APPENDIX 5

Ecological Assessment

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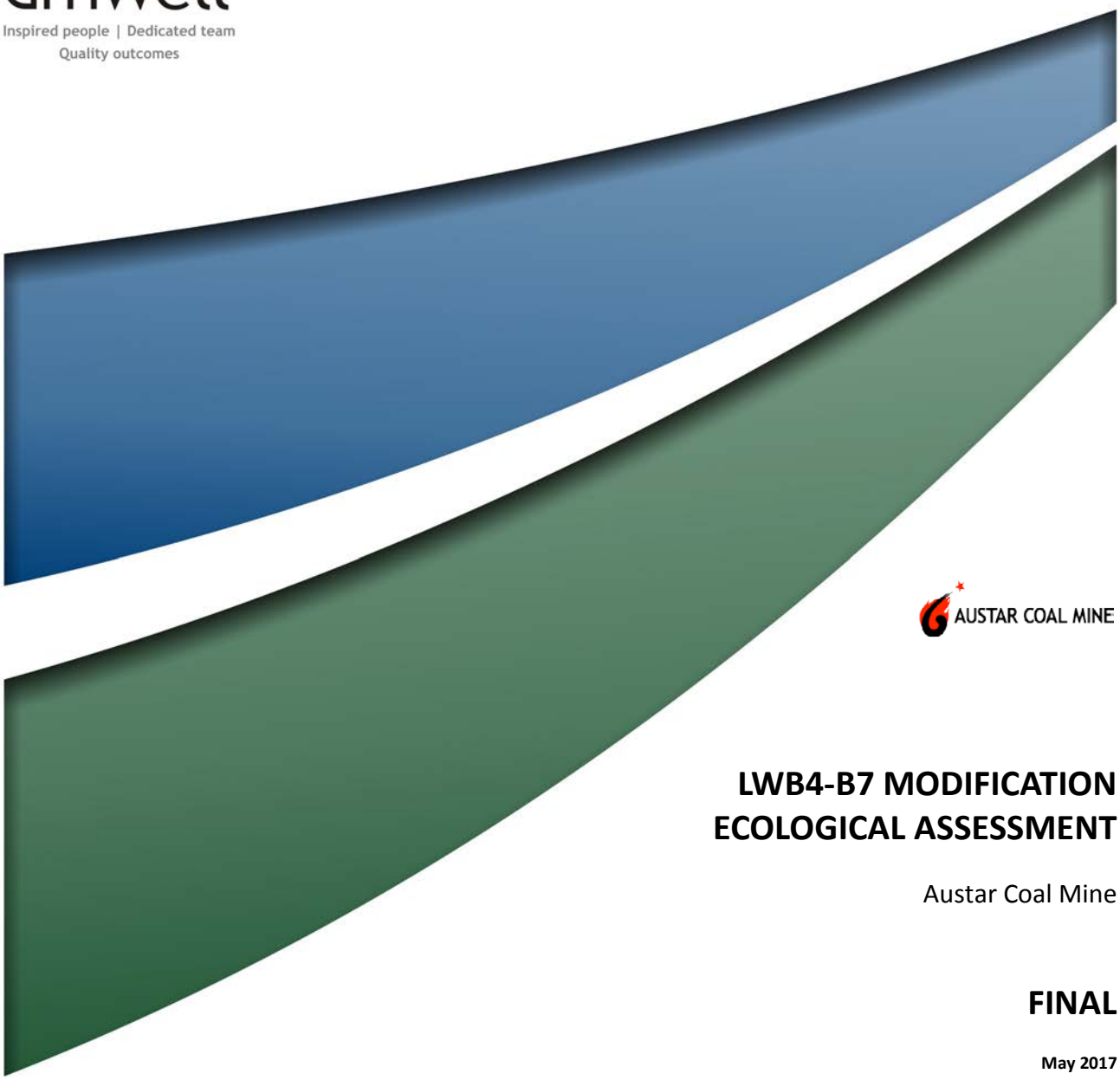

AUSTAR COAL MINE

LWB4-B7 MODIFICATION ECOLOGICAL ASSESSMENT

Austar Coal Mine

FINAL

May 2017

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Austar Coal Mine

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Austar Coal Mine

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Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Gabrielle Allan	24/05/2017	Barbara Crossley	24/05/2017

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1.0 Introduction

Austar Coal Mine Pty Ltd (Austar), a subsidiary of Yancoal Australia Limited (Yancoal), operates the Austar Coal Mine, an underground coal mine located approximately 10 kilometres south of Cessnock in the Lower Hunter Valley in NSW (refer to **Figure 1.1**). The Austar Coal Mine incorporates the former Pelton, Ellalong, Cessnock No. 1 (Kalingo) and Bellbird South Collieries and includes coal extraction, handling, processing and rail and road transport facilities (refer to **Figure 1.2**).

Extensive mining has been undertaken within the Austar Coal Mine since 1916. Historical mining was predominantly via bord and pillar mining and more recently via conventional longwall mining and longwall top coal caving (LTCC) methods. Mining within the Bellbird South areas (Southland, Stage 1 and Stage 2, refer to **Figure 1.2**) was approved by the Minister for Urban Affairs and Planning in 1996 under DA 29/95, while mining of Stage 3 was approved by the Minister for Planning in 2009 under Project Approval 08_0111. Longwall mining commenced in the Ellalong Colliery area in 1983 and has subsequently progressed into the Bellbird South and the Stage 3 areas.

Mining is currently proceeding in the LWB1-B3 mining area in accordance with DA 29/95 (as modified).

A review of accessible coal resources within the Bellbird South / Ellalong Colliery areas has identified the potential for four additional longwall panels (LWB4-B7) adjacent to LWB3 that can be accessed from the Bellbird mains (refer to **Figure 1.3**). This additional longwall resource would provide continuity of mining following the completion of LWB3, and with minimal additional mine development would provide a further approximately 3.65 million tonnes (Mt) of run-of-mine (ROM) coal.

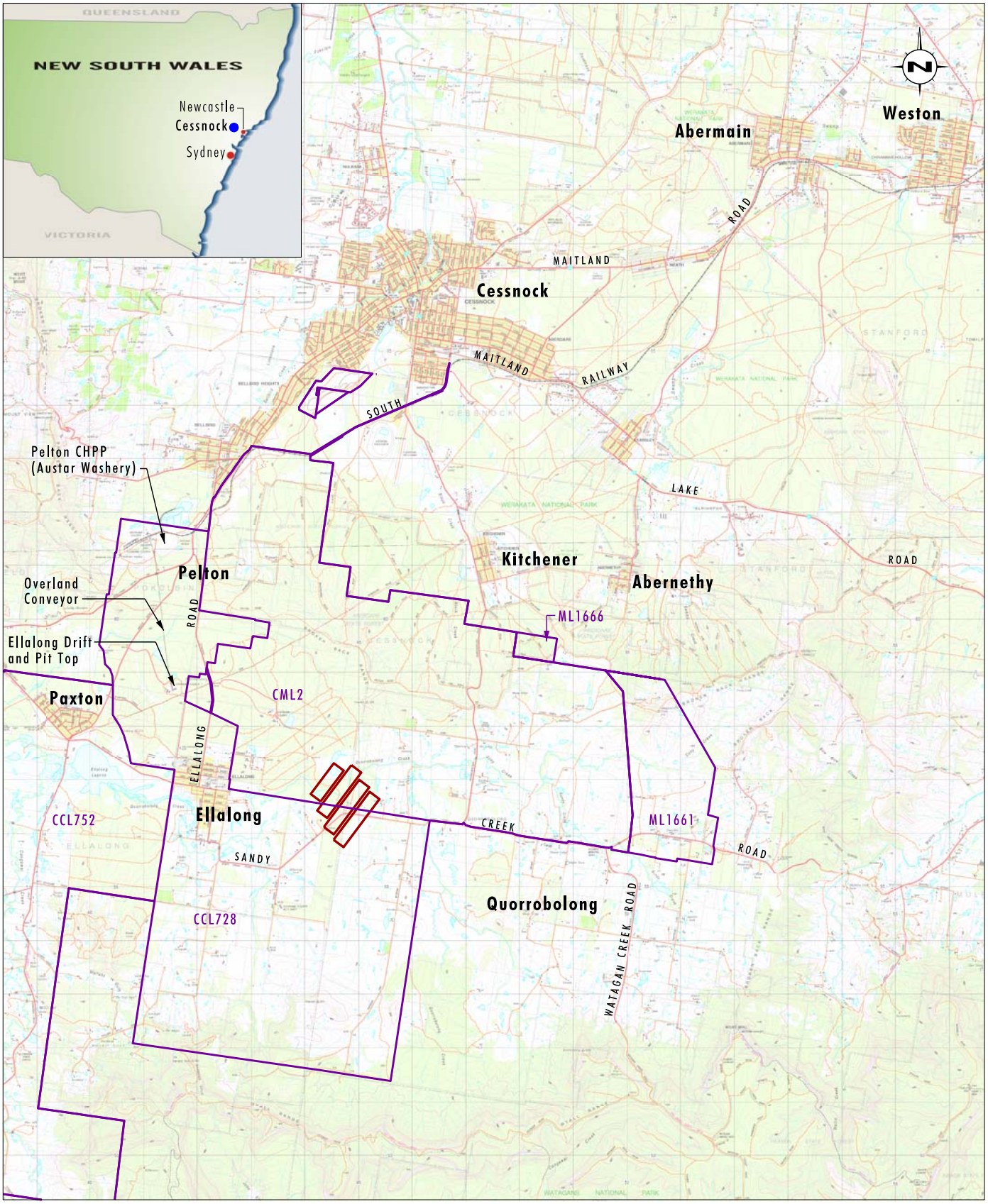

Image Source: LPI NSW (2009)
Data Source: Austar Coal Mine (2016)

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Legend

- Proposed LWB4-B7 Longwall Panels
- Mining Lease Boundary

FIGURE 1.1

Locality Plan

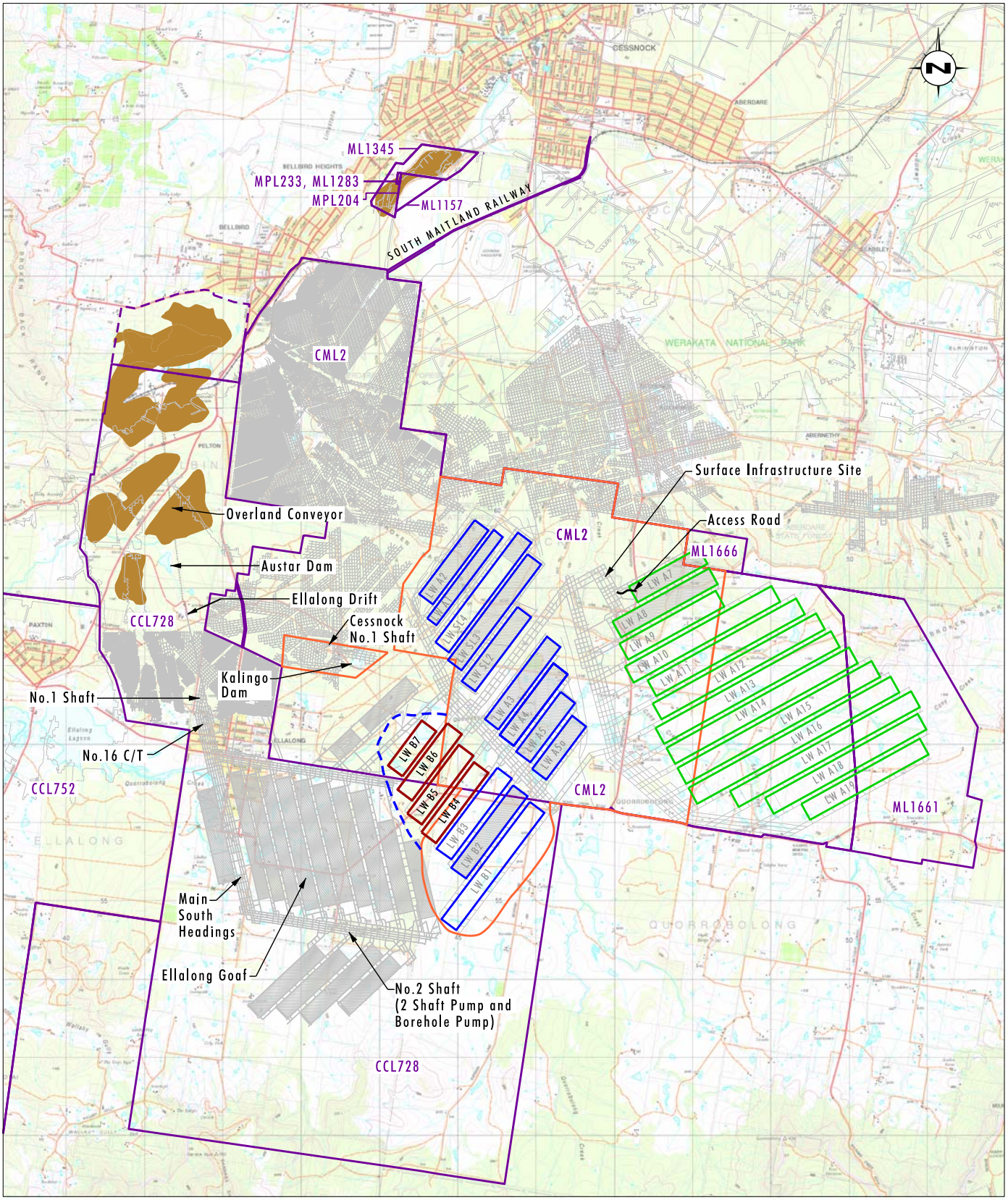

Image Source: LPI NSW (2009)
Data Source: Austar Coal Mine (2016)

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1:70 000

Legend

- Bellbird South Stage 1, Stage 2, Southland and LWB1-B3 Longwall Panels (DA 29/95)
- Proposed LWB4-B7 Longwall Panels (DA 29/95)
- Stage 3 Longwall Panels (PA08_0111)
- DA 29/95 Bellbird South Consent Area (Subsurface) - As Approved
- DA 29/95 Bellbird South Consent Area (Subsurface) - Proposed Extension
- Approved Reject Emplacement Areas
- Completed Underground Workings
- Mining Lease Boundary
- Austar owned CHPP Land

