Biodiversity Technical Report
UG1 Longwalls 101-103 Extraction Plan
Prepared for
Moolarben Coal Operations
January 2017
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Abbreviations

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<th>Description</th>
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<tr>
<td>BMP</td>
<td>Biodiversity Management Plan</td>
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<tr>
<td>EIA</td>
<td>Ecological Impact Assessment</td>
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<td>ELA</td>
<td>Eco Logical Australia</td>
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<tr>
<td>LGA</td>
<td>Local Government Area</td>
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<td>LW</td>
<td>Longwall</td>
</tr>
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<td>MCO</td>
<td>Moolarben Coal Operations</td>
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<tr>
<td>OC</td>
<td>Open Cut</td>
</tr>
<tr>
<td>UG</td>
<td>Underground</td>
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<td>UG1</td>
<td>Underground Area 1</td>
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1 Introduction

Moolarben Coal Operations (MCO) is located approximately 40 kilometres north east of Mudgee, within the western coalfield of New South Wales (NSW). Approval to develop Stage 1 and 2 of the Moolarben Coal Project (MCP) was granted under the NSW Environmental Planning and Assessment Act 1979 on 6 September 2007 (Stage 1) and 30 January 2015 (Stage 2). During July 2015, MCO submitted an application to modify both the Moolarben Coal Complex Stage 1 and Stage 2 Project Approvals (05_0117 and 08_0135, respectively) to allow for changes to the underground mine layout within the UG1 mining area. This modification was approved during April 2016.

Operations at Moolarben Coal Complex include four approved open cut (OC) mines, and three underground (UG) mines. Underground mining activities commenced at MCO in April 2016, with secondary extraction of UG1 planned to commence during 2017. As part of planning for secondary extraction within UG1, MCO is preparing an Extraction Plan for Longwalls 101 to 103 (UG1 LW101 - 103) to monitor and manage the effects of mine subsidence. This technical report will be used to support the completion of the UG1 LW101 – 103 Extraction Plan and will:

- review subsidence predictions for UG1 LW101 - 103 (Mine Subsidence Engineering Consultants Pty Ltd [MSEC], 2017) and associated subsidence related impacts against subsidence predictions within the UG1 Optimisation Modification;
- describe ecological survey work undertaken within the UG1 LW101 - 103 footprint to date;
- demonstrate how MCO will achieve the biodiversity performance impact measures contained within Schedule 4, Condition 1 of the Project Approval (08_0135); and
- provide management and monitoring recommendations for the UG1 LW101 - 103 footprint.

1.1 Subsidence performance measures

Schedule 4, Condition 1 of Project Approval 08_0135 provides subsidence performance measures for natural and heritage features within Stage 2 at MCO. The condition requires that “the project does not cause any exceedance of the performance measures”. Subsidence impact performance measures have been provided for biodiversity (Table 1).

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Impact performance measure</th>
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<td>Threatened species, threatened populations or endangered ecological communities</td>
<td>Negligible subsidence impacts or environmental consequences</td>
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1.2 Subsidence predictions

Subsidence predictions and impact assessments for UG1 (LW101 - 105) were developed by MSEC (2015). These predictions were subsequently reviewed for UG1 LW101 - 103 (MSEC 2017) for the Extraction Plan. These results were used to determine potential impacts to biodiversity within UG1 that may occur as a result of mining activities, and to determine the ability to comply with the subsidence performance measures contained within the Project Approval. An analysis of the predicted subsidence impacts upon biodiversity has been undertaken within Section 3 of this report.
2 Data Review - Ecological Survey Effort

2.1 Previous survey effort
A description of ecological survey work specific to the UG1 LW101-103 area (including survey work completed for the Stage 1 and 2 Ecological Impact Assessments [EIAs], the UG1 Optimisation Modification, the OC4 South-West Modification and the UG1 vegetation validation) is provided in the following sections, along with a summary of the results obtained during these works.

2.1.1 Stage 1 Ecological Impact Assessment
The Stage 1 EIA (Moolarben Biota 2006) was undertaken in accordance with the Director-General’s requirements for assessment of Stage 1 of the Moolarben Coal Project. The EIA focused on assessing the impacts of Stage 1 (including OC1, OC2, OC3, UG4 and all associated infrastructure) and included survey above the UG1 LW101-103 footprint.

The Stage 1 EIA ecological survey consisted of three components, including:

- Mapping of the study area into broad vegetation communities
- Targeted flora surveys
- Targeted fauna surveys

Broad vegetation communities were mapped across the study area through desktop analysis of aerial photography, and validated through preliminary field investigations, and further field survey using systematic methods (i.e. quadrats) to verify and describe the broad vegetation communities. The results of this field survey provided ‘Terrestrial Stratification Units’ (TSU’s), which formed the basis of the terrestrial survey effort within the study area. The following TSU’s were identified throughout the study area:

- Disturbed vegetation
- Sedimentary Ironbark Forests
- Box Woodlands
- Tableland Red Gum Woodlands
- Sedimentary Scribbly Gum Woodlands
- Apple Alluvial Forests

The TSU’s identified during the Stage 1 EIA (listed above) were scattered throughout the study area, with all six mapped above the UG1 LW101-103 longwall footprint.

The floristic surveys used both systematic and opportunistic survey methods within each TSU. Systematic surveys collected data that evaluated the main sources of landform/floristic variability such as aspect, slope, soil type/ geology and topographic position along with full floristic survey. Each systematic survey site consisted of a 20 metre (m) x 20m quadrat and a 50m x 8m transect. Opportunistic observations were collected outside the structure of a stratified, randomised and replicated survey regime. These observations generally targeted threatened and/or seasonal species such as ground orchids.

The flora surveys above UG1 LW101-103 footprint consisted of approximately 11 flora quadrats, with eight located in Sedimentary Ironbark Forests, one located in Box Woodlands, one located in Tableland Red Gum Woodlands, and one located in Sedimentary Scribbly Gum Woodlands. These surveys were undertaken during summer, winter and spring 2005.
Fauna survey undertaken as part of the Stage 1 EIA was conducted over five (5) seasonal survey periods throughout the study area, including summer (December 2004 and January 2005), autumn (April 2005), winter (June/July 2005), early spring (August and September 2005) and late spring (November 2005). Fauna survey design and methodology was determined based upon the TSU’s present across the study area.

