabit grasslands, floodplains, discharge areas and eucalypt forests (Foreman, 1992; Ayers *et al.,* 1996) on heavy soils, often with *Maireana* species in depressions (Thompson and James, 2002), inundated flats and around lakes (Jeanes, 1996).

A number of records exist for this species approximately 30 km to the south of the E42 Modification area (DECC, 2008c; SRBG, 2008a).

Potential habitat resources for Slender Darling-pea (i.e. communities dominated by *Acacia pendula* and *Casuarina cristata*) occur in the E42 Modification area, although this species has not been recorded within ML 1535 or surrounding areas in similar habitat despite several flora surveys. As such it is unlikely that the modified CGM would significantly impact this species.

The modified CGM would not adversely affect any current disturbance regimes applicable to possible occurrences of Slender Darling-pea in the surrounds.

The modified CGM would not reduce the connectivity of habitat for Slender Darling-pea given it is unlikely to occur.

D4.6 THREATENED ECOLOGICAL COMMUNITIES

As described in Section D3.4, one threatened ecological community listed under the TSC Act was found, namely, the Myall Woodland which is listed as endangered. The potential impacts from the modified CGM on this community are assessed below.

D4.6.1 Myall Woodland

Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions is an EEC under the TSC Act.

The Myall Woodland EEC varies in structure from low woodland and low open woodland to low sparse woodland or open shrubland (NSW Scientific Committee, 2005). The tree layer grows to a height of 10 m and includes Myall (*Acacia pendula*) as one of the dominant species or the only tree species present (*ibid.*).

The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of herbs and grasses, although in some areas the shrub layer may have been reduced or removed by clearing or grazing (*ibid*.).

Community 2 recorded in this study equates to the Myall Woodland EEC (Table D-6; Figure D-3).

1. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The modified CGM would involve the clearance of a local occurrence of Myall Woodland EEC of approximately 15 ha in size. However, it is considered that this loss would not significantly impact the overall occurrence of the Myall Woodland EEC in the local area given:

- the relatively small area (approximately 15 ha) of vegetation required to be cleared;
- a larger area of Myall Woodland EEC (approximately 75 ha) occurs to the south of ML 1535, within a reserve of Crown land on the edge of Lake Cowal;
- the floristic condition of the Myall Woodland EEC is considered to be good, although, tree health of the Myall is generally poor and prior grazing has suppressed tree regeneration in past decades; and
- the disjunct nature of the Myall Woodland EEC area which is located adjacent to existing approved mine infrastructure.

Notwithstanding, a number of avoidance and mitigation measures have been developed to manage potential and known impacts on the Myall Woodland EEC:

- In accordance with the Vegetation Clearance Protocol (VCP), seed stock (where available) would be collected from species characteristic of the Myall Woodland EEC for use in the rehabilitation programme (Barrick, 2003d).

- Weed control measures would be implemented (Barrick, 2003c) to minimise the potential for weeds to degrade potential and known areas of the Myall Woodland EEC outside the lease.
- The revegetation programme for the mine would aim to re-establish vegetation communities which occur in the mine area and surrounds. This would include species characteristic of the Myall Woodland EEC (e.g. Myall [*Acacia pendula*] and Belah [*Casuarina cristata*]) (Barrick, 2003d).

2. How is the proposal likely to affect current disturbance regimes?

The modified CGM would not affect the current disturbance regime in the study area.

3. How is the proposal likely to affect habitat connectivity?

The area of Myall Woodland to be cleared for the modified CGM is not connected to any other area of Myall Woodland. As such, the modified CGM would not affect the habitat connectivity of the Myall Woodland EEC.

4. How is the proposal likely to affect critical habitat?

No critical habitat has been identified for the Myall Woodland EEC (DEWHA, 2008c; DECC, 2008d; Bland Shire Council, 2008).

D5 IMPACT AVOIDANCE AND MITIGATION MEASURES

A number of impact avoidance and mitigation measures applicable to flora have been developed for the CGM as described below.

Flora Management

The mitigation measures and management for flora (including threatened ecological communities, populations and species) at the approved CGM are presented in the *Cowal Gold Project Flora and Fauna Management Plan* (FFMP) (Barrick, 2003d). The objectives of the FFMP are to fulfil the relevant consent conditions by providing (*ibid.*):

- methods to conserve and enhance wildlife values around Lake Cowal and within ML 1535;
- monitoring of flora within the Lake Cowal region as documented in the EIS and SIS;
- details to relocate any threatened species and/or its habitat away from disturbed areas that are created by mine operations;
- details of monitoring the mine's impacts particularly on threatened flora, and contingency measures should impacts be identified as occurring; and
- a threatened species management protocol, including provisions for targeted searches prior to construction and proposed mitigation measures where threatened flora species are found.