FIGURE 1.2

Austar Coal Mine and Proposed LWB4-B7

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20170216 10.49

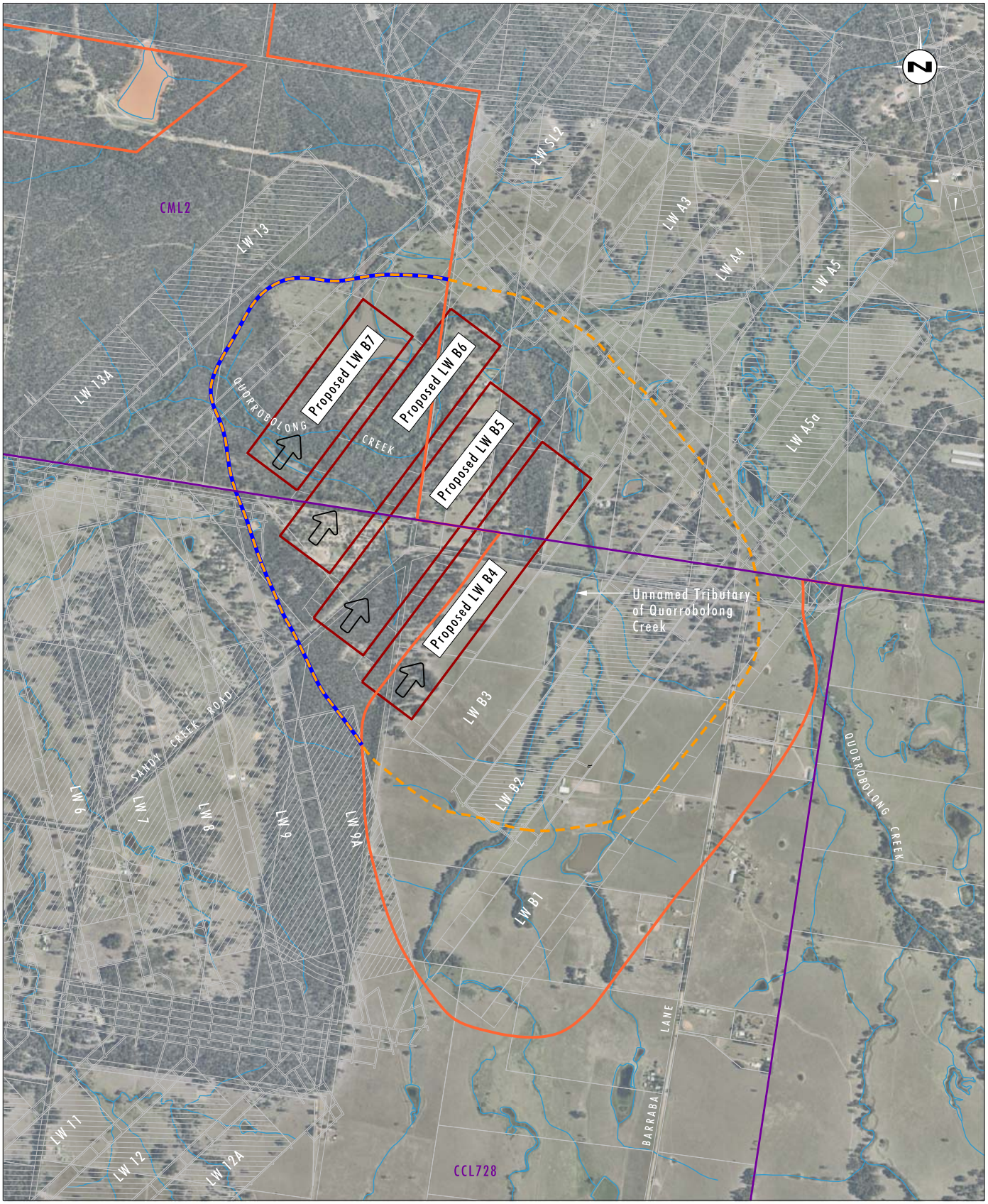

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)

0 0.25 0.5 1.0km
1:20 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- DA 29/95 Bellbird South Consent Area (Subsurface) - As Approved
- DA 29/95 Bellbird South Consent Area (Subsurface) - Proposed Extension
- Mining Lease Boundary
- Completed Underground Workings
- Direction of Mining
- Drainage Line

FIGURE 1.3

Proposed LWB4-B7 Modification

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20170516 11.54

1.1 Overview of Proposed LWB4-B7 Modification

Austar proposes to modify the Bellbird South Consent to permit the transfer and processing of coal from four proposed longwall panels (LWB4-B7) via the existing Bellbird mains and to extend the development consent area to cover the four longwall panels (refer to **Figure 1.3**).

No other changes to the approved mining operations associated surface facilities or production rates are proposed as part of the modification.

1.2 Proposed Modification Area

The environmental impacts of the proposed LWB4-B7 Modification have been assessed within the 20 millimetre subsidence contour for LWB4-B7. This area is referred to as the 'LWB4-B7 Modification Area' and is shown on **Figure 1.3.** The 20 millimetre subsidence contour is considered the vertical limit of subsidence.

1.3 Environmental Context and Land Use

The LWB4-B7 Modification Area is located in Quorrobolong, approximately two kilometres east of the township of Ellalong in the lower Hunter Valley of NSW (refer to **Figure 1.1**). The environmental context of the LWB4-B7 Modification Area is shown on **Figure 1.4**.

The topography of the LWB4-B7 Modification Area is generally characterised by low undulating hills and creek flats associated with Quorrobolong Creek and its unnamed tributary (refer to **Figure 1.4**). Elevations within the LWB4-B7 Modification Area range from approximately 120 metres to 150 metres Australian Height Datum (AHD). Steeper slopes associated with the Broken Back Range are located approximately one kilometre to the north of the LWB4-B7 Modification Area within the Werakata State Conservation Area.

The LWB4-B7 Modification Area is situated within the Quorrobolong Creek Catchment, a sub-catchment to the larger Wollombi Brook and ultimately the Hunter River catchment. Quorrobolong Creek forms part of the Congewai Creek Management Zone of the Upper Wollombi Water Source within the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan area. Quorrobolong Creek crosses the northern portion of the LWB4-B7 Modification Area (refer to **Figure 1.4**) and flows west into Ellalong Lagoon approximately 2.5 kilometres to the west. An un-named tributary of Quorrobolong Creek runs from south to north across the proposed LWB4-B7 Modification Area prior to joining Quorrobolong Creek (refer to **Figure 1.4**).

One soil landscape type is found within the LWB4-B7 Modification Area, being the Quorrobolong soil landscape (Kovac and Lawrie 1991) (refer to **Figure 1.4**). The main soils within this landscape are prairie soils which form in alluvium and occur in drainage depressions and on lower slopes. They are generally poorly drained, have moderate permeability and the upper horizon has moderate erodibility (Kovac and Lawrie 1991). The soils are moderately fertile and the main land use is generally grazing on unimproved pasture.

Land use surrounding the LWB4-B7 Modification Area is primarily rural to the northeast, east, south and west and is dominated by cleared grazing land. Land to the north is owned by Austar Coal Mine and is used for surface mining infrastructure and includes undeveloped native vegetation areas. The Watagans National Park is located approximately four kilometres south of the LWB4-B7 Modification Area, the Werakata State Conservation Area is located approximately one kilometre to the north and Werakata National Park is located approximately five kilometres to the north-east.

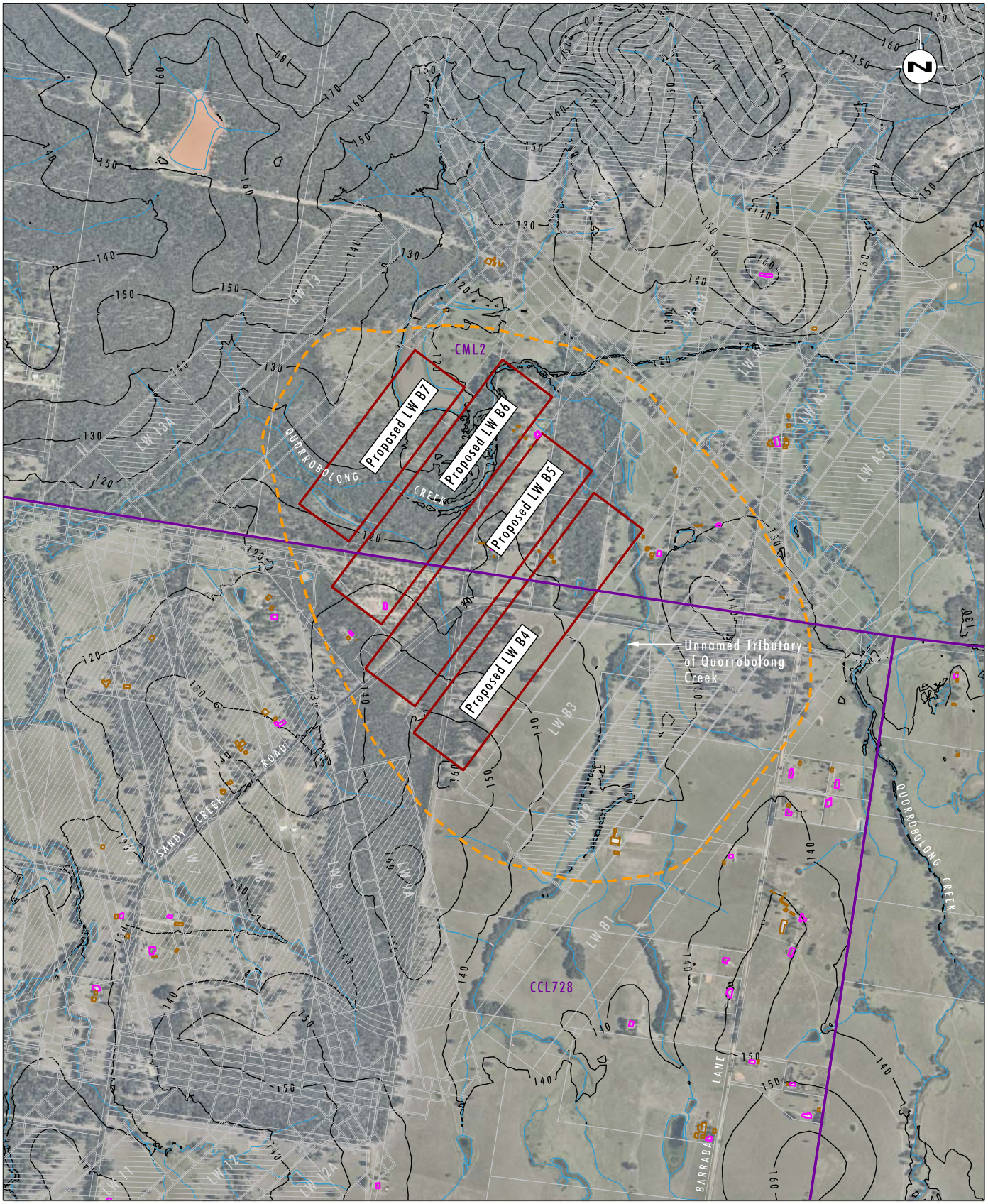

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2015)
Note: Contour Interval 10m

0 0.25 0.5 1.0km
1:20 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Mining Lease Boundary
- Completed Underground Workings
- Drainage Line
- Contour
- Dwelling
- Other Structure

FIGURE 1.4

Topography and Land Use Context

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20170516 12.40

1.4 Objectives of Ecological Assessment

The objectives of this Ecological Assessment are to:

- record the flora and fauna species diversity, vegetation communities and fauna habitats occurring within the LWB4-B7 Modification Area
- identify any threatened species, migratory species, endangered populations or threatened ecological communities (TECs) (or their habitats), listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act), Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act), and the *NSW Fisheries Management Act 1995* (FM Act)
- assess the potential impacts of the proposed modification on threatened species, migratory species, endangered populations and TECs in accordance with the requirements of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) and the EPBC Act
- address the requirements of the State Environmental Planning Policy 44 – Koala Habitat (SEPP 44)
- propose reasonable measures (where required) to mitigate impacts associated with the proposed modification.

2.0 Methods

2.1 Context of Other Recent Impact Assessments

Umwelt was commissioned by Austar in 2015 to undertake an ecological impact assessment for a proposed modification to the Bellbird South Consent to permit the transfer and processing of coal from proposed LWB1-B3. This assessment area for the LWB1-B3 Modification Ecological Assessment (Umwelt 2015), referred to as the LWB1-B3 Modification Area, is located immediately south-east of the current LWB4-LWB7 Modification Area and overlaps the LWB4-B7 Modification Area in part.

Given that the LWB4-B7 Modification Area is immediately adjacent to and overlaps the former LWB1-B3 Modification Area, the ecological information collected during this survey is still relevant and where necessary has been referred to throughout this document.

2.1 Ecological Database Searches

In order to identify potential threatened and migratory species, endangered populations and TECs with potential to occur in the LWB4-B7 Modification Area, a search of relevant ecological databases was completed during December 2016. These database sources comprised:

- a 10 kilometre radius search from the centre of the LWB4-B7 Modification Area of the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (December 2016)
- a 10 kilometre radius search from the centre of the LWB4-B7 Modification Area of the Department of the Environment and Energy (DoEE) Protected Matters Database (December 2016)
- a review of the NSW Department of Primary Industries (DPI) *Fish communities and threatened species distributions of NSW* (NSW DPI 2016).

Records from these database searches were combined with records derived through literature reviews and professional opinion to identify the range of potentially occurring threatened and migratory species, endangered populations and TECs for the area. The results of the database searches are compiled in **Appendix A**.

Current lists of threatened species and key threatening processes were sourced from the OEH, DoEE and the Department of Primary Industries websites.

2.2 Literature Review

A review of relevant and available literature was undertaken in order to gain a greater understanding of the ecological values of the LWB4-B7 Modification Area and its locality. Documents reviewed included previous ecological studies relating to sites in proximity to the LWB4-B7 Modification Area, regional vegetation mapping, relevant papers in scientific journals and threatened species information resources such as the OEH internet resources. A full list of references cited within this report is provided in **Section 6**.

A summary of the ecological findings of the key literature is provided in the following section.

2.2.1 Floristic Species List of Duckworth Property (Elliot 2014)

Although not a formal report, local horticulturalist and native plant specialist Max Elliot compiled a flora species list of Lot 201 DP 1136015 and Lot 31 DP 849031 (1364 Sandy Creek Road and 1392 Sandy Creek Road Quorrobolong) (within the LWB4-B7 Modification Area) on behalf of the landholder. As access to this property was limited during the time of survey, this species list was utilised to inform floristic composition and to inform vegetation community mapping for this area.

2.2.2 Austar Stage 2 Subsidence Management Plan – Appendix 1 Ecological Assessment (Umwelt 2007)

Umwelt prepared an Ecological Assessment for the mining of three longwalls (A3-A5) within the Bellbird South - Stage 2 area (Stage 2 area) located within 1 kilometre of the current LWB4-B7 Modification Area (Umwelt 2007). Field surveys for this project were undertaken to identify threatened and migratory species, endangered populations and TECs occurring or with potential to occur in the Stage 2 area, as well as to map the vegetation communities present and to describe the fauna habitats.

Two TSC Act listed endangered ecological communities (EECs) where recorded in the Stage 2 area, being the River Flat Eucalypt Forest and the Lower Hunter Spotted Gum – Ironbark Forest. Two threatened fauna species were recorded: the grey-crowned babbler (*Pomatostomus temporalis temporalis*) and the speckled warbler (*Chthonicola sagittata*). Two EPBC Act listed migratory species were also recorded: the great egret (*Ardea alba*) and the white-bellied sea-eagle (*Haliaeetus leucogaster*). A number of other threatened flora and fauna species were found to have potential to occur in the Stage 2 area; however none were identified during targeted surveys.

Analysis of changes to surface terrain, creek bed profiles and surface and groundwater regimes as a result of the predicted and upper bound subsidence for Stage 2 indicated that:

- there would be no significant changes to catchment boundaries
- there would be no significant change to channel alignment or bank stability
- there would be no significant change to in channel or out of channel ponding
- groundwater availability to riparian vegetation would not be likely to substantially change as a result of mining.

To ensure the continued protection of significant ecological values of the Stage 2 area, regular monitoring of the predicted subsidence area was recommended to identify unforeseen impacts of the underground mining, and to enable appropriate mitigation measures to be implemented to ameliorate these impacts. The monitoring program was specifically targeted towards identifying changes to River-flat Eucalypt Forest EEC, outcomes of this targeted monitoring indicate no impacts to ecological values as a result of subsidence (as provided in **Section 2.2.6**).