Limited fauna surveys were undertaken above the UG1 LW101-103 footprint. The fauna survey effort undertaken for the Stage 1 EIA included:

- Quantitative bird surveys – birds were detected visually and aurally through surveys timed for 20 minutes per 4 ha area. If a new species was found within the last 10 minutes of survey then the survey continued. Maximum survey time was 1 hour and was completed at 88 sites across the study area. Six quantitative bird surveys were conducted above the UG1 LW101-103 footprint.
- Non-quantitative bird surveys – surveys were conducted at 4 sites across the study area, surveying at water bodies. Non-quantitative bird surveys were not conducted above the UG1 LW101-103 footprint.
- Call playback – involved 3-5 minutes of call playback, with a brief silence of 3 minutes between calls (including where multiple calls played). Once all calls have been played, this is followed by 10-15 minutes of listening, then at least 10 minutes of spotlighting. Call playback was conducted at 14 sites across the study area for one night, at 37 sites (targeting the Masked Owl) for two consecutive nights across the study area, for four consecutive nights at six sites across the study area, and for eight consecutive nights at 17 sites across the study area. Call playback was conducted at one site for two consecutive nights and one site for eight consecutive nights above the UG1 LW101-103 footprint.
- Quantitative herpetological surveys – surveys were conducted for a timed period of 30 minutes at 23 sites across the study area. No quantitative herpetological surveys were conducted above the UG1 LW101-103 footprint.
- Pitfall trapping – trapping involved setting up 30m of drift fence with 4 deep buckets (40cm and 25cm diameter) spaced at 10m intervals. This method was used at 14 sites across the study area. No pitfall trapping was conducted above the UG1 LW101-103 longwall footprint.
- Elliott trapping – trapping involved the use of 25 Elliott Type A traps (20 on the ground and five in trees) in a grid pattern over an area of 1 ha at 12 sites across the study area, and were baited with honey/rolled oats/peanut butter with vanilla. In some cases, three Elliott Type B traps were set at each trapping site, near areas of thicker groundcover to target bandicoots, or six Elliott Type E traps were set at some trapping sites in flowering shrubs to target Pygmy Possums. Tree-mounted Elliott Type A traps or Elliott Type B traps were set in trees at 21 sites across the study area. One tree-mounted Elliott Type B trapping site was located above the UG1 LW101-103 footprint.
- Cage trapping – two cage traps were set near Elliott trapping sites, tracks or Quoll den habitat in order to target carnivores at 17 sites across the study area. These were baited with chicken necks. No cage trapping was conducted above the UG1 LW101-103 footprint.
- Hair tubes – hair tubes were set up along 2.3 km transects, with approximately 30 hair tubes per transect at six locations across the study area. The hair tubes consisted of 12 regular tubes baited with honey/rolled oats/peanut butter, 12 regular tubes baited with dry dog food, and 6 flexi glass tubes baited with whole cans of sardines. One hair tube transect was located above the UG1 LW101-103 footprint.
Harp trapping – harp traps were set up opportunistically at 19 sites across the study area and left in place for a variable number of nights. One harp trapping survey was conducted above the UG1 LW101-103 footprint.

Anabats – Anabat detection devices were used at 33 sites across the study area, with generally 2-4 devices used at each site. One device was placed in a stationary location with the remainder used as a roaming survey. No Anabat surveys were conducted above the UG1 LW101-103 footprint.

Spotlighting surveys – these surveys were conducted for approximately one hour with two persons and two spotlights at 26 sites across the study area. One spotlighting survey was conducted above the UG1 LW101-103 footprint.

Scats, tracks and traces searches – dedicated scat searches for a timed period of 15 mins per 1 ha area were undertaken at 13 sites across the study area. No scat, track and trace surveys were conducted above the UG1 LW101-103 footprint.

The ecological survey undertaken for the Stage 1 EIA identified threatened ecological communities, flora and fauna species across the study area, including above the UG1 LW101-103 footprint.

The endangered ecological community, White Box Yellow Box Blakely’s Red Gum Woodland listed as endangered under the NSW Threatened Species Conservation Act 1995 (TSC Act) and critically endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) was found within an area above the UG1 LW101-103 footprint.

No flora or fauna species being part of any relevant listed endangered population under the TSC Act or EPBC Act were found or were known to occur in the Stage 1 EIA study area, or were likely to be affected.

The Stage 1 EIA identified Goodenia macbarronii (Narrow Goodenia) in an area above the UG1 LW101-103 footprint. This species at the time of the impact assessment was listed as vulnerable under both the TSC Act and EPBC Act, however, since then this species has been delisted and is no longer listed as threatened under either the TSC Act or EPBC Act.

The Stage 1 EIA identified a number of threatened fauna species as being present above the UG1 LW101-103 footprint, including:

- *Climacteris picumnus victoriae* (Brown Treecreeper [eastern subspecies]) – listed as vulnerable under the TSC Act
- *Stagonopleura guttata* (Diamond Firetail) – listed as vulnerable under the TSC Act
- *Callocephalon fimbriatum* (Gang Gang Cockatoo) – listed as vulnerable under the TSC Act
- *Calyptorhynchus lathami* (Glossy Black Cockatoo) – listed as vulnerable under the TSC Act
- *Melanodryas cucullata* (Hooded Robin) – listed as vulnerable under the TSC Act
- *Pyrrholaemus sagittatus* (Speckled Warbler) – listed as vulnerable under the TSC Act
- *Lophoictinia isura* (Square-tailed Kite) – listed as vulnerable under the TSC Act
- *Melithreptus gularis* (Black-chinned Honeyeater) – listed as vulnerable under the TSC Act

### 2.1.2 Stage 2 Ecological Impact Assessment

The Stage 2 EIA (Eco Vision Consulting 2008) was undertaken in accordance with the Director-General’s requirements for Stage 2 of the Moolarben Coal Project. The EIA focused on assessing the impacts of Stage 2 (including UG1, UG2, OC4 and all associated infrastructure) upon terrestrial and aquatic biodiversity within the study area, including threatened flora and fauna species, endangered populations, threatened ecological communities and their associated habitats.
The flora surveys above the UG1 LW101-103 footprint consisted of approximately 11 flora quadrats that were undertaken for the Stage 1 EIA, with an additional three quadrats surveyed for the Stage 2 EIA. These floristic surveys used the same methods as the surveys undertaken for the Stage 1 EIA. The three additional quadrats were located within disturbed lands (two) and Sedimentary Ironbark Forests (one) during spring 2007 and winter 2008.

The fauna surveys undertaken above the UG1 LW101-103 footprint consisted of quantitative bird surveys, call playback, tree-mounted Elliot Type B trapping, hair tube surveys and harp trapping, undertaken as part of the Stage 1 EIA. Additional fauna survey was undertaken as part of the Stage 2 EIA, with the methodologies consistent including with the Stage 1 EIA methods. The additional fauna surveys undertaken included five quantitative bird surveys, one quantitative herpetological survey, three Anabat surveys, and one scats, tracks and traces search.

The ecological survey undertaken for the Stage 2 EIA identified no additional threatened ecological communities above the UG1 LW101-103 footprint than those identified for the Stage 1 EIA.

No flora or fauna species being part of any relevant listed endangered population under the TSC Act or EPBC Act were found or were known to occur in the Stage 2 EIA study area, or were likely to be affected.

The Stage 2 EIA indicated that *Pomaderris queenslandica* (Scant Pomaderris), occurred in an area above the UG1 LW101-103 footprint. This species is listed as endangered under the NSW TSC Act.