The FFMP would be revised to incorporate the E42 Modification.

Vegetation Clearance Protocol

A VCP has been implemented at the approved CGM to minimise the impact of vegetation clearance activities on flora and is described in the FFMP (Barrick, 2003d). The VCP would be continued for the modified CGM. In accordance with the VCP, clearance activities would be restricted to the areas occupied by the mine activities, buildings and paved surfaces, and those necessary for fire control. In accordance with the VCP, the boundary of the E42 Modification disturbance area would be clearly marked or fenced to prevent accidental damage to adjacent areas during vegetation clearance and/or construction works. Protection, where practicable, would extend to all strata and life forms including trees, shrubs, grasses, other herbs and forbs, ground litter, fungi and logs. Accordingly, disturbance to potential habitat of threatened flora species would be minimised, where practicable.

Threatened Species Management Protocol

The *Cowal Gold Project Implementation of the Threatened Species Management Protocol* (TSMP) (Barrick, 2003a) describes how the threatened species management protocol is to be implemented.

The key components of the TSMP include: database interrogation, preliminary assessment, secondary assessment, threatened species management strategy and regulatory review (Barrick, 2003a). The TSMP includes threatened species management strategies prepared for threatened species which have been recorded in the course of targeted surveys or for which habitat resources typically associated with the lifecycle components of a threatened species have been identified (*ibid.*).

The TSMP has been implemented at the approved CGM and would be continued at the modified CGM.

Rehabilitation Planning

In accordance with the TSMP, as a component of the rehabilitation programme for the approved CGM, consideration is to be given to trialling the establishment of the Austral Pillwort (Barrick, 2003a). Trials would be conducted in the event it is determined by a suitably qualified person(s) to be advantageous to the local population of this species. This determination would be made in consideration of the success of the other management strategies implemented. The trials would be conducted when edaphic conditions are suitable.

The revegetation programme for the modified CGM would aim to revegetate new landforms with selected species of native and/or endemic vegetation that are both suitable to the physiographic and hydrological features of each landform, and which expand on the areas of remnant endemic vegetation that currently exist in the immediate region. This would include species characteristic of the Myall Woodland EEC (e.g. Myall [*Acacia pendula*] and Belah [*Casuarina cristata*]), as described in the existing TSMP (Barrick, 2003a).

Further details of the conceptual Rehabilitation and Landscape Management Strategy for the modified CGM are provided in Section 5 of the EA.

Dust Management

The mitigation and management measures for wind blown and mine generated dust at the approved CGM are presented in the *Cowal Gold Project Dust Management Plan* (DMP) (Barrick, 2003e). These management and mitigation measures described in the DMP would continue to be implemented for the modified CGM.

Weed Management

A weed management programme is aimed at minimising the possibility of new weed incursion and controlling the spread of any existing noxious weeds on Barrick-owned land. Barrick currently manage weeds at the approved CGM in accordance with measures described in the Land Management Plan (Barrick, 2003c). The Land Management Plan would be continued for the modified CGM.

Pest (Animal and Vermin) Control

Pest control activities implemented at the approved CGM include (Barrick, 2003c; 2003d):

- regular property inspections to assess the status of pest populations within Barrick-owned land;
- mandatory pest control for declared pests (i.e. rabbits, pigs and wild dogs) in accordance with Pest Control Orders under the *Rural Lands Protection Act, 1998*; and
- inspections to assess the effectiveness of control measures implemented and review these if necessary.

These pest control activities would be continued for the modified CGM.

Compensatory Wetland Management

The *Cowal Gold Project Compensatory Wetland Management Plan* (Barrick, 2003f) details the compensation measures developed for the loss of wetland disturbed by the approved CGM. These compensation measures include the enhancement of existing wetland within ML 1535 during mine operation and following closure of the mine.

These compensation measures would be continued for the modified CGM.

D6 OFFSET MEASURES

The Director General's requirements for modified CGM require a description of the measures that would be implemented to ensure there is no net loss of the biodiversity values of the region in the medium to long-term.

The following discussion describes how biodiversity values would be maintained or improved in accordance with the objectives of the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

Barrick propose two offset areas for the modified CGM located on Barrick-owned Land (Figure D-4). This section considers the flora values of the modified CGM offset areas.

Barrick propose that significant areas of existing native vegetation would be enhanced (some 340 ha) and significant areas of cleared agricultural land would be revegetated (some 120 ha).