2.2.3 Austar Ecological Assessment, Stage 3 Mine Area (Longwalls A6 to A17) and Surface Infrastructure Site (Umwelt 2008)

The Stage 3 project documented in Umwelt (2008) involved two components, the first being the addition of 12 longwall panels (expanding from Stage 2), and the second being the development of associated surface infrastructure. This project is located less than 2 kilometres from the LWB4-B7 Modification Area. A detailed ecological survey and assessment was undertaken by Umwelt to identify the impacts of the

proposed longwall mining and surface infrastructure developments on any ecological values and to integrate into the development any measures to avoid or minimise these impacts.

Extensive multi-season ecological surveys were conducted, a summary of the methods employed is provided in Section 3.1 of this document. The following threatened species, endangered populations and TECs were recorded:

- heath wrinklewort (*Rutidosis heterogama*)
- small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*)
- Lower Hunter Spotted Gum – Ironbark Forest EEC
- River-flat Eucalypt Forest EEC
- Hunter Lowland Red Gum Forest EEC
- Quorrobolong Scribbly Gum Woodland EEC
- gang-gang cockatoo (*Callocephalon fimbriatum*)
- grey-crowned babbler (*Pomatostomus temporalis temporalis*)
- speckled warbler (*Chthonicola sagittata*)
- powerful owl (*Ninox strenua*)
- squirrel glider (*Petaurus norfolcensis*)
- little bentwing-bat (*Miniopterus australis*)
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)
- large-footed myotis (*Myotis macropus*)
- eastern freetail-bat (*Mormopterus norfolcensis*).

The construction of the Surface Infrastructure Site (SIS) required the clearing of an 8-10 hectare area of vegetation which included habitat for two EECs and a number of threatened species. A 17 hectare parcel of land nearby to the SIS, and with similar ecological characteristics to the SIS, was nominated as a biodiversity offset for the SIS development. In addition to the biodiversity offsets, a detailed tree-clearing procedure was developed to minimise the impacts on any hollow-bearing fauna during the construction of the SIS facilities.

Based on the subsidence predictions and modelling, it was determined that the Stage 3 project would not have a significant impact on any threatened species, migratory species, endangered populations or TECs.

2.2.4 Ecological Assessment for Austar Proposed Stage 3 Modification (Umwelt 2011a)

The subject of this ecological assessment was the reorientation of the approved Stage 3 longwall panel alignment. This project was located within 2 kilometres of the LWB4-B7 Modification Area.

Although much of the area had already been subject to ecological survey as part of Umwelt (2008), additional surveys were undertaken by Umwelt to examine previously un-surveyed vegetation to identify threatened species and delineate/clarify existing vegetation mapping.

This project identified:

- eight vegetation communities, of which two (River-flat Eucalypt Forest EEC and Lower Hunter Spotted Gum – Ironbark Forest EEC) were TECs
- three threatened flora species, being heath wrinklewort (*Rutidosis heterogama*), small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) and netted bottle-brush (*Callistemon linearifolius*)
- four further threatened flora species with potential to occur, being Bynoes wattle (*Acacia bynoeana*), leafless tongue orchid (*Cryptostylis hunteriana*), Illawarra greenhood (*Pterostylis gibbosa*) and Groves paperbark (*Melaleuca groveana*)
- twelve threatened fauna species: gang-gang cockatoo (*Callocephalon fimbriatum*), grey-crowned babbler (*Pomatostomus temporalis temporalis*), speckled warbler (*Chthonicola sagittata*), powerful owl (*Ninox strenua*), little lorikeet (*Glossopsitta pusilla*), scarlet robin (Petroica boodang), squirrel glider (*Petaurus norfolcensis*), little bentwing-bat (*Miniopterus australis*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), southern myotis (*Myotis macropus*), eastern false pipistrelle (*Falsistrellus tasmaniensis*) and east-coast freetail-bat (*Mormopterus norfolkensis*)
- 18 additional threatened fauna species with potential to occur.

Based on the subsidence predictions and modelling, it was determined that the revised Stage 3 longwall panel alignment would not have a significant impact on any threatened species, migratory species, endangered populations or TECs.

2.2.5 Ecological Assessment for Austar LWB1-B3 Modification Area (Umwelt 2015)

The subject of this ecological assessment was the addition of three longwall (LW) panels in the Bellbird South mining area. The project was located directly adjacent to and, in part, overlapping the LWB4-B7 Modification Area.

The project identified:

- six vegetation communities of which two (River Flat Eucalypt Forest EEC and Lower Hunter Spotted Gum – Ironbark EEC) were TECs and one potential TEC (Quorrobolong Scribbly Gum Woodland EEC)
- three threatened flora species being heath wrinklewort (*Rutidosis heterogama*), small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) and netted bottle-brush (*Callistemon linearifolius*)
- six threatened fauna species being squirrel glider (*Petaurus norfolcensis*), large-eared pied bat (*Chalinolobus dwyeri*), greater broad-nosed bat (*Scoteanax rueppellii*), koala (*Phascolarctos cinereus*) (OEH database record), grey-crowned babbler (*Pomatostomus temporalis temporalis*), and varied sittella (*Daphoenositta chrysoptera*). One migratory species listed under the EPBC Act was also identified, being the cattle egret (*Ardea ibis*) and
- seven additional threatened species with potential to occur.

Based on the subsidence predictions and modelling, it was determined that the LWB1-B3 Modification would not have a significant impact on any threatened species, migratory species, endangered populations or TECs.

2.2.6 Stage 2, Stage 3 and LWB1-B3 Ecological Monitoring (Umwelt 2009, , Umwelt 2011b, Umwelt 2013, Umwelt 2014a, Umwelt 2014c, Umwelt 2016a, 2016b and 2016c)

Austar established an ecological monitoring program for the Stage 2, Stage 3 and LWB1-B3 areas in order to detect any impacts that may be associated with the longwall mining on the ecological values identified. Monitoring has been undertaken on a biannual basis at both Stage 2 and Stage 3 monitoring sites and on an annual basis for LWB1-B3 monitoring sites.

Monitoring of Stage 2 areas commenced in 2008 and is focused on monitoring riparian vegetation, particularly River-flat Eucalypt Forest EEC. There are six Stage 2 monitoring sites and monitoring consists of a combination of vegetation plot monitoring, condition assessment and photo monitoring.

Monitoring of Stage 3 areas commenced in 2012 and is focused on monitoring values of Lower Hunter Spotted Gum - Ironbark Forest EEC, heath wrinklewort (*Rutidosis heterogama*), small flower grevillea (*Grevillea parviflora* subsp. *parviflora*) and netted bottle brush (*Callistemon linearifolius*). There are nine Stage 3 monitoring sites at which a combination of vegetation plot monitoring, condition assessment, habitat assessment, targeted threatened species monitoring and photo monitoring are undertaken.

Baseline monitoring for the LWB1-B3 sites commenced in spring 2016 and is focused on monitoring values of Lower Hunter Spotted Gum – Ironbark Forest EEC as well as River-flat Eucalypt Forest EEC. There are two monitoring sites in this area at which vegetation plot monitoring, condition assessment, habitat assessment and photo monitoring are undertaken.

To date, there have been no observable impacts of longwall mining on ecological values or channel geomorphology in the Stage 2 area, with mining of all of the Stage 2 longwall panels completed in 2013. There have also been no observed changes to any of the ecological values in the Stage 3 area, with the completion of mining of LWA7 and LWA8 to date. As only baseline ecological monitoring has been completed for the LWB1-B3 Modification Area no observation of post-mining data can be made. The first post mining ecological monitoring event is scheduled to commence in the LWB1-B3 Modification Area in spring 2017.

2.2.7 Longwall Panels A1 and A2 Flora and Fauna Assessment, Austar Coal Mine (ERM 2006)

ERM undertook an ecological survey and assessment for the proposed mining of LWA1 and LWA2 and associated infrastructure, on behalf of Austar Coal Mine (ERM 2006). The ecological survey comprised random meander and vehicle based vegetation transects, habitat assessment and opportunistic fauna observations (including observations for secondary traces of fauna such as scats, tracks, scratches and diggings). This project was located approximately 1 kilometre north of the LWB4-B7 Modification Area.

Three vegetation communities were recorded within the survey area, including the Lower Hunter Spotted Gum – Ironbark Forest and the Hunter Lowland Red Gum Forest, both TSC Act listed EECs. The third community was described as mostly cleared and is unlikely to conform to any TEC listings.

No threatened flora or fauna species were recorded within the survey area during the study, however several species were described as having potential to occur. Two ROTAP species were recorded, being *Grevillea montana* and *Macrozamia flexuosa*.

A 7 Part Test of Significance in accordance with the requirements of the EP&A Act was undertaken for the two EECs recorded and all threatened flora and fauna species found to have potential to occur within the Study Area. This assessment concluded that the proposed longwall mining development and clearing for associated surface infrastructure would not have a significant impact on any threatened species, migratory species, populations or EECs.

2.2.8 Vegetation of Werakata National Park, Hunter Valley, New South Wales. Cunninghamia 8(3): 331-347 (Bell 2004)

Werakata National Park lies within the largest patch of vegetation of the Hunter Valley floor and protects a number of vegetation communities considered to be poorly conserved within the region, as well as populations of a number of threatened flora species. Werakata National Park is located approximately 5 kilometres north-east of the LWB4-B7 Modification Area.

Six vegetation communities were delineated within the Park, which included Lower Hunter Spotted Gum – Ironbark Forest, Central Hunter Riparian Forest, Hunter Lowlands Red Gum Forest, Kurri Sand Swamp Woodland, Kurri Sand Melaleuca Scrub Forest and Riparian Melaleuca Thicket. Each of these communities corresponds with a TSC Act listed EEC, aside from Kurri Sand Melaleuca Scrub Forest and Riparian Melaleuca Thicket.

A total of 190 flora species were recorded within the Park; threatened species recorded included *Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora, Eucalyptus glaucina* and *Eucalyptus parramattensis* subsp. *decadens.* Two ROTAP species were also recorded, being *Grevillea montana* and *Macrozamia flexuosa*.

Callistemon linearifolius was found in two locations within Werakata National Park, which may represent the known northern limit of the species. *Grevillea parviflora* subsp. *parviflora* was found to be common in the southern portion of Werakata National Park near Kitchener. A small population of *Eucalyptus glaucina* was found in the north-west corner of the Bishops Hill portion of Werakata National Park, where it occurs in the Hunter Lowlands Red Gum Forest. In Werakata National Park, *Eucalyptus parramattensis* subsp. *decadens* was found to have a limited distribution, mainly in association with the Neath Soil landscape and the Kurri Sand Swamp Woodland.

2.2.9 Vertebrate Fauna of Werakata National Park (DEC 2005)

A study on the vertebrate fauna of the former Aberdare State Forest (now Werakata State Conservation Area and Werakata National Park) was undertaken to inform the conservation and management of ecological values contained within the Park. The study drew on the findings of a number of previous surveys in the locality, including Ecotone (1995), Hoye (1995), Webster (1995) and Wellington and Wells (1995). This study area is approximately 5 kilometres north-east of the LWB4-B7 Modification Area.

In addition to the literature review, a wide range of systematic site-based fauna survey methods were employed for the project. This included diurnal bird and herpetofauna searches, nocturnal spotlighting, harp trapping, Anabat echolocation recording, call playback, Elliott trapping, hair tube sampling, habitat assessment and opportunistic observations.

The compilation of all data from previous and current surveys found that a total of 210 species of vertebrate fauna were found to be present within Werakata National Park, including 18 which are now listed under the NSW TSC Act (four of which are also now listed under the Commonwealth EPBC Act). The following lists all the threatened fauna species that were recorded within Werakata National Park:

- Stephens banded snake (*Hoplocephalus bungaroides*)
- black bittern (*Ixobrychus flavicollis*)
- glossy black-cockatoo (*Calyptorhynchus lathami*)
- swift parrot (*Lathamus discolor*)
- turquoise parrot (*Neophema pulchella*)
- barking owl (*Ninox connivens*)
- powerful owl (*Ninox strenua*)
- masked owl (*Tyto novaehollandiae*)
- brown treecreeper (eastern subsp.) (*Climacteris picumnus victoriae*)
- speckled warbler (*Chthonicola sagittatus*)
- black-chinned honeyeater (eastern subsp.) (*Melithreptus gularis gularis*)
- regent honeyeater (*Anthochaera phrygia*)
- hooded robin (*Melanodryas cucullata*)
- grey-crowned babbler (eastern subsp.) (*Pomatostomus temporalis temporalis*)
- koala (*Phascolarctos cinereus*)
- yellow-bellied glider (*Petaurus australis*)
- squirrel glider (*Petaurus norfolcensis*)
- grey-headed flying-fox (*Pteropus poliocephalus*)
- east-coast freetail-bat (*Mormopterus norfolkensis*)
- eastern false pipistrelle (*Falsistrellus tasmaniensis*)
- little bentwing-bat (*Miniopterus australis*)
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*).

Ten introduced fauna species have been recorded in Werakata National Park, the most common being wild/domestic dog (*Canis lupus familiaris*) and European red fox (*Vulpes vulpes*).

The report identifies two areas of high conservation significance, the Tomalpin Arboreal Zone and the known Swift Parrot Locations. In the Tomalpin Arboreal Zone, the highest density of hollow-bearing trees was recorded. Hollow-bearing trees are an important habitat component for a number of threatened fauna species recorded in the park including the squirrel glider, yellow-bellied glider, masked owl, powerful owl and micro-bat species. There were a number of locations at which the swift parrots have been recorded, in which important foraging resources were present such as spotted gum (*Corymbia maculata*) blossom and nectar; and grey box (*Eucalyptus moluccana*) lerp.

Several recovery plan actions were outlined in the document, primarily focusing on the protection of the swift parrot (*Lathamus discolor*), regent honeyeater (*Anthochaera phrygia*), large forest owls, barking owl (*Ninox connivens*), koala (*Phascolarctos cinereus*) and the yellow-bellied glider (*Petaurus australis*). A number of general recovery actions were outlined, including fire and pest species management and other habitat management practices.

2.2.10 Vertebrate Fauna of Werakata National Park and Werakata State Conservation Area (DECC 2008a)

This report was a study into the vertebrate fauna present in Werakata NP and Werakata SCA and built upon the content of DEC 2005. Data that went into the report comprised 72 DECC systematic survey sites that sampled for frogs, reptiles, birds and mammals as well as a compilation of past records from the Atlas of NSW Wildlife.

This study identified a total of 236 native terrestrial vertebrate fauna across both areas (totalling 6,300 hectares), comprised of 15 frogs, 27 reptiles, 159 birds and 35 mammals. It additionally identified 11 feral mammal species and five introduced birds.

Diversity of these areas was identified as being particularly high in comparison to other reserves of a similar size, likely as a result of the following:

- The study area lies within a corridor of contiguous vegetation (the largest patch of remnant vegetation on the Hunter Valley floor) that links Cessnock to the surrounding Hunter Ranges
- Dominance by spotted gum (*Corymbia macualta*), one of the few trees near the coast that are winter flowering.
- The ecological linkage for the movement of many species between the dry western environments and those along the coast.