The ecological survey undertaken for the Stage 2 EIA identified no additional threatened fauna species above the UG1 LW101-103 footprint than those identified for the Stage 1 EIA.

### 2.1.3 UG1 Optimisation Modification

A flora and fauna impact assessment (Eco Logical Australia [ELA] 2015a) for a Part 3A Modification to UG1 was undertaken in 2015. The flora and fauna impact assessment was undertaken to determine any potential impacts from the proposed modification on threatened vegetation communities, and flora and fauna within and adjacent to the proposed impact area.

In order to complete the flora and fauna impact assessment, ELA undertook field survey during June 2014 which consisted of validating BioMetric vegetation types, identifying general floristic structure, targeted threatened flora searches, targeted microbat and diurnal bird surveys, habitat assessment, Koala habitat assessment and opportunistic fauna sightings. Potential habitat for threatened species was also recorded (if present) during the field survey.

Fauna habitat features within the study area were GPS located for mapping. These features include:

- hollow-bearing trees
- nests
- large woody debris
- rocks and outcrops
- woody understorey plants

Flora surveys were conducted within the modification study area using rapid vegetation survey plots and the random meander technique (Cropper 1993). Rapid surveys allowed improved understanding of the extent of vegetation communities across the UG1 Optimisation Modification area while the random meander surveys allowed identification of aboveground vascular flora. The random meander technique was used in areas where there was potential threatened flora habitat.
The UG1 Optimisation Modification area was mapped into five BioMetric vegetation types by ELA, comprising 11 vegetation communities and their respective cleared equivalents within the study area. One endangered ecological community, White Box Yellow Box Blakely’s Red Gum Woodland listed as endangered under the TSC Act and critically endangered under the EPBC Act was found within an area above the UG1 Optimisation Modification area.

No flora or fauna species being part of any relevant listed endangered population under the TSC Act or EPBC Act were found or were known to occur in the UG1 Optimisation Modification area, or were likely to be affected by the modification.

*Opuntia stricta* (Prickly Pear) was recorded within the study area. This species is listed as a Weed of National Significance (WONS) under the EPBC Act and a Class 4 Noxious weed in the Mid-Western Regional Council Local Government Area (LGA) under the NSW *National Parks and Wildlife Act 1974*.

The survey undertaken for the UG1 Optimisation Modification identified six threatened fauna species including five birds and one mammal (a microbat) listed as vulnerable under the TSC Act. These were the:

- Glossy Black Cockatoo
- Brown Treecreeper [eastern subspecies]
- Speckled Warbler
- *Daphoenositta chrysoptera* (Varied Sittella)
- Diamond Firetail
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat)

### 2.1.4 OC4 South-West Modification

ELA was engaged to undertake a flora and fauna impact assessment to relocate the Stage 2 OC4 haul road, located above UG1 LW101-103 (ELA 2015b). The flora and fauna impact assessment was undertaken to determine any potential impacts from the proposed modification on threatened vegetation communities, and flora and fauna within and adjacent to the proposed impact area.

In order to complete the flora and fauna impact assessment, ELA undertook field survey during July 2014 to validate BioMetric vegetation types, identify general floristic structure, target threatened flora searches, habitat assessment, Koala habitat assessment and opportunistic fauna sightings. Potential habitat for threatened species was targeted during the field survey where it was present.

The OC4 South-West Modification area was mapped into two BioMetric vegetation types by ELA, comprising the White Box – Narrow-leaved Ironbark Shubby Open Forest on hills of the central Hunter Valley, Sydney Basin and Grey Gum - Narrow-leaved Stringybark - Ironbark Woodland on ridges of the upper Hunter Valley, Sydney Basin. No endangered ecological communities were mapped within the OC4 South-West Modification area.

No flora or fauna species being part of any relevant listed endangered population under the TSC Act or EPBC Act were found or were known to occur in the OC4 South-West Modification area, or were likely to be affected by the modification.

No threatened flora or fauna species listed under the NSW TSC Act and/or the Commonwealth EPBC Act were observed during the field survey undertaken for the OC4 South-West Modification.
2.1.5 UG1 Vegetation Validation

ELA (2016) was engaged to undertake vegetation validation within the area of the UG1 LW101-103 footprint to revise existing vegetation mapping to include detailed extents, and to assign each vegetation community present to a Plant Community Type (PCT) in accordance with the current NSW Vegetation Information Classification System (ELA 2015c). The survey also specifically targeted any endangered/critically endangered ecological communities (EEC/CEECs) present, and any other vegetation that may be reliant on groundwater. The UG1 Vegetation Validation report is provided in Appendix 1.

In order to complete the vegetation validation, ELA undertook a desktop review of existing vegetation mapping for the area, including the vegetation communities mapped and described in Eco Vision Consulting (2008) and ELA (2015a, 2015b), and the subsequent mapping of vegetation to Biometric Vegetation Types and EEC/CEECs by ELA (2015c).

Field based vegetation mapping of the UG1 LW101-103 footprint was undertaken over a three day period during March 2016 and used two complimentary methods to map vegetation present within the survey area:

1. Transect based surveys – used across larger, more heterogeneous areas to confirm the vegetation community present. Descriptions of ecological communities encountered were recorded, and the locations, including any boundaries, were logged with a handheld GPS.
2. Traversing the full extent of the boundaries between distinct ecological communities and logging these with a handheld GPS, noting which community lay either side of the boundary.

Each vegetation community encountered during the field survey was described in the field and assigned to a “working” field community name. Descriptions were based on (often multiple) rapid survey assessments conducted within each vegetation community, in accordance with the NSW Office for Environment and Heritage (OEH) standards for vegetation field validation and type mapping (NSW Department of Environment, Climate Change and Water [DECCW] 2010; OEH 2015). Rapid assessments involved describing the vegetation structure (dominant species and cover within each vegetation strata), as well as topographic position, soils and any other relevant abiotic factors.

A single 50m x 20m biometric plot was established within an area of White Box Grassy Woodland and assessed in accordance with the BioBanking assessment methodology (OEH 2014a, 2014b).