Flora Characteristics

Site evaluations of the two modified CGM offset areas were conducted in April and May 2008.

The southern offset area (Figure D-4) provides the following vegetation types:

- Dwyer's Mallee Gum/Black Cyperss Pine/Currawang Woodland (*Eucalyptus dwyeri*/*Callitris endlicheri*/*Acacia doratoxylon*);
- Dwyer's Mallee Gum Grassy Woodland (*E. dwyeri*);
- Dwyer's Mallee Gum/White Cypress Pine Woodland (*E. dwyeri*/*C. glaucophylla*);
- Secondary Native Grassland with Scattered Wilga, Rosewood and Belah (*Geijera parviflora*/*Alectryon oleifolius*/*Casuarina cristata*);
- Inland Grey Box/Mugga Ironbark Tall Woodland (*E. microcarpa*/*E. sideroxylon*);
- Inland Grey Box/Wilga/White Cypress Pine Tall Woodland (*E. microcarpa*/*G. parviflora*/*C. glaucophylla*); and
- White Cypress Pine regeneration (*Callitris glaucophylla*).

The northern offset area (Figure D-4) provides the following vegetation types:

- Secondary Native Grassland with Scattered Wilga, Rosewood and Belah (*Geijera parviflora*/*Alectryon oleifolius*/*Casuarina cristata*); and
- Secondary Native Grassland on Gilgai with Scattered Myall/Belah/Rosewood and Inland Grey Box (*Acacia pendula*/*C. cristata*/ *A. oleifolius*/*Eucalyptus microcarpa*).

The northern offset area also provides the opportunity to increase the area of Myall Woodland in the landscape through natural regeneration and revegetation.

Cleared agricultural land also occurs within the offset areas, which provides the opportunity to increase the existing remnant patch sizes through revegetation works.

During a targeted survey, large populations of the Austral Pillwort were recorded from gilgai within the northern offset area in 1998 (Bower, 1998a). In excess of 4000 Austral Pillwort plants were recorded (Bower, 1998a).

Management

The conservation of the offset areas would be secured through rezoning and/or re-conditioning of relevant landholdings to reflect conservation purposes. The rezoning and/or re-conditioning would be undertaken in consultation with the Bland Shire Council. The rezoning and/or re-conditioning of relevant landholdings would be undertaken within three years of the Development Consent being modified or a time period to the satisfaction of the Director-General of the NSW Department of Planning.

In addition, a management plan would be prepared, by suitably qualified person(s), to facilitate the management of the relevant lands. It is anticipated that the plan would detail measures including:

- revegetation planting;
- exclusion of grazing to facilitate the regeneration of native vegetation;
- weed management;
- soil erosion remediation;
- selective use of native plant fertilizer and mineral rock products;
- pest management;
- signage of the vegetation offset areas; and
- monitoring the performance of the offset by suitably qualified person(s).

It is considered that the offset areas would constitute a suitable offset against potential residual impacts associated with the modified CGM (after the avoidance and mitigation measures provided in Section D5), given the anticipated improvement in the flora value of the land within the offset areas in the medium to long-term.

D7 KEY THRESHOLDS

Key thresholds are discussed below in relation to the modified CGM in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts would maintain or improve biodiversity values.

It is likely that the biodiversity values of the region would be maintained or improved considering the modified CGM proposed measures to avoid and mitigate for potential impacts outlined in Section D5.

Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

The modified CGM is unlikely to reduce the long-term viability of a local population of any flora species, population or ecological community as:

- No threatened flora species or populations listed under the TSC Act or EPBC Act were identified during the survey.
- The potential threatened flora species and ecological communities habitat components which occur within the E42 Modification area are wide-spread within their range.

Whether or not the proposal is likely to accelerate the extinction of a species, population or ecological community or place it at risk of extinction.

The modified CGM is unlikely to accelerate the extinction of any flora species, population or ecological community as:

- No threatened flora species or populations listed under the TSC Act or EPBC Act were identified during the survey.
- The potential threatened flora species and ecological communities habitat components which occur within the E42 Modification area are wide-spread within their range.

Whether or not the proposal would adversely affect critical habitat.

No critical flora habitat occurs within the vicinity of the E42 Modification area as designated by the Register of Critical Habitat held by the Commonwealth Minister of the DEWHA (DEWHA, 20068c), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008d), the Register of Critical Habitat held by the Director-General of the DPI-Fisheries (DPI-Fisheries, 2008) or identified within the Bland Local Environment Plan (Bland Shire Council, 2008). Therefore, the modified CGM would not affect any critical habitat.