Threatened species identified were the:

- Stephens banded snake (*Hoplocephalus bungaroides*)
- black bittern (*Ixobrychus flavicollis*)
- regent honeyeater (*Anthocahera phrygia*)
- swift parrot (*Lathamus discolor*)
- white-bellied sea eagle (*Haliaeetus leucogaster*)
- square-tailed kite (*Lophoictinia isura*)

- little eagle (*Hieraatus morphnoides*)
- barking owl (*Ninox connivens*)
- powerful owl (*Ninox strenua*)
- masked owl (*Tyto novaehollandiae*)
- brown treecreeper (*Climacteris picumnus*)
- speckled warbler (*Chthonicola sagittata*)
- black-chinned honeyeater (*Melithreptus gularis*)
- grey-crowned babbler (*Pomatostomus temporalis*)
- glossy-black cockatoo (*Calyptorhychus lathami*)
- gang gang cockatoo (*Callocephalon fimbriatum*)
- turquoise parrot (Neophema pulchella)
- little lorikeet (*Glossopsitta pusilla*)
- hooded robin (*Melanodryas cucullata*)
- scarlet robin (*Petroica boodang*)
- varied sittella (*Daphoenositta chrysoptera*)
- dusky woodswallow (*Artamus cyanopterus*)
- koala (*Phascolarctos cinereus*)
- squirrel glider (*Petaurus norfolcencis*)
- yellow-bellied glider (*Petaurus australis*)
- eastern freetail-bat (*Mormopterus norfolkensis*)
- little bentwing-bat (*Miniopterus australis*)
- eastern betwing-bat (*Miniopterus schreibersii oceanensis*)
- grey-headed flying fox (*Pteropus poliocephalus*)
- false pipistrelle (*Falsistrellus tasmaniensis*)
- New Holland Mouse (*Pseudomys novaehollndiae*).

2.2.11 Watagans National Park and Jilliby State Conservation Area Plan of Management (DECCW 2010)

The Watagans NP and Jilliby SCA cover areas of 7,798 hectares and 12,159 hectares respectively. Both are located in an area where the ecologically rich and productive moist forests of the mid north coast's give way to the drier forests of the Sydney sandstone country. This plan was designed to protect native vegetation, biodiversity, land, rivers and coastal waterways.

This plan identifies the key ecological values being protected. Key ecological features identified within the Watagas NP were:

- Hunter Lowland Redgum Forest EEC (TSC Act)
- Lowland Rainforest EEC (TSC Act) and CEEC (EPBC Act)
- yellow satinheart (*Bosistoa transversa*)
- giant barred frog (*Mixophyes iteratus*)
- stuttering frog (*Mixophyes balbus*)
- barking owl (*Ninox connivens*)
- glossy black cockatoo (*Calyptorhynchus lathami*)
- masked owl (*Tyto novaehollandiae*)
- sooty owl (*Tyto tenebricosa*)
- brush-tailed rock wallaby (*Petrogale penicillata*)
- yellow-bellied glider (*Petarurus australis*)
- koala (*Phascolarctos cinereus*)
- large-eared pied bat (*Chalinolobus dwyeri*)
- spotted-tailed quoll (*Dasyurus maculatus*).

2.2.12 Vegetation of the Cessnock-Kurri Kurri Region, Cessnock LGA, New South Wales: Survey, Classification & Mapping (Bell and Driscoll 2008)

A vegetation survey, classification and mapping project was undertaken for the Cessnock-Kurri region (Bell & Driscoll 2008) on behalf of OEH, (formerly DECC). The area covered by the project included 70,000 hectares of land between the foothills of the Watagan Range in the south, the Corrabare and Broken Back Ranges in the west, North Rothbury in the north and the Wallis Creek floodplain in the east. The principal driver for the project was to clarify the composition and distribution of EECs within the project area, while also providing vegetation community maps and descriptions of extant and pre-1750 vegetation. The conservation significance of each vegetation community described was determined, assisted by comparisons with other proximate regional vegetation classification projects. Recommendations for which communities might meet the criteria for nomination as EECs under the TSC Act were also made.

Within the project area close to 800 native plant taxa and 37 vegetation communities were recorded, including 10 threatened flora species and three undiscovered or previously undescribed flora taxa. Seven EECs were found to be present within the Study Area, including Lower Hunter Spotted Gum-Ironbark Forest EEC (TSC Act), Hunter Lowlands Red Gum Forest EEC (TSC Act) and Kurri Sand Swamp Woodland EEC (TSC Act).

2.3 Flora and Vegetation Community Surveys

Targeted field surveys were completed in the LWB4–B7 Modification Area in order to classify and map vegetation communities and fauna habitats and included targeted threatened flora and fauna species searches. Field surveys were designed with consideration of the *Threatened Species Surveys and Assessment: Guidelines for developments and activities* (working draft) (DEC 2004) and Cessnock Council *Flora and Fauna Survey Guidelines – Lower Hunter and Central Coast Region 2002* (Murray, Bell and Hoye 2002).

Surveys were undertaken on 23 March 2017, between 20 and 22 December 2016, 4 to 6 August 2015 and on 16 September 2015. The temperature during the 2017 survey was approximately 25 degrees Celsius and the weather was clear. Weather during the 2016 survey ranged between 11 and 34 degrees Celsius. Wind speeds were between 20 and 48 kilometres an hour and no rain was recorded. During 2015 surveys, temperatures ranged between 12 and 22 degrees Celsius and temperatures at night ranged between 1 and 15 degrees Celsius. Wind averaged 12 kilometres an hour and no rain was recorded.

2.3.1 Flora Surveys

Flora surveys comprised plot-based surveys, rapid assessments, and transect-based surveys. The locations of each of the flora surveys methods are shown on **Figure 2.1**. The aims of floristic surveys were to:

- record floristic diversity
- map vegetation communities
- describe the condition of vegetation
- determine the occurrence and extent of any threatened species, endangered populations or TECs within the LWB4-B7 Modification Area.

The extent of flora survey effort undertaken is provided in **Table 2.1** below.

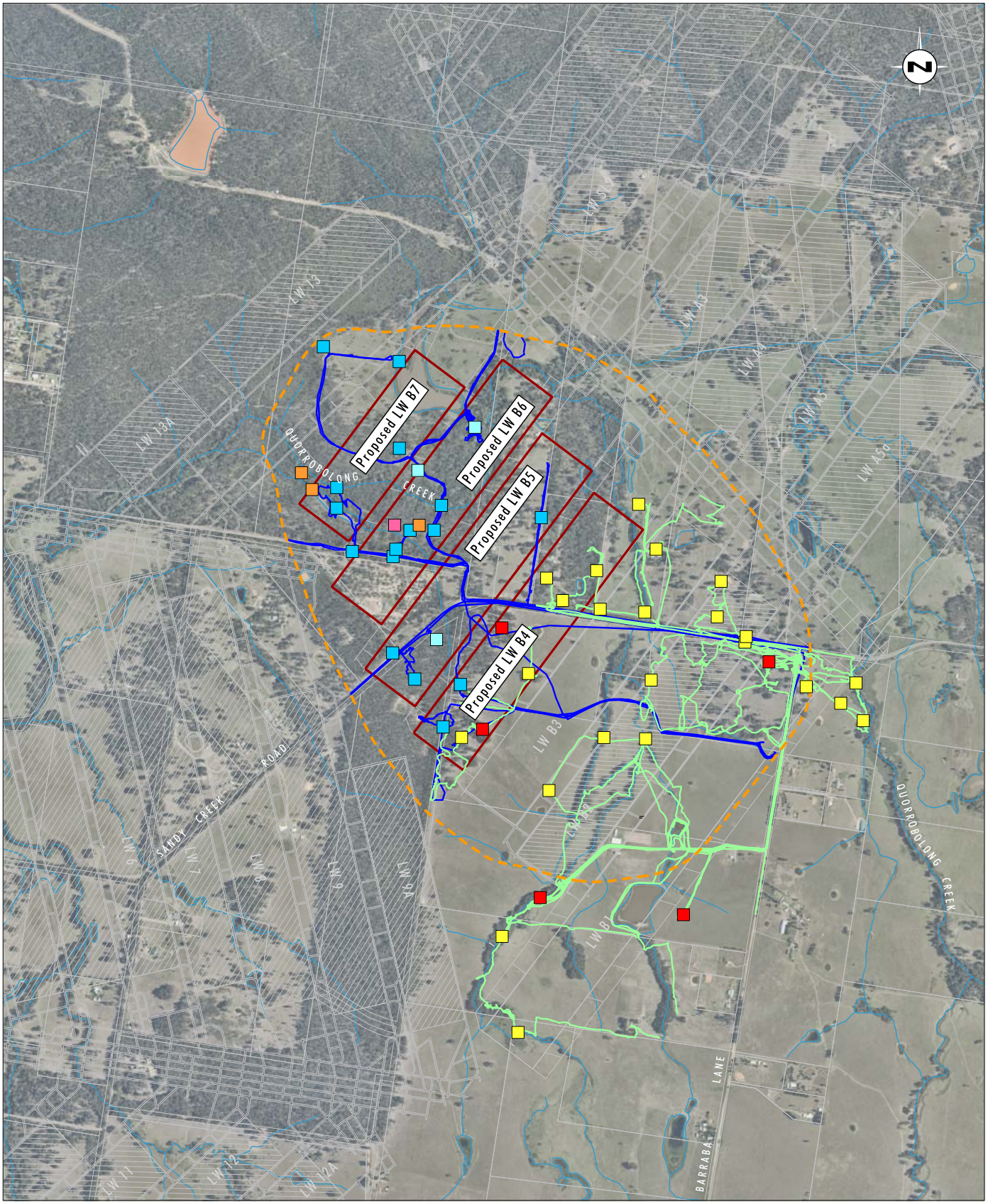

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Completed Underground Workings
- 2015 Meander Transect
- 2016 Meander Transect
- 2015 Plot-based Assessment
- 2015 Rapid Assessment
- 2016 Plot-based Assessment
- 2016 Rapid Assessment
- 2017 Plot-based Assessment
- 2017 Rapid Assessment

FIGURE 2.1

Flora Survey Methods

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Table 2.1 Extent and Adequacy of Flora Surveys Undertaken in the LWB4-B7 Modification Area

Survey Technique	Extent Required in Accordance with OEH Draft Guidelines (DEC 2004)	Extent Undertaken in LWB4-B7 Modification Area (Vegetation Community) 2015 and 2016	Adequacy
Floristic Plots	1 quadrat per stratification unit <2 hectares 2 quadrats per 2-50 hectares of stratification unit 3 quadrats per 51-250 hectares of stratification unit	1 (Riparian Swamp Oak Open Forest) 2 (Riparian Cabbage Gum Open Forest) 0 (Coastal Foothills Transition Forest) 0 (Melaleuca Scrubland with Emergent Eucalypts) 4 (Lower Hunter Spotted Gum Ironbark Forest (including variants)) 0 (Planted Vegetation) 0 (Grassland)	Considered sufficient given modified nature of vegetation (large amounts of grazing land), level of fragmentation, extent of mapping undertaken in region (see **Section 2.2**), and level of supplementary rapid assessments undertaken.

Survey Technique	Extent Required in Accordance with OEH Draft Guidelines (DEC 2004)	Extent Undertaken in LWB4-B7 Modification Area (Vegetation Community) 2015 and 2016	Adequacy
Rapid Assessments	Not required	5 (Riparian Swamp Oak Open Forest) 7 (Riparian Cabbage Gum Open Forest) 6 (Coastal Foothills Transition Forest (including variants)) 13 (Lower Hunter Spotted Gum Ironbark Forest (including variants)) 1 (Melaleuca Scrubland with Emergent Eucalypts) 1 (planted vegetation) 2 (Grassland) 2 (water body)	Sufficient to provide supplementary information regarding floristic composition and extent of community.

Survey Technique	Extent Required in Accordance with OEH Draft Guidelines (DEC 2004)	Extent Undertaken in LWB4-B7 Modification Area (Vegetation Community) 2015 and 2016	Adequacy
Transects	1x100m traverse per stratification unit <2 hectares 2x100m traverses per 2-50 hectares of stratification unit 3x100m traverses per 51-250 hectares of stratification unit and 30 minutes of random meanders for each quadrat sampled within the same stratification unit	2.0 km (Riparian Swamp Oak Open Forest) 2.1 km (Riparian Cabbage Gum Open Forest) 1.9 km (Coastal Foothills Transition Forest (including variants)) 0.4 km(Melaleuca Scrubland with Emergent Eucalypts) 12.8 km (Lower Hunter Spotted Gum Ironbark Forest (including variants)) 0.2 km (Planted Vegetation) 8.4 km (Grassland) 0.22 (Water Body))	Sufficient to provide supplementary information regarding floristic composition and extent of community.

2.3.2 Plot-based Surveys

A total of nine (five in 2015, three in 2016 and 1 during 2017) plot-based assessments were undertaken in the LWB4-LWB7 Modification Area, locations are provided on **Figure 2.1**.

The plot-based systematic vegetation surveys were undertaken using methods that were standard with the 2015 surveys. This ensured that data collected by other surveys could be incorporated into the current work, and that the data from the current study could be analysed in an equivalent way to that collected by other recognised studies.

When undertaking systematic sampling to assist vegetation community mapping and description, plot-based (or quadrat) surveys have several distinct advantages over non-quantitative transects, including:

- providing a quantitative examination of species distribution and abundance
- being likely to detect inconspicuous or rare species (especially forbs and grasses) within the given sampling area, as a smaller area is surveyed in a concentrated search
- providing a basis for any subsequent monitoring required.

Systematic 400 m^2 plots were used to undertake semi-quantitative sampling of vegetation. The typical dimensions of the plots are 20 x 20 metres. This plot size is used widely, including by the Royal Botanic Gardens Sydney and OEH.

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

Species within the plot were assigned a cover-abundance value to reflect their relative cover and abundance in the plot. Species located outside the plot were marked as present but were not assigned a cover-abundance value. A modified Braun-Blanquet 6-point scale (Braun-Blanquet 1927, with selected modifications sourced from Poore 1955 and Austin *et al*. 2000) was used to estimate cover-abundances of all plant species within each plot. **Table 2.2** shows the cover-abundance categories used.

Table 2.2 Modified Braun-Blanquet Crown Cover-abundance Scale

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

Note: * Modified Braun-Blanquet scale (Poore 1955; Austin *et al*. 2000).

All flora species that were readily identified in the field were recorded on pro forma field survey datasheets. All flora species that could not be immediately identified and samples of all threatened flora species were collected, dried and identified or sent to the National Herbarium of NSW for identification.

In addition, information was gathered on the condition of the vegetation at each of the survey sites, including fire history and the density of weeds and evidence of disturbance such as feral animals.

2.3.3 Rapid Assessments

A total of 42 (23 during 2015, 16 during 2016 and three during 2017) rapid vegetation assessments were completed, primarily to assist in the delineation and refinement of vegetation mapping. These assessment sites were located within each broadly mapped vegetation community to allow data collection for each community without confounding effects from adjacent communities. Dominant, common and some uncommon plant taxa were recorded within each vegetation community along meandering transects, carried out on foot, at each location.

The rapid vegetation assessments did not utilise a quantitative sampling approach as this method was designed to allow rapid collection of non-quantitative species dominance data within limited timeframes. This technique involved walking a transect and recording species found at points along the transect. Rapid vegetation assessments were selected instead of the plot-based method because it increased the amount of data that could be collected within the available survey time, thereby maximising the quality and coverage of vegetation description and mapping. This technique also facilitates the recording of general species richness, assists in the delineation of vegetation community boundaries and targets the presence of threatened and significant flora species, endangered populations and TECs.