The vegetation validation above the UG1 LW101-103 footprint identified 12 PCTs, listed below:

- PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions
- PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion
- PCT 277 Blakely’s Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion
- PCT 401 Rough-barked Apple-Blakely’s Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region
- PCT 420 Red Stringybark – Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP – Coolah regions
- PCT 424 Dwyer’s Red Gum heathy low open woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion
• PCT 478 Red Ironbark - Black Cypress Pine - Stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion
• PCT 479 Narrow-leaved Ironbark – Black Cypress Pine – Stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the Brigalow Belt South Bioregion and Sydney Basin Bioregion
• PCT 480 Black Cypress Pine – ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion
• PCT 864 Grey Gum – Narrow-leaved Stringybark – ironbark woodland on ridges of the upper Hunter Valley, Sydney Basin Bioregion
• PCT 1606 White Box - Narrow-leaved Ironbark – Blakely’s Red Gum shrubby open forest of the central and upper Hunter
• PCT 1696 Blakely’s Red Gum – Rough-barked Apple shrubby woodland of central and upper Hunter

The vegetation validation above the UG1 LW101-103 footprint identified three endangered ecological communities, including:

• White Box, Yellow Box, Blakely’s Red Gum Grassy Woodland and DNG – EPBC Act (DEH 2006)/White Box, Yellow Box, Blakely’s Red Gum Woodland – TSC Act (NSW Scientific Committee 2002) (EEC/CEEC)
• Central Hunter Valley Eucalypt Forest and Woodland – EPBC Act (Threatened Species Scientific Committee 2015) (CEEC1)
• Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions – TSC Act (NSW Scientific Committee 2010) (EEC)

1 This CEEC was listed in May 2015 and does not apply to the approved Stage 1 and Stage 2 mining operations pursuant to Section 158A of the EPBC Act.
3 Subsidence Impacts

Subsidence predictions and impact assessments were developed for the UG1 Optimisation Modification by MSEC (2015). These were then reviewed for this UG1 LW101 - 103 Extraction Plan (MSEC 2017) and remain consistent with the predictions for the UG1 Optimisation Modification.

Accordingly, potential subsidence impacts to biodiversity remain consistent with the impacts described in the UG1 Optimisation Modification (ELA 2015a).

3.1 Overall predicted subsidence

The predicted systematic subsidence parameters for UG1 LW101 - 103 were made by MSEC (2017) using the Incremental Profile Method (IPM). The method is an empirical model based on a large database of observed monitoring data from previously mined areas within the coalfields of NSW.

The predicted subsidence effects of secondary extraction (longwall mining) of UG1 LW101-103 have been determined (MSEC 2017). The maximum predicted total systematic subsidence due to the extraction of UG1 LW101 - 103 is 2400 millimetres (mm) at a location over LW101 where the depth of cover is 130m and the proposed extracted seam thickness is 3.5m. This predicted maximum total subsidence represents 68.6% of the extracted seam thickness.

The maximum predicted total systematic tilt over the UG1 LW101 – 103 footprint is >100 millimetres/metre (mm/m) and is expected to be expressed near the tailgate of LW102 where the depth of cover is approximately 50m. The maximum predicted total systematic tensile and compressive strains over UG1 resulting from the extraction of the longwalls is expected to be greater than 50mm/m and 100mm/m respectively. The maximum predicted total systematic tensile and compressive strains are both expected to occur near the tailgate of LW102.

3.2 Predicted subsidence effects

The overall predicted subsidence effects and impacts upon biodiversity above UG1 LW101-103 are summarised below in Table 2.
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<th>Description</th>
<th>Subsidence prediction</th>
<th>Impact Assessment</th>
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| Threatened, Protected Species or Critical Habitats | Known EEC/CEEC occurs within UG1 LW101-LW103 area including:  
- White Box, Yellow Box, Blakely’s Red Gum Grassy Woodland and DNG - EPBC Act (DEH 2006)/White Box, Yellow Box, Blakely’s Red Gum Woodland - TSC Act (NSW Scientific Committee 2002) (EEC/CEEC)  
- Central Hunter Valley Eucalypt Forest and Woodland – EPBC Act (CEEC)  
- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions – TSC Act (EEC)  
Known habitat exists within UG1 LW101-LW103 footprint for multiple threatened flora and fauna species, including some cave roosting microbats. | The maximum predicted systematic subsidence at the vegetation communities is 2400mm. The maximum predicted systematic tilt at the vegetation communities, at any time during or after the extraction of the longwalls, is >100mm/m (i.e. 11.5 %), or a change in grade of 1 in 9.  
The approximate natural grade of the surface within the mapped areas of the EEC/CEEC’s varies between near level surfaces to approximately 500mm/m (i.e. 50 %) with an estimated average of approximately 140mm/m (i.e. 14%) or a change of grade of 1 in 7. The maximum predicted systematic tensile and compressive strains at the EEC/CEEC’s are greater than 50mm/m and 100mm/m respectively. | Potential subsidence impacts would be consistent with those described in ELA (2015a):  
Subsidence of vegetation within the underground mining area is not expected to result in the loss of vegetation cover or community structure. Fauna habitat (including that identified as Koala habitat) will not be directly impacted by the occurrence of subsidence. Direct mortality of plants and animals (including cave roosting bats) may occur as a result of subsidence-induced rock fall or collapse; however the impacts of such events are expected to be short-term and insignificant.  
The potential subsidence of cliff line habitats due to the increase of underground mining may impact upon cave roosting bats, particularly Chalinolobus dwyeri (Large-eared Pied Bat), which is known to occur in the proposed mining area and surrounds. The nature and extent of habitat for cave roosting bats is not likely to be significantly altered as a result of the proposed modification in a way that would jeopardise the species in the locality. Furthermore, extensive potential |

| Natural Vegetation | The UG1 Study Area generally consists of disturbed land and undisturbed native vegetation. The vegetation validation above the UG1 LW101-LW103 impact area resulted in the identification of 12 PCT’s. | | |
## Aspect Description Subsidence prediction Impact Assessment

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
<th>Subsidence prediction</th>
<th>Impact Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>habitat has been recorded within the Stage 2 offset areas and the Large-eared Pied Bat has been recorded by surveys on one of the offset properties, where sandstone outcrops provide habitat for this species.</td>
</tr>
</tbody>
</table>

In summary, the potential subsidence of vegetation is not expected to result in a loss of vegetation cover or community structure or direct impacts to fauna habitat. This conclusion is supported by previous local studies that have been unable to detect an impact of subsidence on local vegetation communities.

Direct mortality of a small number of individual plants and animals may occur as a result of subsidence induced rock fall or collapse, however the impacts of such events are expected to be short-term, localised and not significant.

The effect of subsidence is unlikely to cause any significant impact on vegetation communities or critical habitats.

---

1 This CEEC was listed in May 2015 and does not apply to the approved Stage 1 and Stage 2 mining operations pursuant to Section 158A of the EPBC Act.
4 Discussion & Recommendations

4.1 Subsidence predictions

Given subsidence impacts for LW101 - 103 would be consistent with those for the UG1 Optimisation Modification, it is considered that the UG1 LW101-103 would satisfy the condition set out in Schedule 4, Condition 1 of Project Approval 08_0135, requiring that the "the project does not cause any exceedance of the performance measures" and more specifically has negligible subsidence impacts or environmental consequences upon threatened species, threatened populations or endangered ecological communities.

Furthermore, the monitoring program and management measures recommended below will identify where potential impacts upon ecological values occur and mitigate these should they occur.

4.2 Recommendations for monitoring

The recommended monitoring approach has been developed with consideration of the results of the previous survey effort and focusses on monitoring potential impacts of subsidence so that the project does not exceed the performance measures as set out in Schedule 4, Condition 1 of Project Approval 08_0135.