D8 CONCLUSIONS

The following conclusions can be made:

- It is likely that the biodiversity values of the region would be maintained and possibly improved, considering the proposed measures to mitigate and/or offset potential impacts.
- The modified CGM will result in the loss of a local occurrence of the Myall Woodland EEC, however, it is unlikely to lead to the loss of the community in the surrounding area.
- The modified CGM is unlikely to lead to the extinction of any flora species, population or ecological community or place any at risk of extinction.
- The modified CGM will not affect any listed threatened population of a flora species.
- The modified CGM is unlikely to adversely affect critical habitat as no critical habitats are known to occur within the vicinity of the E42 Modification area.
- The modified CGM is very unlikely to adversely affect areas of high conservation value.
- Vegetation that would be removed or modified by the modified CGM is not considered to adversely impact the long-term viability of any flora species, population or ecological community.
- Matters of national environmental significance are not likely to be significantly impacted by the modified CGM.

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ATTACHMENT DA

FLORA SPECIES RECORDED DURING THE SURVEY OF THE E42 MODIFICATION AREA

Table DA-1
Flora Species Recorded During the Survey of the E42 Modification Area

Scientific Name	Common Name	Quadrat Number							Random Meanders
		Community 1				Community 2			
		1	2	3	4	5	6	7	
CLASS FILICOPSIDA									
Marsileaceae									
Marsilea drummondii	Common Nardoo								●
CONIFEROPSIDA									
Cupressaceae									
Callitris glaucophylla	White Cypress Pine	●	●		●				
CLASS MAGNOLIOPSIDA **SUBCLASS MAGNOLIIDAE**									
Amaranthaceae									
Alternanthera denticulata	Lesser Joyweed								●
Amaranthus macrocarpus var. *macrocarpus*	Dwarf Amaranth						●		
Ptilotis exaltatus subsp. *exaltatus*	Tall Mulla Mulla					●		●	
Asteraceae									
**Arctotheca calendula*	Capeweed	●							
Eclipta platyglossa	Yellow Twin-heads								●
**Sonchus asper*	Prickly Sowthistle					●	●		
Vittadinia gracilis	Woolly New Holland Daisy								●
**Xanthium spinosum*	Bathurst Burr	●			●	●			
Xerochrysum bracteatum	Golden Everlasting								●
Boraginaceae									
**Echium plantagineum*	Paterson's Curse	●	●		●				
**Heliotropium europaeum*	Potato Weed	●							
Brassicaceae									
**Sisymbrium orientale*	Hedge Mustard						●		●
Casuarinaceae									
Casuarina cristata	Belah						●	●	
Chenopodiaceae									
Atriplex semibaccata	Creeping Saltbush							●	
Atriplex spinibractea	Spiny-fruit Saltbush		●	●	●			●	●
Chenopodium desertorum subsp. *anidiophyllum*	Mallee Goosefoot	●	●	●					
Chenopodium melanocarpum	Black Crumbweed		●						
Chenopodium pumilio	Small Crumbweed	●	●	●	●		●		
Einadia nutans	Climbing Saltbush						●	●	
Einadia polygonoides	Climbing Saltbush			●	●	●			
Einadia trigonos	Fishweed					●			
Enchylaena tomentosa	Ruby Saltbush						●		
Maireana enchylaenoides	Wingless Fissure-weed	●	●	●	●	●	●	●	
Maireana decalvans	Black Cotton Bush					●	●		
Maireana microphylla	Eastern Cotton Bush					●	●	●	●
Rhagodia spinescens	Spiny Saltbush					●	●	●	
Salsola kali	Buckbush	●	●	●	●	●	●	●	
Sclerolaena diacantha	Grey Copperburr					●	●	●	
Sclerolaena muricata	Black Rolypoly		●	●	●	●	●	●	

Table DA-1 (Continued)
Flora Species Recorded During the Survey of the E42 Modification Area