2.3.4 Meander Transect Surveys

Meander transects and field reconnaissance was undertaken across the LWB4-B7 Modification Area while both walking and driving. This form of survey is an alternative method of flora data collection that enables the surveyor to sample flora across a much larger area than that sampled in systematic plots. However, the data collected are usually in the form of presence records, rather than semi-quantitative values, and therefore do not contribute as much to the delineation of vegetation communities. Notwithstanding this, meander transects and field reconnaissance are valuable in that they enable a wide coverage of the area under investigation, and also facilitate the discovery of widely dispersed rare plant species and the identification of vegetation community boundaries.

Specific threatened species searched for during these surveys were:

- heath wrinklewort (*Rutidosis heterogama*) – vulnerable under the TSC Act and the EPBC Act
- Bynoes wattle (*Acacia bynoeana*) – endangered under the TSC Act and vulnerable under the EPBC Act
- black-eyed Susan (*Tetratheca juncea*) – vulnerable under the TSC Act and the EPBC Act
- netted bottle brush (*Callistemon linearifolius*) – vulnerable under the TSC Act
- *Eucalyptus parramattensis* subsp. *decadens* – vulnerable under the TSC Act and the EPBC Act
- slaty red-gum (*Eucalyptus glaucina*) – listed as vulnerable under the TSC Act and EPBC Act
- Craven grey box (*Eucalyptus largeana*) – listed as vulnerable under the TSC Act

- Pokolbin mallee (*Eucalyptus pumila*) - listed as vulnerable under the TSC Act and EPBC Act

- small-flower grevillea (*Grevillea parviflora* subsp*. parviflora*) – vulnerable under the TSC Act and the EPBC Act

- *Spyridium burragorang* – endangered population in the Cessnock local government area under the TSC Act.

2.3.5 Plant Identification and Nomenclature Standards

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

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

2.3.6 Vegetation Mapping

Vegetation mapping involved the following steps to delineate community boundaries:

- review of aerial photography

- review of previous mapping undertaken (particularly Bell and Driscoll 2008)

- revision of existing vegetation mapping based upon ground-truthing.

Vegetation communities were delineated through the identification of repeating patterns of plant species assemblages in each of the identified strata. Communities were then compared to those vegetation communities identified in the *Vegetation of the Cessnock-Kurri Region* (Bell and Driscoll 2008).

Vegetation communities were grouped into three vegetation formations, which were based solely on structural characteristics rather than floristic components. These comprised:

- woodland (dominated by trees of 10 to 40 per cent cover and typically 6 to 20 metres height, with or without a mid-understorey or understorey)

- riparian and floodplain forest (dominated by trees of 10 to 80 per cent cover and typically 6 to 20 metres height, in a linear strip along waterways, or restricted to floodplains, with or without a mid-understorey or understorey) and

- grassland (dominated by grasses, sedges and forbs, with trees and shrubs very sparse or absent).

2.4 Fauna Surveys

Given that the proposed modification will not cause direct surface disturbance (i.e. tree-clearing), minimal disturbance to fauna habitat is considered likely to occur. As such, the fauna component of the field surveys focussed on potentially occurring threatened fauna with low mobility, or with potential to be impacted by disruptions to surface water (i.e. creek lines and dams). Fauna species surveys were designed with consideration of the *Threatened Species Surveys and Assessment: Guidelines for developments and activities* (working draft) (DEC 2004) and locations are provided on **Figure 2.2**.

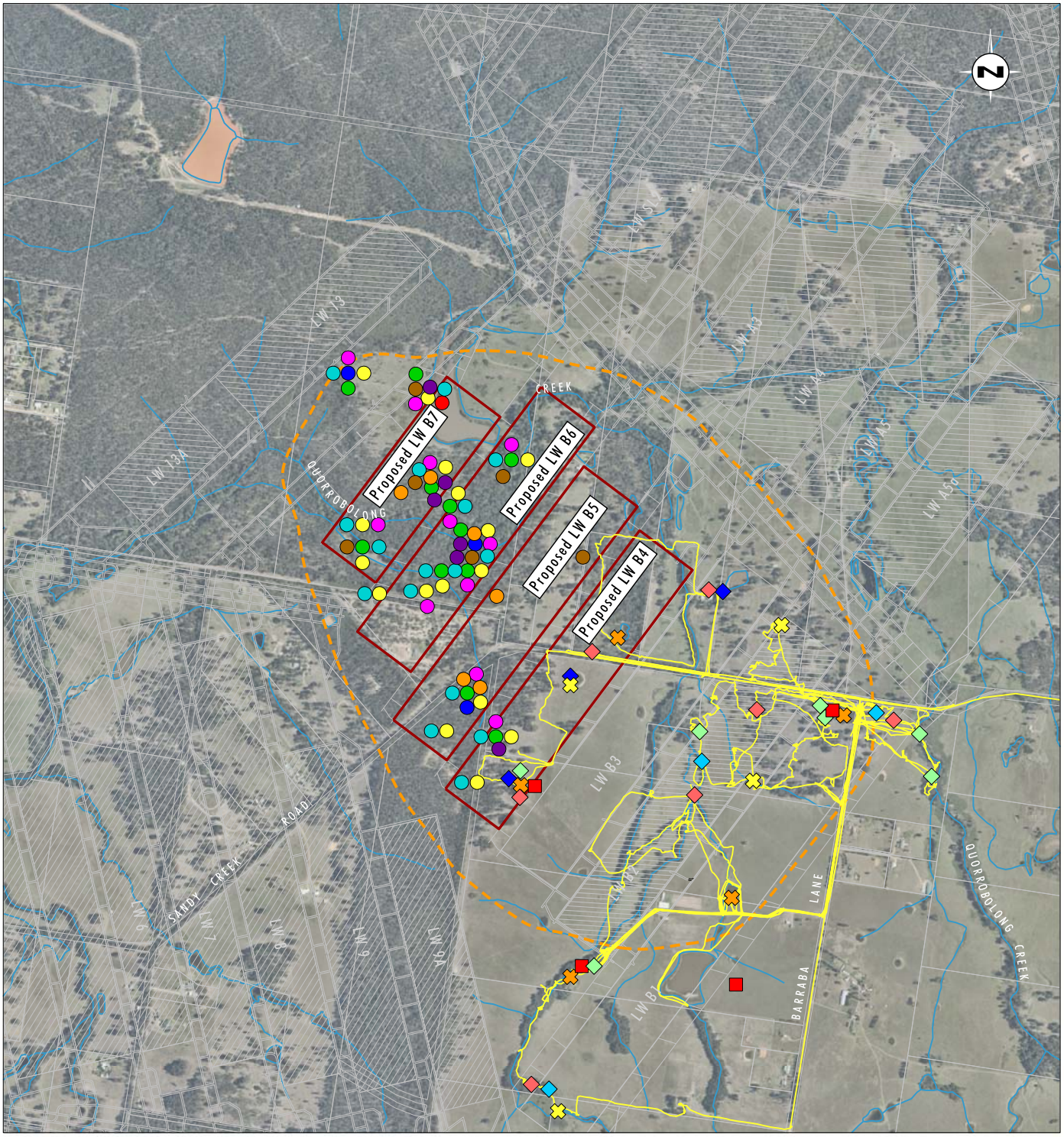

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)

0 0.25 0.5 1.0km
1:20 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Completed Underground Workings
- Drainage Line
- Cadastral Boundary
- 2015 Habitat Assessment Location
- 2015 Diurnal Bird Survey
- 2015 Green and Golden Bell Frog Call Playback and Search
- 2015 Herpetofauna Search
- 2015 SEPP 44 Assessment
- 2015 Threatened Mammal and Bird Call Playback
- 2015 Anabat Echolocation Survey
- 2015 Spotlighting Track
- 2016 Anabat Echolocation Surveys
- 2016 Diurnal Bird Surveys
- 2016 Green and Golden Bell Forg Call Playback and Search
- 2016 Habitat Assessment
- 2016 Herpetofauna
- 2016 Remote Camera
- 2016 SEPP 44 Assessment
- 2016 Spotlighting
- 2016 Threatened Mammal and Bird Call Playback

FIGURE 2.2

Fauna Survey Methods

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2.4.1 Diurnal Bird Surveys

Bird searches were each undertaken for approximately half an hour (by one or two observers); however were sometimes reduced to 15 minutes in the event of low/no bird activity (particularly during strong winds). Bird species were identified from characteristic calls and by observation using 10 by 42 binoculars. Bird surveys included opportunistic observation of dams for waterbirds.

Opportunistic observations were recorded during all other aspects of the field survey, particularly when travelling between survey sites.

A total of 18 (6 in 2015 and 12 during 2016) bird surveys were undertaken across the LWB4-B7 Modification Area, the locations of bird surveys are shown on **Figure 2.2**.

2.4.2 Herpetofauna Searches

Diurnal searches targeting reptiles and amphibians were undertaken during the warmest parts of the day. Diurnal searches were undertaken by two people for between half a person hour and one person hour (although were sometimes much less if the habitat present was limited to a small dam in which case the survey was limited to the time it took to meander the perimeter of the dam boundary).

Nocturnal searches targeted amphibians and nocturnal reptiles as part of the general spotlighting effort. All reptile and amphibian searches were undertaken by two ecologists for a period of at least 30 minutes. Nocturnal reptile and amphibian searches were undertaken using Petzl headlamps and/or 30 watt Lightforce spotlights.

Habitat features investigated during reptile and amphibian searches included water bodies, emergent vegetation, wet soak areas, logs, rocks, loose bark on tree trunks, exposed bedrock, leaf litter and open grassland areas. Amphibians not identifiable from their calls were captured for visual identification. All amphibians were handled according to the hygiene protocol for the control of disease in frogs (DECC 2008b). Non-venomous snake species and small lizards were captured for identification where necessary.

During the surveys a total of 15 (three in 2015 and 12 in 2016) herpetofauna searches were undertaken across the LWB4-B7 Modification Area (refer to **Figure 2.2**).

2.4.2.1 Targeted Green and Golden Bell Frog Surveys

In addition to general amphibian surveys, four (three during 2015 and one during 2016) water bodies within the LWB4-B7 Modification Area were assessed for potential to provide green and golden bell frog (*Litoria aurea*) habitat. This assessment included:

- searches for this species
- assessment of the presence of appropriate fringing vegetation and diurnal basking sites
- assessment of the clarity of the water
- size of the water body
- presence of tadpole predatorial species such as the plague minnow (*Gambusia holbrooki*).

2.4.3 Anabat Echolocation Surveys

Echolocation calls were detected using an Anabat II Bat Detector. Echolocation calls were recorded using an Anabat CF storage ZCAIM. The combination of detector and recording device is hereafter collectively referred to as the 'Anabat echolocation recorder'. The recorders were positioned horizontally on tree trunks or at an approximate 30 degree angle on the ground, with a small roof protecting the detector from rain. This protective cover enabled the recording of calls regardless of weather conditions. Anabat echolocation recorders were positioned in the vicinity of potential micro-bat flyways. Anabat echolocation recording was undertaken at three separate locations. At each of these locations Anabat echolocation recorders were left out for the duration of night work.

All Anabat detector recordings were analysed by Anna McConville (a micro-bat specialist) of ECHO Ecology. The echolocation calls were identified to one of four levels of confidence:

- definite
- probable
- possible
- species group (where the call could not be identified to species level and could belong to one of two or more species that were not necessarily of the same genus).

The first three levels of confidence (definite, probable and possible) were treated as positive identifications for the purposes of impact assessment. The 'species group' identification level was only treated as a possible identification, and only where species had previously been recorded in the vicinity of the LWB4-B7 Modification Area; otherwise confidence levels were considered too low to be accepted as a positive identification.

The locations of Anabat surveys are shown on **Figure 2.2**. Three Anabat echolocation sites were assessed during 2015, each over a single survey night. Three Anabat echolocation sites were also assessed during 2016, each over two survey nights.

2.4.4 Camera Traps

Remote-sensing camera trapping was undertaken at six locations and consisted of baited motion sensing remote cameras (herein referred to as remote cameras). At each of the monitoring sites, single remote cameras were positioned in an area of likely high fauna activity. The remote camera was set to record three photographs each time it was triggered. All remote cameras were left in-situ for three survey nights. Remote cameras were downloaded and resulting images analysed at the completion of the three nights.

2.4.5 Spotlighting

Spotlighting searches were undertaken both on foot and from a moving vehicle. Walking spotlighting searches were undertaken by two observers for a period of at least 30 minutes (total of one person hour) on each occasion. Vehicle spotlighting searches were undertaken by at least the passenger(s) from a slow moving vehicle along vehicle tracks between trapping sites. Walking and vehicle spotlighting searches were undertaken using 30 watt Lightforce spotlights. Vehicle spotlighting was typically taken from roadside vantage points for inaccessible areas, whereas walking spotlighting was undertaken for accessible areas.

A total of 11 survey sites (five in 2015 and six in 2016) were completed across the LWB4-B7 Modification Area (refer to **Figure 2.2**).

2.4.6 Nocturnal Call Playback

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

- squirrel glider (*Petaurus norfolcensis*)
- koala (*Phascolarctos cinereus*)
- masked owl (*Tyto novaehollandiae*)
- barking owl (*Ninox connivens*)
- sooty owl (*Tyto tenebricosa*)
- powerful owl (*Ninox strenua*).

A total of ten nocturnal call playback sessions (five in 2015 and five in 2016) were undertaken (refer to **Figure 2.2**).

2.4.7 Signs of Presence Searches

Searches for indirect evidence of animal presence were conducted opportunistically during all survey activities, particularly during habitat searches and reptile and amphibian searches. Due to the opportunistic nature of signs of presence surveys the level of survey effort was not recorded. Evidence of presence included scats, feathers, nests, burrows, bones, tufts of hair and scratch marks on trees. All hair, scat and bone samples were identified by Barbara Triggs (scatologist, hair expert, author of *Scats, Tracks and Other Traces* (1996) and recognised in the *Survey Guidelines for Australia's Threatened Mammals* (DSEWPC 2011) as an expert in the field.

2.4.8 SEPP 44 Surveys

Any development application in a SEPP 44 specified local government area, affecting an area of 1 hectare or greater, must be assessed under SEPP 44. The Cessnock local government area is listed under Schedule 1 of SEPP 44. Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala (*Phascolarctos cinereus*) habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 of the policy constitute 15 per cent or more of the total number of trees in the upper or lower strata of the tree component. If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat.

The species listed in Schedule 2 of the policy are listed in **Table 2.3**.

Table 2.3 Species of Eucalypt listed in Schedule 2 of SEPP 44

Scientific Name	Common Name
Eucalyptus tereticornis	forest red gum
Eucalyptus microcorys	tallowwood
Eucalyptus punctata	grey gum
Eucalyptus viminalis	ribbon or manna gum
Eucalyptus camaldulensis	river red gum
Eucalyptus haemastoma	broad-leaved scribbly gum
Eucalyptus signata	scribbly gum
Eucalyptus albens	white box
Eucalyptus populnea	bimble box or poplar box
Eucalyptus robusta	swamp mahogany

Across the LWB4-B7 Modification Area, an assessment of the presence of koala feed tree species (as listed on **Table 2.3**) was made at 24 locations (seven in 2015 and 17 in 2016).

2.4.9 Habitat Assessment

Twenty-two habitat assessments (five in 2015 and 17 in 2016) were undertaken across the range of habitat types present (refer to **Figure 2.2**). The assessment targeted potential habitat and resources for fauna species, particularly threatened fauna species. Records of a number of habitat features were made at each site, including:

- evidence of disturbance such as fire, weeds, feral animals, dumping, erosion and logging
- presence of fallen timber/logs
- presence of stumps and stags
- presence of groundcover features such as rock, litter, grasses, logs, boulder, soil and lichen
- presence of dieback and/or insect attack
- mistletoe presence
- presence of perch sites, fallen and loose bark
- vegetation strata and composition
- tree size class (trunk diameter), and age (old growth, mature, regenerating, saplings)

- presence of other specific feed tree species (such as for cockatoos and honeyeaters)

- collection of detailed hollow data, including tree species and height, hollow size, orientation, position and height.