At a local scale, longwall traverses, coupled with floristic-based subsidence monitoring should be undertaken to identify subsidence related impacts such as deterioration of tree health (related to subsidence or ponding) and weed incursions. The monitoring program is summarised in Table 3 and further described in the sections below.

Table 3: Monitoring program

<table>
<thead>
<tr>
<th>Data source</th>
<th>Type</th>
<th>Scale</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longwall traverses</td>
<td>Transects and permanent monitoring sites</td>
<td>Baseline before and following mining, above each longwall every spring (one prior to mining and two years post mining), with nine permanent monitoring sites established at random locations along the transects (i.e. total, not per transect)</td>
<td>Canopy health and defoliation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vegetation structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Photographs</td>
</tr>
</tbody>
</table>

4.2.1 Baseline monitoring requirements

Baseline monitoring should be undertaken to understand current conditions above UG1 LW101-LW103. Baseline monitoring should include longwall traverses and floristic-based subsidence monitoring as described in Section 4.2.2. During baseline monitoring, identification of potential roosting caves for the Large-eared Pied Bat would also be undertaken.

The baseline monitoring would build on monitoring data obtained to date at the Moolarben Coal Complex.
4.2.2 Longwall panel traverses and floristic-based subsidence monitoring

Prior to mining and once undermining has occurred, each longwall panel should be traversed annually in spring to identify any subsidence related impacts (i.e. one prior to mining, and two years post-mining). Key triggers to undertake more detailed monitoring should include:

- areas of cracking or ponding that exceed predictions in the subsidence predictions and assessment of the impacts relating to the predicted subsidence above LW101 to LW103 (MSEC 2017);
- deterioration in tree health; and
- areas of weed incursion and/or infestation.

A series of transects should be established across the width of each longwall (Figure 1). Along these transects, nine permanent monitoring sites (i.e. total, not per transect) should be established at random locations, with a minimum of 50m between each site. Each monitoring site should be permanently marked with a metal star picket.

Data collected at each permanent monitoring site is to include:

- Canopy health and defoliation (all in 5% increments):
  - Percentage of epicormic foliage in relation to total tree foliage
  - Proportion of primary branches within canopy that have died back
  - Percentage of current canopy foliage as a proportion of the estimated canopy foliage volume/potential canopy
  - Percentage of canopy foliage discoloured
- Vegetation structure:
  - Projected foliage cover (PFC – 1-5%, then 5% increments) of native grass/ground cover; native shrubs <1m height, native shrubs/small trees >1m height
  - PFC 5% increments of upper canopy (assessed at each quadrat corner and averaged)
  - Exotic species
  - Number of stags, estimated time since cause of death
  - Lower, estimated median and upper diameter at breast height (DBH) over bark of canopy stems (centimetres [cm])
  - Abundance of each canopy species (identified to species level); calculated, total stems per hectare
- Photograph of the canopy (camera placed on top of the star picket, facing up); photograph facing due north, south, east and west from the star picket.

Any evidence of subsidence, such as subsidence cracks, opportunistically observed during transect monitoring should be recorded with a handheld GPS.

In addition to annual panel traverses of the transects, opportunistic inspections of the surface environment above the longwalls should be undertaken by MCO personnel. This will enable prompt detection of impacts to tree health caused by surface cracking, ponding or other longwall mining consequences.
Figure 1: Indicative monitoring locations
4.3 **Recommendations for management**

Recommended management measures should be implemented, as appropriate, to comply with the relevant statutory requirements and the subsidence impact performance measures. Based upon the predicted subsidence effects and consequences upon biodiversity values within UG1 LW101-LW103 footprint, management measures for have been prescribed below for:

- vegetation;
- terrestrial fauna and habitat;
- weed management; and
- additional monitoring.

4.3.1 **Vegetation**

Potential management measures for impacts on vegetation include the implementation of weed control measures (e.g. mechanical removal or the application of approved herbicides), the preservation of stags (dead trees) and the planting of endemic plant species should monitoring indicate that subsidence impacts are having a negative effect on the distribution and health of vegetation communities.

Weed management measures should be consistent with those represented within the MCO Biodiversity Management Plan (BMP) and further described in Section 4.3.3.

Vegetation plantings should use flora species characteristic of the particular vegetation community in that area. All rehabilitation methods and species used in plantings should be consistent with those prescribed in the MCO BMP.

Any vegetation clearing (e.g. for subsidence remediation activities) must follow the protocol outlined in the MCO BMP. Rehabilitation of disturbed areas should be undertaken in accordance with the requirements of the Rehabilitation Management Plan.

4.3.2 **Terrestrial fauna and habitat**

Terrestrial fauna monitoring will be used to assess the environmental consequences of subsidence impacts, including the nature and extent of impacts on flora and fauna habitats and evidence of impacts on terrestrial fauna. The terrestrial fauna and habitat monitoring will be based on a review of the results of the flora/vegetation monitoring to determine any potential impacts on fauna habitats. Opportunistic recordings of fauna species will also be undertaken during the traverses of the longwall transects.

Implementation of management measures will be considered with regard to the specific circumstances of the subsidence impact (e.g. the location, nature and extent of the impact) and environmental consequence occurring as a result.

Review of the cliff line monitoring data should be undertaken, particularly in relation to any potential roosting sites for the Large-eared Pied Bat. In the event that impacts are considered likely to occur, or are identified as having occurred, inspection of any potential roosting sites for the Large-eared Pied Bat would be undertaken to document any potential impacts.

4.3.3 **Weed management**

Weed management activities will be implemented to limit the spread of noxious and environmental weeds, where weeds are found to occur within the UG1 LW101-LW103 footprint. Weed management should be consistent with the BMP and targeted at noxious weeds initially. All noxious weeds recorded within the Mining Lease to date are Category 4 noxious weeds, which must be controlled by the
landowner according to the measures specified in a management plan published by the local control authority.

4.3.4 Additional monitoring

Where a predicted subsidence impact has been exceeded, it may be appropriate to conduct additional monitoring (e.g. increase the frequency of monitoring or the parameters monitored) or conduct additional test work. For example, if the analysis of vegetation communities indicates a greater impact from subsidence, more frequent monitoring of specific areas, such as incidence of vegetation dieback, may be appropriate.
References


Department of Environment, Climate Change and Water. 2010. *Native Vegetation Interim Type Standard*. Department of Environment, Climate Change and Water.


Appendix A – UG1 Vegetation Validation
16 March 2016

Dear Graeme,

Re: Moolarben Coal UG1 Vegetation Validation

INTRODUCTION

Eco Logical Australia (ELA) was engaged to undertake vegetation validation within the area above Underground 1 (UG1) Longwalls (LW) 101 to 103. This vegetation validation was undertaken to revise existing vegetation mapping to include detailed extents, and to assign each vegetation community present to a Plant Community Type (PCT) in line with the current NSW Vegetation Information Classification System. The survey also specifically targeted any endangered/critically endangered ecological communities (EEC/CEECs) present, and any other vegetation that may be reliant on groundwater.