Scientific Name	Common Name	Quadrat Number							Random Meanders
		Community 1				Community 2			
		1	2	3	4	5	6	7	
Cucurbitaceae									
**Citrullus lanatus*	Wild Melon								●
**Cucumis myriocarpus*	Paddy Melon	●	●				●		
Euphorbiaceae									
Chamaesyce drummondii	Caustic Weed	●	●	●	●	●	●	●	
Fabaceae-Faboideae									
Glycine pacifica	A Glycine	●							
Fabaceae-Mimosoideae									
Acacia pendula	Weeping Myall					●	●	●	
Geraniaceae									
Erodium crinitum	Blue Storksbill	●	●	●					●
Haloragaceae									
Haloragis glauca	Grey Raspwort								●
Lamiaceae									
Teucrium racemosum	Grey Germander								●
Lobeliaceae									
Pratia concolor	Poison Pratia								●
Loranthaceae									
Amyema quandang	Grey Mistletoe							●	
Malvaceae									
**Malva parviflora*	Small Flowered Mallow	●							
Sida corrugata	Corrugated Sida	●			●	●	●	●	●
Sida cunninghamii	Hill Sida	●							●
Sida fibulifera	Pin Sida					●	●	●	●
Myrtaceae									
Eucalyptus dwyeri	Dwyer's Red Gum	●	●	●	●				
Eucalyptus microcarpa	Inland Grey Box			●					
Eucalyptus populnea	Poplar Box								●
Nyctaginaceae									
Boerhavia dominii	Tarvine	●	●	●	●				●
Oxalidaceae									
Oxalis perennans	A Woodsorrel	●			●	●			●
Polygonaceae									
Muehlenbeckia florulenta	Lignum					●	●	●	
Rumex brownii	Swamp Dock				●				
Rumex tenax	Shiny Dock								●
Portulacaceae									
Portulaca oleracea	Pigweed								●
Rubiaceae									
**Galium murale*	Small Bedstraw					●			
Solanaceae									
**Lycium ferocissimum*	African Boxthorn					●	●	●	
Solanum esuriale	Quena	●		●	●	●			

Table DA-1 (Continued)
Flora Species Recorded During the Survey of the E42 Modification Area

Scientific Name	Common Name	Quadrat Number							Random Meanders
		Community 1				Community 2			
		1	2	3	4	5	6	7	
Zygophyllaceae									
Tribulus micrococcus	Yellow Vine	●	●						
SUBCLASS LILIIDAE									
Cyperaceae									
Cyperus concinnus	Trim Flat-sedge								●
Cyperus sp.	A Flat-sedge								●
Eleocharis pallens	Pale Spike-sedge								●
Eleocharis plana	Flat Spike-sedge								●
Eleocharis pusilla	Field Woodrush								●
Juncaceae									
Juncus sp.	A Rush								●
Lomandraceae									
Lomandra bracteata	A Mat-rush			●	●				
Poaceae									
Aristida behriana	Bunch Wiregrass	●							
Aristida jerichoensis	Jericho Wiregrass		●						
Austrodanthonia eriantha	Hill Wallaby Grass			●	●				
Austrodanthonia setacea	Small-flowered Wallaby Grass					●			
Austrostipa nitida	A Speargrass	●	●		●		●		●
Austrostipa scabra	Speargrass	●	●	●	●				
Dactyloctenium radulans	Button Grass								●
Elymus scaber	Wheat Grass	●	●		●				
Enteropogon acicularis	Windmill Grass	●	●	●	●	●	●	●	
**Eragrostis cilianensis*	Stinkgrass	●							
Eragrostis lacunaria	Purple Lovegrass	●							
Eragrostis parviflora	Weeping Lovegrass	●	●						
Eriochloa pseudoacrotricha	Early Spring Grass								●
Lachnagrostis filiformis	Blown Grass	●	●						
Panicum laevinode	Pepper Grass								●
Panicum queenslandicum	Yadbila Grass	●					●		●
Panicum simile	Two-colour Panic	●							
Paspalidium gracile	Slender Panic	●	●	●	●				
Paspalidium jubiflorum	Warrego Grass								●
Sporobolus caroli	Fairy Grass					●	●	●	
Sporobolus mitchellii	Rat's Tail Couch								●
Tragus australianus	Small Burrgrass	●	●				●		
	Total Native Species	75							
	Total Introduced Species	12							
	Total Species	**87**							

* introduced flora species

ATTACHMENT DB

HABITAT CONDITION

Table DB-1
Measures of Habitat Condition

Vegetation Community	No. of Replicates	Values		
		Lower	Upper	Average
Native plant species richness (number of species)				
1	4	21	27	21.8
2	3	20	22	20. 7
Native overstorey cover (%)				
1	4	14.5	23.0	17.3
2	3	4.0	34.0	14.2
Native midstorey cover (%)				
1	4	0	0	0
2	3	0	0	0
Native groundcover – grasses (%)				
1	4	12.0	28.0	16.5
2	3	0.0	8.0	2.7
Native groundcover – shrubs (%)				
1	4	0	0	0
2	3	0.0	8.0	2.7
Native groundcover – other (%)				
1	4	4.0	22.0	17.5
2	3	26.0	34.0	30.7
Exotic plant cover (%)				
1	4	0	0	0
2	3	0	0	0
Regeneration (proportion of tree species)				
1	4	0	0.5	0.13
2	3	0.5	1	0.83