In addition to these general habitat features, searches for specific habitat requirements for threatened fauna species with potential to occur in the area were also made including the presence of winter-flowering eucalypt species for the regent honeyeater (*Anthochaera phrygia*) and the swift parrot (*Lathamus discolor*).

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

2.5 Aquatic Surveys

An assessment was undertaken in order to record the aquatic habitats present in the ephemeral watercourses within the LWB4-B7 Modification Area and in a large ponded farm dam area in the north of the modification area. The assessment also sought to identify aquatic threatened species, populations or communities under the EPBC Act, FM Act or the TSC Act, that have potential to occur.

The AUSRIVAS sampling is a national, standardised sampling and prediction system used for the assessment of the ecological condition of Australia's rivers. It was developed in 1994 as part of the National River Health Program, which has been adopted by the major environmental federal, state and territory agencies in Australia. AUSRIVAS includes a habitat assessment component for recording the river substratum, flow conditions, water quality and aquatic riparian attributes. Locations of aquatic habitat assessment survey effort are identified on **Figure 2.3**.

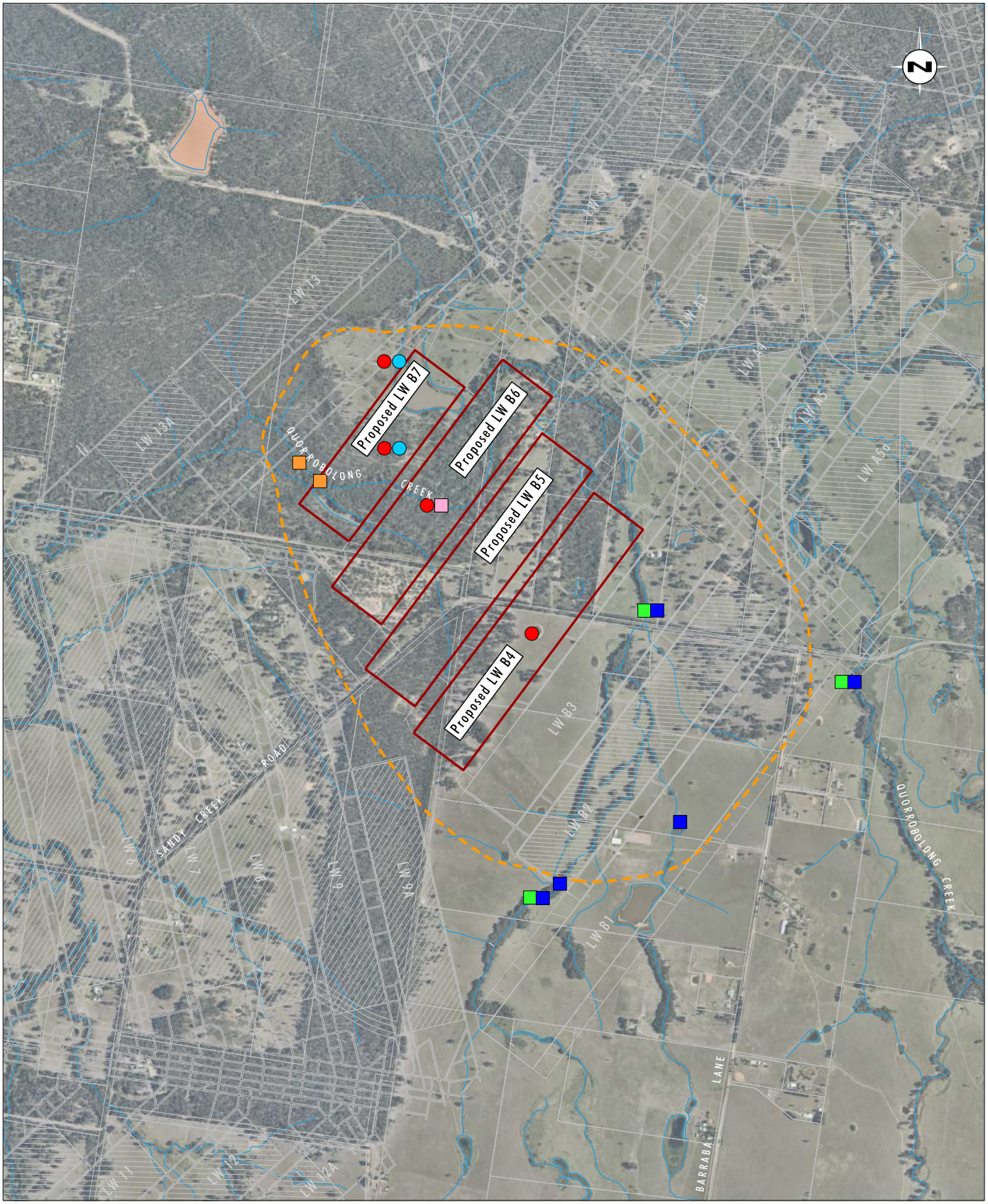

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)

0 0.25 0.5 1.0km
1:20 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Completed Underground Workings
- 2015 Aquatic Fauna Assessment Point
- 2015 Stream Assessment
- 2016 Dip-netting
- 2016 Box Trapping
- 2016 Stream Assessment
- 2017 Stream Assessment

FIGURE 2.3

Aquatic Survey Methods

File Name (A4): R02/3900_028.dgn
20170516 12.47

Assessment was undertaken along the three separate lengths of Quorrobolong Creek and the unnamed tributary of Quorrobolong Creek within the LWB4-B7 Modification Area, and at the large ponded farm dam area in the north of the modification area.

Water flow was absent at several points along Quorrobolong Creek and its unnamed tributary and in places was shallow (less than 5 cm depth). Aquatic fauna assessment points were undertaken at eight sites, four along Quorrobolong Creek, three along the unnamed tributary of Quorrobolong Creek and one at the large ponded in the north of the modification area. Visibility at each of these locations was good and dip-netting sessions for fish and large macroinvertebrates (such as yabbies (*Cherax destructor*)) were undertaken for approximately 15 minutes targeting areas of fringing vegetation and snags where available. Box traps were also deployed at two locations along Quorrobolong Creek where depths were appropriate to do so.

Captured aquatic vertebrates were identified in-situ with the aid of *Field Guide to Freshwater Fishes of Australia* (Allen et al. 2002) and released. Fauna captured were identified to at least a family level. Handling of any fish was undertaken in accordance with *A Guide to Acceptable Procedures and Practices for Aquaculture and Fisheries Research* (Barker et al. 2009).

2.5.1 Aquatic Mammal Surveys

The likelihood of aquatic mammals occurring within the LWB4–B7 Modification Area was also considered during the habitat assessment, in particular the water rat (*Hydromys chrysogaster*) and the platypus (*Ornithorhynchus anatinus*). The potential presence of these species was assessed by searching for suitable bank habitat, burrows and also through searches for characteristic scats, tracks and other signs.

2.5.2 Aquatic Habitat Assessment

An assessment of the aquatic habitat characteristics was undertaken for the length of Quorrobolong Creek and its unnamed tributary within the LWB4-B7 Modification Area, with indicators of creek condition noted. Stream Assessment sampling in accordance with the AUSRIVAS sampling protocol was undertaken at five locations (see **Figure 2.3**) in areas considered likely to provide the greatest aquatic habitat value. The aquatic habitat characteristics were recorded using standard recording sheets (adapted from those developed for the AUSRIVAS sampling protocol). Some of the habitat features and creek condition indicators assessed included:

- local rainfall
- characteristics of bed substrate
- presence of woody debris
- presence of gravel beds
- presence of drought and flood refuge areas
- depth of water
- width of channel
- stream order
- presence of pool, riffle and edge habitats

- height of bank and evidence of erosion
- channel geomorphology
- evidence of sediment deposition
- degree of bank erosion
- presence of natural or artificial barriers to fish passage upstream and downstream
- anthropogenic disturbance
- colour and clarity of water, and any visual evidence of water quality
- characteristics of aquatic, riparian and floodplain vegetation.

An overview of the riparian condition was also made using the Riparian, Channel and Environmental Inventory (RCE) of Peterson (1992). The inventory assesses 16 characteristics for a 100 metre length of stream providing a maximum score of 360 and a lowest of 16 (with 360 indicating excellent habitat and 16 indicating poor habitat).

2.5.2.1 Fish Habitat

The quality of fish habitat at each surveyed site was assessed in accordance with the waterway classifications set out in the DPI 'Policy and Guidelines: Aquatic Habitat Management and Fish Conservation' (NSW Fisheries 1999), namely:

Class 1 – Major Fish Habitat

Waterways in this class consist of large, named and permanently flowing streams, creeks or rivers. These waterways provide threatened species habitat or are declared as 'critical habitat' under the FM Act. High quality native aquatic vegetation and structural habitat is present and it provides known fish habitat and/or fish have been observed inhabiting the water.

Class 2 – Moderate Fish Habitat

Moderate fish habitats are smaller named permanent or intermittent streams, creeks or watercourses with clearly defined drainage channels. They can be permanent waters or semi-permanent pools, or connected areas with limited aquatic vegetation or structure present. Known fish habitat and/or fish observed inhabiting the area.

Class 3 – Minimal Fish Habitat

Class 3 waterways can be named or unnamed with intermittent flows. They provide potential refuge, breeding or feeding areas for some aquatic fauna (such as yabbies). The drainage channel is often poorly defined with semi-permanent pools, ponds, farm dams or wetlands nearby, or in the form of watercourses after rain events. The watercourse may be interconnected with wetlands or other stream habitats.

Class 4 – Unlikely Fish Habitat

These waterways can be named or unnamed with intermittent flows during rain events only. There is little or no defined drainage channel. Little or no free standing water is present after rains and no permanent wetland aquatic flora is present. No aquatic or wetland vegetation is present.

2.5.3 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are described in the NSW GDE Policy (DLWC 2002) and can include terrestrial vegetation, base flow in streams, aquifer and cave ecosystems and wetlands.

A review of the Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (BoM Atlas) was completed in December 2016 to inform the identification of GDEs prior to detailed field surveys that were used to ground truth Atlas of Groundwater Dependent Ecosystems mapping and to identify any other potentially groundwater dependent ecosystems in the LWB4–B7 Modification Area.

It was also confirmed that no high priority GDEs listed under the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009 were located within the region potentially impacted by the proposed modification.

3.0 Results

3.1 Floristics and Vegetation Communities

A full list of flora species recorded in the LWB4-B7 Modification Area is provided in **Appendix B**. A total of 220 flora species were recorded, of which 175 species are native and 45 are introduced. Four species were from the Class Filicopsida (ferns), and 216 from Magnoliopsida (flowering plants) (of which 67 were from sub-class Liliidae (monocots) and 149 from sub-class Magnoliidae (dicots)). Flora species were recorded from 69 plant families, the most speciose being Poaceae (grasses), Asteraceae (daisies), Fabaceae (legumes) and Myrtaceae (eucalypts, Melaleucas and Leptospermums).

Of the introduced species identified in the LWB4-B7 Modification Area, three are listed as noxious weeds under the *Noxious Weeds Act 1993* (NW Act), being blackberry (*Rubus fruticosus*), green cestrum (*Cestrum parqui*) and fireweed (*Senecio madagascariensis*). The two former tended to occur in damper riparian vegetation, whereas fireweed (*Senecio madagascariensis*) was more prevalent in open grassland areas.

3.1.1 Threatened Species, Endangered Populations and Regionally Significant Plants

Of the flora species identified within the LWB4-B7 Modification Area, three are listed as threatened species, being the netted bottlebrush (*Callistemon linearifolius*), small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) and heath wrinklewort (*Rutidosis heterogama*). Locations of threatened species are provided on **Figure 3.1**.

Heath wrinklewort (*Rutidosis heterogama*) was abundant (approximately 500 records documented) throughout partially disturbed areas in the centre of the LWB4-B7 Modification Area, particularly in areas of Spotted Gum – Ironbark Forest. It is likely that there are numerous more records present than those that were identified; however certain areas were inaccessible and surveys were not undertaken during peak flowering times for this species.

A total of 86 small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) were identified in the central areas of the LWB4-B7 Modification Area. These were found in similar habitats to the heath wrinklewort (*Rutidosis heterogama*).

Approximately 30 netted-bottle brush (*Callistemon linearifolius*) were identified in the LWB4-B7 Modification Area. These were only identified in the lower quality areas of Spotted Gum - Ironbark Forest in the east.

No endangered flora populations were identified occurring within the LWB4-B7 Modification Area, and based upon the habitats identified, none are expected to occur.

In addition to threatened species, the following flora species (**Table 3.1**) were identified in the LWB4-B7 Modification Area that is considered to be locally significant. These species may be considered regionally significant for a range of reasons, including:

- endemic taxa
- uncommon taxa
- records close to a geographic range extension
- significant reductions in population size or areas occupied.

Table 3.1 Locally Significant Flora Species

Species	Hunter Rare Plants Database (Peake 2003)	ROTAP
Grevillea montana	-	2VC
Parsonsia straminea	?W	-
Maytenus silvestris	U	-
Eucalyptus amplifolia subsp. *amplifolia*	T	-

Key to Criteria
2 = Restricted distribution - range extending over less than 100km
C = Species is known to occur within a proclaimed reserve
U = everywhere uncommon
V = Vulnerable - at risk over a longer period (20-50 years)
N or W = distributional limit in Hunter Region
T = may be threatened
? = code is uncertain

Regionally significant flora identified within the LWB4-B7 Modification Area is relatively widespread throughout the region, and therefore are not considered further within this assessment (particularly as none are proposed to be removed as part of the proposed modification).

3.1.2 Vegetation Communities

A total of seven vegetation communities (**Figure 3.1**) were identified in the LWB4-B7 Modification Area. These are all low-lying communities (between 130 and 163 metres AHD) as no hilltops or ridges are present within the LWB4-B7 Modification Area. The extent of each vegetation type within the LWB4-B7 Modification Area is presented in **Table 3.2** below.

Table 3.2 Vegetation Communities within the LWB4-B7 Modification Area

Community Name	Status	Approximate Extent (ha)
Vegetation Communities		
Riparian Swamp Oak Open Forest	-	18.1
Riparian Cabbage Gum Open Forest	River-flat Eucalypt Forest EEC (TSC Act)	56.7
Coastal Foothills Transition Forest	Lower Hunter Spotted Gum – Ironbark Forest EEC (TSC Act)	7.4
Coastal Foothills Transition Forest – underscrubbed		4.9
Spotted Gum - Ironbark Forest		24.3
Modified Spotted Gum - Ironbark Forest		62.0

Community Name	Status	Approximate Extent (ha)
Spotted Gum Ironbark forest -Underscrubbed		5.6
Melaleuca Shrubland with Emergent Eucalypts	Potential Quorrobolong Scribbly Gum Woodland EEC (TSC Act)[1]	1.6
Grassland	-	115.8
Planted Vegetation	-	0.7
Non Vegetated Areas		
Water Bodies	-	6.5
Total		**303.7**

[1] Potential EEC however could not be confirmed without further detailed sampling.

Each of the vegetation communities identified in **Table 3.2** above is described in greater detail below.