METHODS

Review of existing mapping

A desktop review was conducted of existing vegetation mapping for the area, including the vegetation communities mapped and described in EcoVision Consulting (2008) and ELA (2014), and the subsequent mapping of vegetation to Biometric Vegetation Types and EEC/CEECs by ELA (2015).

Field survey

Field based vegetation mapping of the UG1 LW 101 to 103 survey area (Appendix A) was undertaken over three days by ELA ecologists David Allworth and Sarah Dickson-Hoyle from March 2nd to 4th, 2016. Due to the large area to be surveyed (approximately 444 ha), the limited road access, rugged topography and dense vegetation, required surveys had to be conducted predominantly by traversing the area by foot.

Field surveys utilised two complimentary methods to map vegetation present within the survey area:

1. Transect based surveys – predominantly used across larger, more heterogeneous areas to confirm the vegetation community present. Descriptions of ecological communities encountered were recorded, and the locations, including any boundaries, were logged with a handheld GPS.
2. Traversing the full extent of the boundaries between distinct ecological communities and logging these with a handheld GPS, noting what community lay either side.

Each distinct vegetation community encountered during the field survey was described in the field and assigned to a “working” field community name. Descriptions were based on (often multiple) rapid survey assessments conducted within each vegetation community, in accordance with the Office for Environment and Heritage standards for vegetation field validation and type mapping (DECCW 2010; OEH 2015). Rapid assessments involved describing the vegetation structure (dominant species and cover within each vegetation strata), as well as topographic position, soils and any other relevant abiotic factors.
A single temporary 50 m x 20 m biometric plot was established within an area of White Box Grassy Woodland and assessed in accordance with the BioBanking assessment methodology (OEH 2014).

**NSW Vegetation Information System (VIS) database search, and assigning PCTs**

Following the field survey, the vegetation communities determined from rapid assessment data and general field observations were assigned a PCT and located within a soil landscape as defined by Murphy and Lawrie (1998).

The NSW PCT system has been developed with the approach of “listing plant communities based on differences in floristic assemblages, generally within one or two structural classes” (Benson 2006), and as such it is possible to assign a PCT on floristics and structure alone. However, the majority of PCT descriptions also include reference to landscape position, NSW Landscapes (Mitchell 2002), and IBRA bioregion; the former two of which are not available as search parameters in the NSW Vegetation Information System 2.1 (used to identify PCTs for this study). Furthermore, there is no guide in the database or associated literature regarding the weighting that should be given to floristics versus landscape position.

In determining the PCTs present within the survey area, emphasis was placed on identifying PCTs for which the description best reflected both floristic composition, landscape position and geology. This approach is also consistent with the IBRA Bioregion system that draws on both floristic and abiotic factors to determine boundaries.

It was found that each PCT located itself into only one soil landscape type with the exception of two, PCT 76 and PCT 479. These distinct occurrences were distinguished by suffixes incorporating a landscape descriptor as well as ‘a’, ‘b’ etc by the authors (see PCT 76 and PCT 479 in Table 1 below).

The division of PCTs into their respective soil landscape gives more ready insight into the patterns of vegetation community occurrence, and provides additional important ecological information. For example, *Eucalyptus blakelyi* grassy woodland on a granite ridge will have a very different ecology and habitat values to the same vegetation formation occurring on alluvial areas that may sometimes be waterlogged. The grouping of PCTs to soil landscapes can inform both revegetation strategies as well as location of appropriate analogue sites if required.

**RESULTS AND DISCUSSION**

**Vegetation communities and associated PCTs**

A summary of all vegetation communities identified and mapped within the survey area is presented in Table 1 below. Results from rapid assessments and the biometric plot can be provided in Excel format upon request.
<table>
<thead>
<tr>
<th>Soil landscape</th>
<th>PCT</th>
<th>Keith Class</th>
<th>Vegetation description (field)</th>
<th>Topographic/landscape position</th>
<th>Geology</th>
<th>Comments</th>
<th>EEC/CEEC</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bald Hills</td>
<td>PCT 266</td>
<td>Western Slopes, Grassy woodland</td>
<td><em>Eucalyptus albens</em> (White Box) grassy woodland</td>
<td>Lower slopes and colluvial areas</td>
<td>Basalts, outcrop within Triassic sediments with Eucrozem soils</td>
<td>Y</td>
<td>15.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PCT 76(a)</td>
<td>Western Slopes, Grassy woodland</td>
<td><em>E. moluccana</em> (Grey Box) grassy woodland on basalt</td>
<td>Low slopes and colluvial areas</td>
<td>Basalt outcrop within Triassic sediments. Occurs at junction of two geologies, with harder setting duplex soils</td>
<td>N</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Munghorn</td>
<td>PCT 424</td>
<td>Western Slopes, Dry Sclerophyll Forest</td>
<td><em>E. crebra</em> (Narrow-leaved Ironbark) – <em>E. dwyeri</em> (Dwyer’s Mallee) +/- <em>C. endlicheri</em> (Black Cypress) heathy woodland/open forest</td>
<td>Sandy ridge tops</td>
<td>Triassic sandstone, with sandy soils</td>
<td>N</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PCT 479(a)</td>
<td>Western Slopes, Dry Sclerophyll Forest</td>
<td><em>E. crebra</em> (Narrow-leaved Ironbark) – <em>Callitris endlicheri</em> (Black Cypress) open forest</td>
<td>Low undulating hills of the Triassic formation</td>
<td>Sandstone</td>
<td>Canopy species’ dominance varies with disturbance (fire) history and substrate</td>
<td>N</td>
<td>38.1</td>
</tr>
<tr>
<td></td>
<td>PCT 480</td>
<td>Western Slopes, Dry</td>
<td><em>E. fibrosa</em> (Red Ironbark) – <em>C. endlicheri</em> (Black Cypress Pine) +/- <em>E. dwyeri</em> (Dwyer’s Mallee)</td>
<td>Sandy and rocky ridge tops</td>
<td>Sandstone</td>
<td>This community shares components of PCT 1511 (Dwyer’s Red Gum woodland)</td>
<td>N</td>
<td>187.6</td>
</tr>
<tr>
<td>Soil landscape</td>
<td>PCT</td>
<td>Keith Class</td>
<td>Vegetation description (field)</td>
<td>Topographic/landscape position</td>
<td>Geology</td>
<td>Comments</td>
<td>EEC/CEEC</td>
<td>Area (ha)</td>
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</tr>
<tr>
<td>Upper Hunter region of the Sydney Basin Bioregion</td>
<td>Sclerophyll Forest</td>
<td>+/- <em>E. rossi</em> (Scribbly Gum) open forest</td>
<td></td>
<td></td>
<td></td>
<td>on siliceous substrates) in areas, particularly on rocky outcrops above escarpments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCT 420 Red Stringybark – Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrambungle NP – Coolah regions</td>
<td>Western Slopes Dry Sclerophyll Forest</td>
<td><em>E. macrorhyncha</em> (Red Stringybark) – <em>Angophora floribunda</em> (Rough-barked Apple) open forest</td>
<td>Narrow gullies and flats at junction of Triassic onto Permian formation.</td>
<td>Triassic sediments</td>
<td>While PCT 420 is described as being outside this specific survey region, the species composition and general landscape position resulted in this being the best ‘fit’ for the described vegetation community</td>
<td>N</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>PCT 401 Rough-barked Apple - Blakely’s Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region</td>
<td>Western Slopes Grassy woodland</td>
<td><em>A. floribunda</em> (Rough-barked Apple) +/- <em>E. punctata</em> (Grey Gum) +/- <em>Acacia linearifolia</em></td>
<td>In broadening low slope gullies with deep sands derived from steep Triassic and Permian beds immediately above.</td>
<td>Permian sediments</td>
<td></td>
<td>N</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Lees Pinch</td>
<td>Western Slopes Dry Sclerophyll Forest</td>
<td><em>E. fibrosa</em> (Broad-leaved Ironbark) – <em>E. dawsonii</em> (Slaty Gum) – <em>E. punctata</em> (Grey Gum) – <em>C. endlicheri</em> (Black Cypress) open forest</td>
<td>Moderate slopes on Permian beds below Triassic sediments; shallow soils</td>
<td>Permian sediments</td>
<td><em>E. dawsonii</em> is found as scattered remnant trees along the border of this remnant PCT and its cleared formation.</td>
<td>N</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Soil landscape</td>
<td>PCT</td>
<td>Keith Class</td>
<td>Vegetation description (field)</td>
<td>Topographic/landscape position</td>
<td>Geology</td>
<td>Comments</td>
<td>EEC/CEEC</td>
<td>Area (ha)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
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<td>--------------------------------------------------------</td>
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</tr>
<tr>
<td>PCT 478 Red Ironbark - Black Cypress Pine - stringy bark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion (Cleared)</td>
<td>Western Slopes Dry Sclerophyll Forest</td>
<td>E. <em>fibrosa</em> (Broad-leaved Ironbark) – <em>E. dawsonii</em> (Slaty Gum) – <em>E. punctata</em> (Grey Gum) – <em>C. endlicheri</em> (Black Cypress) shrubby open forest (regenerating/DNG)</td>
<td>Moderate slopes on Permian beds below Triassic sediments. Shallow soils.</td>
<td>Permian sediments</td>
<td>Regenerating/derived native grassland formation</td>
<td>N</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>PCT 864 Grey Gum- Narrow-Leaved Stringy bark – ironbark woodland on ridges of the upper Hunter Valley, Sydney Basin Bioregion</td>
<td>Western Slopes Dry Sclerophyll Forest</td>
<td><em>E. sparsifolia</em> (Narrow-leaved Stringybark) – <em>E. punctata</em> (Grey Gum) +/- <em>Eucalyptus fibrosa</em> (Broad-leaved Ironbark) +/- <em>C. endlicheri</em> (Black Cypress) open forest</td>
<td>Escarpment areas of Triassic formation onto steeper Permian sediments immediately below. <em>E. sparsifolia</em> dominates on slopes, and <em>E. punctata</em> dominates in broad gullies</td>
<td>Outcropping Triassic sandstone and onto Permian sediments</td>
<td>Open forest rather than woodland formation. This community intergrades with PCT 480 on upper slopes and immediately above escarpments</td>
<td>N</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>PCT 1606 White Box - Narrow-leaved Ironbark – Blakely’s Red Gum shrubby open forest of the central and upper Hunter</td>
<td>Western Slopes Dry Sclerophyll Forest</td>
<td><em>E. albens</em> (White Box) – <em>E. crebra</em> (Narrow-leaved Ironbark) shrubby open forest/woodland</td>
<td>Moderate slopes to gullies on Permian beds below Triassic sediments</td>
<td>Permian mudstone, or other fine-grained sediments</td>
<td>Variously dominated by <em>E. crebra</em> or <em>E. albens</em> depending on specific landscape position</td>
<td>Y</td>
<td>20.9</td>
<td></td>
</tr>
<tr>
<td>1696 Blakely’s Red Gum – Rough-barked Apple shrubby woodland of central and upper Hunter</td>
<td>Western Slopes Dry Sclerophyll Forests</td>
<td><em>E. blakelyi</em> (Blakely’s Red Gum) shrubby woodland</td>
<td>Widening drainage lines of poorer sandy soils or sometime waterlogged areas</td>
<td>Permian sediments</td>
<td>Both remnant and mature regeneration</td>
<td>N</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>


*Comments:*
- Variously dominated by *E. crebra* or *E. albens* depending on specific landscape position
- Widening drainage lines of poorer sandy soils or sometime waterlogged areas
- Regenerating/derived native grassland formation
- Open forest rather than woodland formation. This community intergrades with PCT 480 on upper slopes and immediately above escarpments
- Both remnant and mature regeneration
- Variously grass/shrub formation, characterised by presence of *Melaleuca thymifolia*
<table>
<thead>
<tr>
<th>Soil landscape</th>
<th>PCT</th>
<th>Keith Class</th>
<th>Vegetation description (field)</th>
<th>Topographic/landscape position</th>
<th>Geology</th>
<th>Comments</th>
<th>EEC/CEEC</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulan</td>
<td>PCT 76 (b) Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions</td>
<td>Western Slopes Grass Grassy Woodland</td>
<td><em>E. moluccana</em> (Grey Box) grassy woodland on duplex soils derived from sediments.</td>
<td>Rises towards talus slopes below Triassic sediments</td>
<td>Permian sediments</td>
<td><em>E. moluccana</em> not <em>E. microcarpa</em> (as referenced in PCT)</td>
<td>N</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>PCT 277 Blakely’s Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion</td>
<td>Western Slopes Grass Grassy Woodland</td>
<td><em>E. blakelyi</em> (Blakely’s Red Gum) grassy woodland</td>
<td>Broad drainage lines with greater depth of soil than shrubby PCT 1696</td>
<td>Permian sediments</td>
<td>Remnant mature trees and natural regeneration (modified)</td>
<td>Y</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>PCT 479 (b) Narrow-leaved Ironbark – Black Cypress Pine – stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the Brigalow Belt South Bioregion and Sydney Basin Bioregion</td>
<td>Western slopes Dry Sclerophyll Forests</td>
<td><em>E. crebra</em> (Narrow-leaved Ironbark) shrubby woodland (regenerating/cleared)</td>
<td>From medium slopes areas of Permian sediments below Triassic sediments to low slope areas on Permian sediments with some degree of soil formation.</td>
<td>Permian sediments</td>
<td>Regenerating/derived native grassland formation</td>
<td>Y*</td>
<td>11.7</td>
</tr>
</tbody>
</table>

*Y*: Isolated areas with presence of *E. moluccana* / ecotone with PCT 76 b only. See below for further information.
Presence and extent of EEC/CEEC

PCTs and vegetation map units deemed to meet the listing criteria for EEC/CEECs are identified in Table 1 above. These communities, and the rationale for determining the EEC/CEEC condition and status, are described in additional detail below and are shown in Appendix C.