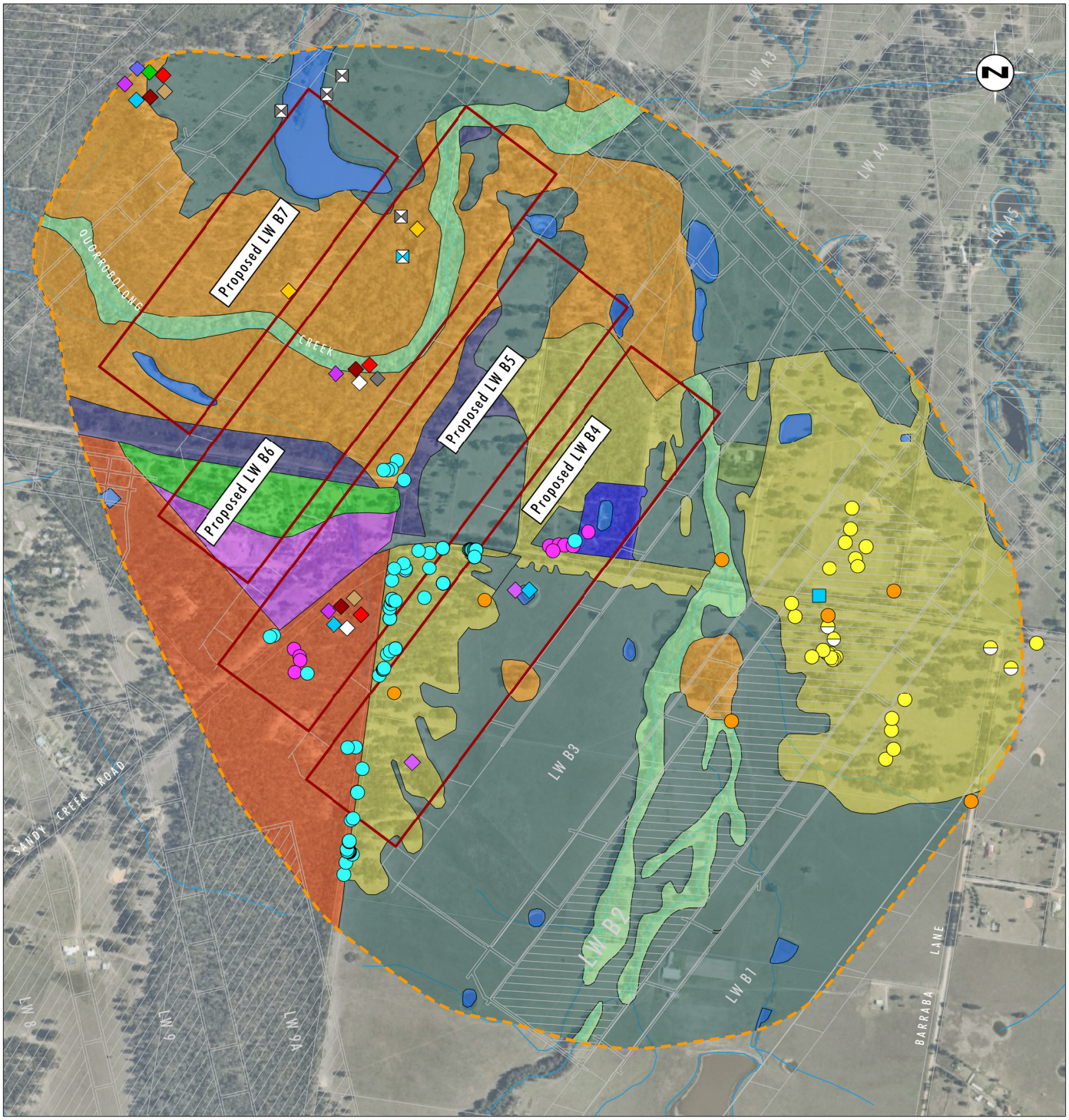

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)
Note: PR - Probable, SG - Species Group, D - Definite

0 200 400 600m
1:12 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Completed Underground Workings
- Drainage Line
- Cadastral Boundary
- Modified Grassland
- Planted Vegetation
- Water Body
- Riparian Swamp Oak Open Forest

River Flat Eucalyptus Forest EEC:

- Riparian Cabbage Gum Open Forest

Lower Hunter Spotted Gum-Ironbark Forest EEC:

- Coastal Foothills Transition Forest
- Coastal Foothills Transition Forest - underscrubbed
- Spotted Gum Ironbark Forest
- Modified Spotted Gum Ironbark Forest
- Spotted Gum Ironbark Forest - underscrubbed

Potential Quorrobolong Scribbly Gum Woodland EEC:

- Melaleuca Shrubland with Emergent Eucalypts
- East-coast freetail-bat (Definite)
- Eastern bentwing-bat (Species Group)
- Eastern cave bat (Species Group)
- Eastern false pipistrelle (Species Group)
- Grey-crowned babbler (eastern subspecies)
- Grey-crowned babbler nests
- Grey-headed flying-fox
- Large-eared pied bat
- Greater broad-nosed bat (Species Group)
- Little bentwing-bat (Species Group)
- Little bentwing-bat (Probable)
- Squirrel glider
- Southern myotis (Species Group)
- Varied sittella
- White-bellied sea eagle
- White-bellied sea eagle Nest
- Yellow-bellied sheathtail-bat (Probable)
- *Callistemon linearifolius*
- *Grevillea parviflora* subsp. *parviflora*
- *Rutidosis heterogama*

FIGURE 3.1

Vegetation Communities and Threatened Species Results

File Name (A4): R02/3900_024.dgn
20170516 12.43

3.1.2.1 Riparian Swamp Oak Open Forest

The vegetation along the Quorrobolong Creek and its unnamed tributary within the LWB4-B7 Modification Area is dominated by Riparian Swamp Oak Open Forest. This community covers an area of approximately 18.1 hectares and occurs as a narrow, sometimes fragmented corridor. A representative photo of this vegetation type is presented in **Plate 3.1**.

Plate 3.1 Representative Photo of Riparian Swamp Oak Open Forest

This community is typified by an emergent occasional cabbage gum (*Eucalyptus amplifolia*), or rough-barked apple (*Angophora floribunda*), and rare occurrences of introduced camphor laurel (*Cinnamomum camphora*) (more commonly in the south). The height of the emergent layer was approximately 20 metres with typically less than 2 per cent cover.

This community typically supported a moderately dense (approximately 30 per cent) low tree stratum comprising swamp oak (*Casuarina glauca*), with occasional occurrences of river oak (*Casuarina cunninghamiana*) (mostly planted). The height of this layer was typically to approximately 15 metres.

This community typically lacked a shrub layer in southern grazed areas, however was moderately dense in the north. Where present, species included ball honeymyrtle (*Melaleuca nodosa*), *Leptospermum polygalifolium* and the introduced wild tobacco bush (*Solanum mauritianum*).

The ground stratum of the Riparian Swamp Oak Open Forest comprised a mixture of native and introduced grasses, graminoids and small herbs. Species recorded within this stratum include couch (*Cynodon dactylon*), weeping grass (*Microlaena stipoides*), native violet (*Viola hederacea*), native wandering Jew (*Commelina cyanea*), maidenhair fern (*Adiantum aethiopicum*), bracken fern (*Pteridium esculentum*) and *Lomandra longifolia*. Groundcover vegetation was much more dense and taller in northern areas compared to their grazed counterparts in the south.

A number of weed species were commonly recorded throughout this vegetation community, including sharp rush (*Juncus acutus*), panic veldtgrass (*Ehrharta erecta*), kikuyu (*Pennisetum clandestinum*), blackberry (*Rubus fruticosus* sp. agg.), fireweed (*Senecio madagascariensis*) and buffalo grass (*Stenotaphrum secundatum*). The weed species and their density varied throughout the LWB4-B7 Modification Area, as a result of the different land management practices.

The majority of riparian areas occurring within the southern LWB4-B7 Modification Area are unfenced from stock grazing and are subsequently degraded. Overall, the vegetation of this community is currently considered to be in low-moderate condition in the south and good to the north of Sandy Creek Road.

3.1.2.2 Riparian Cabbage Gum Open Forest

Riparian Cabbage Gum Open Forest covers an area of approximately 56.7 hectares, primarily occurring north of Sandy Creek Road. This community is characterised by a cabbage gum (*Eucalyptus amplifolia*) and to a lesser extent forest red gum (*Eucalyptus tereticornis*) and rough-barked apple (*Angophora floribunda*). The height of this layer was approximately 20 to 30 metres with approximately 20 per cent cover. A representative photo of this vegetation type is presented in **Plate 3.2**.

Plate 3.2 Representative Photo of Riparian Cabbage Gum Open Forest

South of Sandy Creek Road, this community comprises small remnant fragments subject to moderate grazing and is considered to be in moderate condition due to historical clearing and ongoing land management practices.

North of Sandy Creek Road this vegetation is better connected and subject to less detrimental land management practices with lower stocking rates. Vegetation in these areas is in good condition.

Shrubby vegetation is dominated by silver wattle (*Acacia dealbata)*, silver-stemmed wattle (*Acacia parvipinnula*), native raspberry (*Rubus parvifolius*), native blackthorn (*Bursaria spinosa*), orange bush (*Maytenus silvestris*), dogwood (*Jacksonia scoparia*), flax-leaved paperbark (*Melaleuca linarifolia)*, and occasional introduced green cestrum (*Cestrum parqui*). Snake vine (*Stephania japnica*) was also regularly encountered.

The groundcover species diversity is dominated by blady grass (*Imperata cylindrica*), bracken fern (*Pteridium esculentum*), *Lomandra longifolia*, couch (*Cynodon dactylon*) and kidney weed (*Dichondra repens*). Introduced species were common in these areas (mainly in low numbers) and included flat weed (*Hypochaeris radicata*), fireweed (*Senecio madagascariensis*), fleabane (*Conyza bonariensis*) and variegated thistle (*Silybum marianum*).

3.1.2.3 Coastal Foothills Transition Forest

Coastal Foothills Transition Forest covers an area of approximately 7.4 hectares in LWB4-B7 Modification Area (**Figure 3.1**), occupying the drier low slopes in the north-west.

Canopy vegetation comprised grey gum (*Eucalyptus punctata*) and spotted gum (*Corymbia maculata*), as well as narrow-leaved ironbark (*Eucalyptus crebra*) and broad-leaved ironbark (*Eucalypts fibrosa*). The midstorey was open and dominated by *Melaleuca* sp.

Groundcovers provided moderate coverage and included kangaroo grass (*Themeda australis*), barbed wire grass (*Cymbopogon refractus*), common everlasting (*Chrysocephalum apiculatum*) and a variety of other grasses, graminoids and herbs. Commonly identified introduced species were fireweed (*Senecio madagascariensis*), *Gamochaeta* sp., fleabane (*Conyza bonariensis*) and flatweed (*Hypochaeris radicata*).

Coastal Foothills Transition Forest (Underscrubbed variant)

This variant comprises canopy vegetation consistent with Coastal Foothills Transition Forest, however has been underscrubbed and was subsequently largely devoid of shrubs. Groundcover vegetation was present, however is heavily maintained with many of the grasses present not identifiable. This vegetation comprised approximately 4.9 hectares. A representative photo of this vegetation type is presented in **Plate 3.3**.

Plate 3.3 Representative Photo of Coastal Foothills Transition Forest (Underscrubbed)[1]

3.1.2.4 Spotted Gum – Ironbark Forest

Spotted Gum – Ironbark Forest covers an area of approximately 24.3 hectares in LWB4-B7 Modification Area (**Figure 3.1**), occupying the drier low slopes in the central areas. This community is widespread within the local area, and is the dominant community within the nearby Werakata State Conservation Area and National Park. A representative photo of this vegetation type is presented in **Plate 3.4**.

[1] This underscrubbing has been undertaken by the private landholder on privately owned land within the LWB4-B7 Modification Area, and is not as a result of mining related works.

Plate 3.4 Representative Photo of Spotted Gum - Ironbark Forest

The canopy stratum of this community was dominated by broad-leaved ironbark (*Eucalyptus fibrosa*) with fewer occurrences of spotted gum (*Corymbia maculata*). A number of other canopy species occur within this community in different abundances, including grey box (*Eucalyptus moluccana*) typically with between 15 and 25 per cent cover (dependent on land management practices), growing to heights between 18 and 30 metres (depending on the age of vegetation). Regeneration of canopy species in this community was moderate.

The Spotted Gum – Ironbark Forest has an open shrub stratum in the eastern-most areas (generally less than 5 per cent cover as a result of historical clearing and ongoing grazing practices) and more dense in the west where vegetation was relatively undisturbed. Height ranges were consistently between 0.5 metres to 4 metres. The dominant species recorded include native blackthorn (*Bursaria spinosa*), narrow-leaved orange bark (*Maytenus silvestris*), *Daviesia ulicifolia* and western boobialla *(Myoporum montanum*).

The ground stratum of this community is dominated by native grasses, with a lesser extent of herbs, ferns and creepers. The more common species recorded include threeawn speargrass (*Aristida vagans*), hedgehog grass (*Echinopogon ovatus*), barbed wire grass (*Cymbopogon refractus*), threeawn speargrass (*Aristida vagans*), couch (*Cynodon dactylon*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Glycine clandestina* and *Goodenia rotundifolia*. Introduced species were also common encountered although not dominant. The ground stratum has a cover of approximately 70 per cent and was generally less than 0.5 metres in height.

Threatened species heath wrinklewort (*Rutidosis heterogama*), typically occurs in this vegetation community.

This vegetation community was considered to be in moderate condition in the east and good condition in the west.

Modified Spotted Gum – Ironbark Forest

The Modified Spotted Gum Ironbark Forest variant comprised 62.0 hectares. The modified variant of this community comprises areas subject to cattle grazing. Canopy vegetation was consistent with the undisturbed form. Regeneration of canopy species in this community was low.

The Modified Spotted Gum – Ironbark Forest has a sparse shrub stratum (generally less than 5 per cent cover as a result of historical clearing and ongoing grazing practices) and predominantly comprised native blackthorn (*Bursaria spinosa*). Many of the shrubs identified appeared to be stunted from grazing.

Groundcover vegetation in these areas comprised predominantly low grasses, with an abundance of introduced species, particularly fireweed (*Senecio madagascariensis*), onion grass (*Romulea rosea*), flatweed (*Hypochaeris radicata*) and burr medic (*Medicago polymorpha*).

Spotted Gum – Ironbark Forest (Underscrubbed)

The Spotted Gum - Ironbark Forest (Underscrubbed) variant comprised 5.6 hectares. This variant comprises canopy vegetation consistent with Spotted Gum – Ironbark Forest, however has been underscrubbed and was subsequently largely devoid of shrubs. Groundcover vegetation was present, however is heavily maintained with many of the grasses present not identifiable.

3.1.2.5 Melaleuca Shrubland with Emergent Eucalypts

A small area (1.6 hectares) in the north-west of the LWB4-B7 Modification Area comprised Melaleuca Shrubland with Emergent Eucalypts. The soil surface in this area appeared sandy. This community was typified by an open canopy to heights of approximately 25 metres with occasional occurrences of by grey gum (*Eucalyptus punctata*), forest red gum (*Eucalyptus tereticornis*), and smooth-barked apple (*Angophora costata*) (although no consistent canopy vegetation was identified). The dense understorey layer typified this vegetation and occurred to heights of 5 metres dominated by *Melaleuca nodosa*, *Banksia spinulosa*, needlebush (*Hakea sericea*), *Leptospemum trinerum* and occasional narrow-leaved geebung (*Persoonia linearis*). Groundcover vegetation was sparse as a result of shading from the dense midstorey, however typically encountered species included kangaroo grass (*Themeda australis*) and purple wiregrass (*Aristida vagans*). Typical weed species encountered were whisky grass (*Andropogon virginicus*) and fireweed (*Senecio madagascariensis*) however densities of these species were low. A representative photo of this vegetation type is presented in **Plate 3.5**.