**EEC/CEEC 1: White Box, Yellow Box, Blakely’s Red Gum Grass Woodland and DNG - EPBC Act (DEH 2006)/White Box, Yellow Box, Blakely’s Red Gum Woodland - TSC Act (NSW Scientific Committee 2002)**

This woodland community is characterised by the presence or prior occurrence of *E. albens*, *E. melliodora* and/or *E. blakelyi*. The understorey is predominantly grassy, and is dominated by native perennial species (tussock grasses, herbs and scattered shrubs). In NSW it occurs in the tablelands and western slopes on moderate to highly fertile soils.

Vegetation communities dominated or assessed as having been previously dominated by one or more of the above canopy species were assessed against both the TSC Act and EPBC listing criteria for this EEC/CEEC (respectively). Note that while a full floristic survey within a 0.1 ha patch to identify the presence or other of 12 or more native understorey species (excluding grasses, and including one or more important species), which is a step in the EPBC Act Policy Statement assessment flowchart (DHE 2006: 5), was only conducted in one patch of White Box grassy woodland (PCT 266), a broad review of previous mapping and floristic surveys within the survey area resulted in the attribution of all areas of PCT 277 and PCT 266 being attributed to this EEC/CEEC.

A total of 17.9 ha of this EEC/CEEC is present within the survey area. Areas mapped as PCT 1696 were not deemed to meet the listing criteria or descriptions outlined in the Scientific Determinations, predominantly due to their shrubby formation characterised by the presence of *Melaleuca thymifolia*, and location on poorer sandy soils of lower fertility.

**CEEC 2: Central Hunter Valley Eucalypt Forest and Woodland – EPBC Act (TSSC 2015)**

This CEC is described as an open forest or woodland dominated by one or more of *E. crebra*, *Corymbia maculata*, *E. dawsonii* and *E. moluccana*, often in local association with species such as *A. floribunda*, *E. blakelyi* or *E. albens*. The mid-storey is typically shrubby, and ground cover species include *Aristida ramosa* (Purple Wire Grass) and *Cymbopogon refractus* (Barbed Wiregrass) (TSSC 2015).

The area(s) of PCT 1606 was assessed against the key diagnostic characteristics of this CEEC (TSSC 2015: 9), including its presence in the Hunter River Catchment, occurrence on lower hillslopes, ridges or valley flors on soils derived from Permian sedimentary rocks, and its vegetation structure and composition. Based on this assessment, the areas mapped as PCT 1606 were deemed as meeting the criteria for listing as the above CEEC.

A total of 20.9 ha of this CEEC is present on site.

It should be noted that this CEEC was listed in May 2015, after the Environmental Assessment and Project Approval for UG1. As such this report simply notes its presence for any future reference.

**EEC 3: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (NSW Scientific Committee 2010)**

This EEC is described as a woodland to open forest occurring on slopes and undulating hills on Permian sediments. It is characterised by a canopy dominated by *E. crebra*, *E. moluccana* and *Brachychiton populneus* (Kurrajong), often with *A. floribunda* and *C. endlicheri* as associate or co-dominant species. A shrub layer may also be present, and ground cover can be moderately dense to dense.

PCT 76b (Grey Box grassy woodland) and PCT 479b (Narrow-leaved Ironbark shrubby woodland, regenerating/cleared) are located adjacent or in close proximity to each other on lower slopes and flats. Small
(between approximately 0.1 and 0.7 ha) isolated patches of this EEC have previously been mapped by ELA in the areas now mapped as either PCT 76b or PCT 479b. These previously mapped EEC areas are likely where these two PCTs overlap or intergrade, and therefore where both *E. crebra* and *E. moluccana* are present. These areas, totalling approximately 1.4 ha, have been included in the map of EEC/CEECs in Appendix C.

It should be noted that this EEC was listed in 2011, after the Environmental Assessment was undertaken for UG1. As such this report simply notes its presence for any future reference.

**RECOMMENDATIONS FOR FUTURE MONITORING**

Based on the results of the vegetation validation, and ELA’s experience and knowledge of conducting subsidence-based vegetation monitoring, vegetation monitoring for potential impacts of LW subsidence on vegetation above UG1 may include the following general components:

- Combination of transect based monitoring (cross panel traverses to identify any subsidence cracks or disturbances) and rapid vegetation assessments (located at defined points along transects)
- Rapid assessments to focus on vegetation structure (dominant species, height and covers within each strata) and tree canopy health (e.g. evidence of dieback, discolouration or snapped limbs)
- Within each panel, ensure monitoring covers the range vegetation communities present across the diversity of geologies and landscape positions, i.e. sandstone ridge tops, slopes and lower lying valleys/drainage areas, including any EEC/CEEC present

It should be noted that development of a detailed and statistically rigorous monitoring program is beyond the scope of this project. As such, additional advice should be sought prior to initiating monitoring, including how to align vegetation monitoring methods with groundwater monitoring.

**CONCLUSION**

The vegetation validation for UG1 has revised and described in detail the ecological communities present within the UG1 LW 101 to 103 survey area based on more intensive survey efforts compared to previous mapping, and updated vegetation mapping in order to reflect the current PCT classification system. The spatial data for this updated vegetation mapping has been supplied to MCO in the form of an Arc GIS shape file. The survey also refined the boundaries and extent of EEC/CEEC present within the survey area, and has resulted in recommendations for areas to target in future subsidence-based monitoring programs.

If you wish to discuss any of the above, I can be contacted via the details provided below.

Sincerely

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Ecologist

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REFERENCES

Department of Environment, Climate Change and Water. 2010. *Native Vegetation Interim Type Standard*. Department of Environment, Climate Change and Water.


Threatened Species Scientific Committee. 2015. *Approved Conservation Advice (including listing advice) for the Central Hunter Valley eucalypt forest and woodland ecological community*. Threatened Species Scientific Committee.
Appendix A: UG1 Survey Area
Appendix C – EEC/CEEC present within the study area

Legend
- Central Hunter Grey Box - Ironbark Woodland (regenerating/cleared)
- White Box Yellow Box Blakely's Red Gum Grassy Woodland (White Box dominated)
- White Box Yellow Box Blakely's Red Gum Grassy Woodland (Blakely's Red Gum dominated)
- Central Hunter Valley Eucalypt Forest
- UG1 Survey Area

Datum/Projection: GDA 1994 MGA Zone 55
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