Plate 3.5 Melaleuca Shrubland with Emergent Eucalypts

3.1.2.6 Grassland

Grassland covers an area of approximately 115.8 hectares in LWB4-B7 Modification Area (**Figure 3.1**). The areas of Grassland are likely to have previously supported woodland vegetation similar to that of surrounding vegetation remnants; however they have been cleared of tree and shrub species primarily for agricultural purposes. These are no longer considered to comprise grasslands derived from native vegetation communities as their species composition is not representative of native vegetation of any of the locally occurring communities and contain virtually no regeneration. A representative photo of this vegetation type is presented in **Plate 3.6** (higher quality areas) and **Plate 3.7** (lower quality areas).

Plate 3.6 Representative Photo of Grassland in the North

Plate 3.7 Representative Photo of Grazed Grassland in the South

The Grassland community generally lacks tree and shrub strata, however occasional individual paddock trees or shrubs are scattered throughout. Regeneration of shrubby vegetation is particularly prevalent; however due to the modification of the groundcover it was not possible to identify the source community of this vegetation. The community is characterised by a dense low layer of a range of native and introduced grasses, and also a diversity of small herbs. Species commonly recorded include slender rats tail grass (*Sporobolus creber*), couch (*Cynodon dactylon*), kangaroo grass (*Themeda australis*), and the introduced species paspalum (*Paspalum dilatatum*), flatweed (*Hypochaeris radicata*), plantain (*Plantago lanceolata*), *Setaria* sp., burr medic (*Medicago polymorpha*), chickweed (*Stellaria media*), and fireweed (*Senecio madagascariensis*). It should be noted that other grass species were present; however were unidentifiable due a lack of seed heads.

The floristic composition of the Grassland is variable between the different properties throughout the LWB4-B7 Modification Area, which is the result of different land management practices associated with different landholders.

This grassland was considered to be in a low condition as a result of historical clearing and current land management practices.

3.1.2.7 Planted Vegetation

This vegetation comprised a very small area of approximately 0.7 ha in size. This vegetation was planted around a residence and was not considered to be consistent with native vegetation.

3.1.2.8 Water Bodies

The LWB4-B7 Modification Area incorporates several water bodies, including a section of Quorrobolong Creek, an ephemeral tributary and first order drainage line associated with Quorrobolong Creek, a number of small farm dams and a larger ponded farm dam water body in the north of the modification area. The aquatic habitats present within the LWB4-B7 Modification Area are discussed in **Section 3.5**.

3.1.3 Threatened Ecological Communities

Two confirmed and one potential TEC were identified in the LWB4-B7 Modification Area being *River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* EEC (River-flat Eucalypt Forest EEC), the *Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion EEC* (Lower Hunter Spotted Gum – Ironbark Forest EEC) and potential *Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion EEC* (potential Quorrobolong Scribbly Gum Woodland EEC). These EECs are listed under the TSC Act. No TECs were identified in the LWB4-B7 Modification Area that was consistent with listings under the EPBC Act. The details of these EECs as they occur within the LWB4-B7 Modification Area are provided in greater detail below.

River-flat Eucalypt Forest EEC

Based upon geographic location, geology, structural and floristic composition of the riparian vegetation within the LWB4-B7 Modification Area, 56.7ha of vegetation (those areas identified as Riparian Cabbage Gum Open Forest) were considered to be consistent with River-flat Eucalypt Forest EEC listed under the TSC Act (**Figure 3.1**).

River-Flat Eucalypt Forest EEC is associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The community generally occurs below 50 metres above sea level (ASL); however it may occur on localised river flats up to 250 metres ASL. The EEC ranges in structure from tall open forest to woodland, with a canopy dominated by forest red gum (*Eucalyptus tereticornis*), cabbage gum (*Eucalyptus amplifolia* subsp. *amplifolia*), rough-barked apple (*Angophora floribunda*) and broad-leaved apple (*Eucalyptus subvelutina*). A small tree layer often is present, which may comprise *Melaleuca decora*, prickly-leaved tea tree (*Melaleuca styphelioides*), grey myrtle (*Backhousia myrtifolia*), white cedar (*Melia azedarach*), river oak (*Casuarina cunninghamiana*) and swamp oak (*Casuarina glauca*). The mid-stratum is often absent, but where present may comprise species such as black thorn (*Bursaria spinosa*), forest nightshade (*Solanum prinophyllum*), native raspberry (*Rubus parvifolius*), coffee bush (*Breynia oblongifolia*) and *Ozothamnus diosmifolius*. The ground cover consists of a number of forbs, scramblers and grasses (NSW Scientific Committee 2011). The vegetation present is consistent with this EEC.

A seven part test of significance (in accordance with the EP&A Act) was undertaken to determine if the proposed modification would result in a significant impact on this EEC (**Appendix E**). The results of this test have been summarised in **Section 4**.

Lower Hunter Spotted Gum – Ironbark Forest EEC

Based on the geographic location, geology, structural and floristic composition of the Spotted Gum – Ironbark Forest and Coastal Foothills Transition Forest (including the variants of these communities) occurring on the lower slopes within the LWB4-B7 Modification Area, these communities are considered to be consistent with Lower Hunter Spotted Gum – Ironbark Forest EEC listed under the TSC Act (**Figure 3.1**). A total of 104.2 hectares of this EEC were identified.

The Lower Hunter Spotted Gum – Ironbark Forest EEC occurs in the central to lower Hunter Valley, principally on Permian geology. The EEC is restricted to a range of approximately 65 kilometres by 35 kilometres centred on the Cessnock – Beresfield area and corresponds to the Lower Hunter Spotted Gum – Red Ironbark Forest as described by Bell and Driscoll (2008) for the Vegetation of the Cessnock-Kurri Region. The dominant canopy species of this community are spotted gum (*Corymbia maculata*) and broad-leaved ironbark (*Eucalyptus fibrosa*), with grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*) present occasionally in lower frequency. A sparse (due a history of clearing and grazing) understorey comprising the following shrub species is present: (*Daviesia ulicifolia*), black thorn (*Bursaria spinosa* subsp. *spinosa*) and ball honeymyrtle (*Melaleuca nodosa*). The ground layer has a moderate species diversity, comprising poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), barbed-wire grass (*Cymbopogon refractus*), blue-flax lily (*Dianella revoluta*), wiry panic (*Entolasia stricta*), love creeper (*Glycine clandestina*), many-flowered mat-rush (*Lomandra multiflora*), weeping grass (*Microlaena stipoides* var. *stipoides*), kangaroo grass (*Themeda australis*) and white root (*Pratia purpurascens*) although dominated by introduced species in patches (NSW Scientific Committee 2010). The vegetation present is consistent with this EEC.

A seven part test of significance (in accordance with the EP&A Act) was undertaken to determine if the proposed modification would have a significant impact on this EEC (**Appendix E**). The results of this test have been summarised in **Section 4**.

Potential Quorrobolong Scribbly Gum Woodland EEC

The Melaleuca Shrubland with Emergent Eucalypts on the lower slopes in the centre of the LWB4-B7 Modification Area (refer to **Figure 3.1**) has the potential to conform to the Quorrobolong Scribbly Gum Woodland EEC listed under the TSC Act. This is based on the geographic location, geology, structural and floristic composition of the vegetation observed during rapid assessment survey. This area was not surveyed for confirmation of presence during the 2016 surveys as landholder access was not permitted, as such the presence of this community could not be confirmed.

The Quorrobolong Scribbly Gum Woodland EEC occurs on residual sand deposits overlying Permian clay sediments in the Hunter Valley. The EEC is only known to occur between Quorrobolong and Mulbring in the Hunter Valley NSW, but may occur elsewhere. The dominant canopy species that typify this EEC are scribbly gum (*Eucalyptus racemosa*), Sydney peppermint (*Eucalyptus piperita*) and red mahogany (*Eucalyptus resinifera*). Although these species were not identified within this area, the composition of the dense shrubby vegetation was sufficiently different from the adjacent areas of Spotted Gum - Ironbark Forest to warrant separation of the communities. The following flora species (out of a total list of 57 species) were identified during walking transects and rapid assessments of this area undertaken during 2015 and are considered characteristic from the final determination for this community (NSW Scientific Committee 2011b):

- *Allocasuarina littoralis*
- *Angophora costata*
- *Aristida vagans*
- *Banksia spinulosa*
- *Billardiera scandens*
- *Daviesia ulicifolia*
- *Dillwynia retorta*

- *Eucalyptus punctata*
- *Eragrostis brownii*
- *Glycine clandestina*
- *Hakea sericea*
- *Imperata cylindrica*
- *Hardenbergia violacea*
- *Jacksonia scoparia*
- *Leptospermum polygalifolium*
- *Leptospermum trinerum*
- *Lomandra multiflora*
- *Melaleuca nodosa*
- *Persoonia linearis*
- *Themeda australis.*

Given the regenerating condition of this community, the floristic dominants of this community are difficult to define. Despite this, the key species present, lead to the possibility of this community comprising the Quorrobolong Scribbly Gum Woodland EEC. As such, this Ecological Assessment has adopted a conservative approach and assessed the community as being the EEC.

A seven part test of significance (in accordance with the EP&A Act) was undertaken to determine if the proposed modification would have a significant impact on this potentially occurring EEC (**Appendix E**). The results of this test have been summarised in **Section 4**.

3.2 Fauna Results

The following section provides the results of the fauna surveys undertaken. This includes a list of fauna species recorded, threatened species identified and with potential to occur and habitats available to fauna species.

3.2.1 Fauna Species Recorded

A total of 123 fauna species were confidently recorded in the LWB4-B7 Modification Area. The following sections provide detail on the fauna species recorded, with a complete list of species recorded during field surveys provided in **Appendix C**.

3.2.1.1 Amphibian Species

Eleven frog species were recorded within the LWB4-B7 Modification Area. This included the following commonly identified species, bleating tree frog (*Litoria dentata*), eastern dwarf tree frog (*Litoria fallax*),

Peron's tree frog (*Litoria peroni*), Gunther's frog (*Litoria latopalmata*), Tyler's tree frog (*Litoria tyleri*) and the striped marsh frog (*Limnodynastes peroni*).

No threatened amphibian species were recorded within the LWB4-B7 Modification Area.

3.2.1.2 Reptile Species

Eleven reptile species were recorded within the LWB4-B7 Modification Area during the surveys. Commonly recorded species were the eastern water-skink (*Eulamprus quoyii*), pale-flecked garden sunskink (*Lampropholis guichenoti*), water dragon (*Intellagama lesueurii*), eastern snake-necked turtle (*Chelodina longicollis*), Jacky dragon (*Amphibolurus muricatus*), southern rainbow-skink (*Carlia tetradactyla*) and the delicate garden skink (*Lampropholis delicata*). All of these species are considered to be locally common.

No threatened reptile species were recorded at within the LWB4-B7 Modification Area.

3.2.1.3 Bird Species

A total of 74 bird species were recorded within the LWB4-B7 Modification Area. The species recorded are typical of those associated with open woodland and grassland habitats, such as the Australian magpie (*Gymnorhina tibicen*), noisy miner (*Manorina melanocephala*), masked lapwing (*Vanellus miles*) and Australian magpie-lark (*Grallina cyanoleuca*). The most commonly encountered bird family was Meliphagidae (honeyeaters).

Three threatened bird species was recorded within the LWB4-B7 Modification Area, being the grey-crowned babbler (*Pomatostomus temporalis temporalis*), varied sittella (*Daphoenositta chrysoptera*) and the white-bellied sea eagle (*Haliaeetus leucogaster*). These species are listed as vulnerable under the TSC Act. The locations of threatened fauna species recorded in the LWB4-B7 Modification Area are shown on **Figure 3.1**.

3.2.1.4 Mammal Species

A total of 27 mammal species were confidently recorded within the LWB4-B7 Modification Area, with a further 11 (micro-bat) species that could not be confidently (either identified as a possible record or as part of a species group due to the echolocation recordings). Commonly recorded species included common brush-tail possum (*Trichosurus vulpecula*) and common ring-tailed possum (*Pseudocheirus peregrinus*).

Seven threatened mammal species, squirrel glider (*Petaurus norfolcensis*), grey-headed flying fox (*Pteropus poliocephalus*), little bentwing-bat (*Miniopterus australis*), east-coast freetail-bat (*Mormopterus norfolkensis*), yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*), large-eared pied bat (*Chalinolobus dwyeri*) and greater broad-nosed bat (*Scoteanax rueppellii*) were confidently identified (either visually or by echolocation call) with in the LWB4-B7 Modification Area (**Figure 3.1**). The eastern falsistrelle (*Falsistrellus tasmaniensis*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), southern myotis (*Myotis macropus*), and eastern cave bat (*Vespadelus troughtoni*) were also identified however only as possible records, however for the purposes of this impact assessment, and undertaking a conservative approach these have been assumed as positive records.

All threatened mammals species identified are listed as vulnerable under the TSC Act, with the large-eared pied bat (*Chalinolobus dwyeri*) and grey-headed flying-fox (*Pteropus poliocephalus*) additionally listed as vulnerable under the EPBC Act.

Although not recorded during surveys undertaken by Umwelt, a single record of the koala (*Phascolarctos cinereus*), has also been identified from Atlas records (BioNet 2016) in the LWB4-B7 Modification Area. The koala (*Phascolarctos cinereus*) is listed as vulnerable under both the TSC Act and the EPBC Act.

Six introduced fauna species were also identified, being the fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), rusa deer (*Rusa timorensis*), fallow deer (*Dama dama*), the domesticated cattle (*Bos taurus*) and horse (*Equus caballus*).

3.2.1.5 Threatened Fauna Species

A total of 15 threatened fauna species were identified in the LWB4-B7 Modification Area, being the:

- grey-crowned babbler (*Pomatostomus temporalis temporalis*)
- varied sittella (*Daphoenositta chrysoptera*)
- white-bellied sea eagle (*Haliaeetus leucogaster*)
- grey-headed flying fox (*Pteropus poliocephalus*)
- koala (*Phascolarctos cinereus*) (OEH database record)
- squirrel glider (*Petaurus norfolcensis*)
- little bentwing-bat (*Miniopterus australis*)
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)
- east-coast freetail-bat (*Mormopterus norfolkensis*)
- yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*)
- eastern falsistrelle (*Falsistrellus tasmaniensis*),
- southern myotis (*Myotis macropus*)
- eastern cave bat (Vespadelus troughtoni)
- large-eared pied bat (*Chalinolobus dwyeri*)
- greater broad-nosed bat (*Scoteanax rueppellii*).

A range of potentially occurring threatened flora and fauna species were also identified on the basis of the presence of potential habitat and local records. These species are included in **Appendix A**, along with a preliminary impact assessment to determine the need for further assessment under the EP&A Act or EPBC Act.

Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)

Records of the grey-crowned babbler were made at two locations (**Figure 3.1**) being a group of three and a group of eight birds. It is considered likely that the LWB4-B7 Modification Area provides habitat for a resident population of grey-crowned babblers.

Varied Sittella (*Daphoenositta chrysoptera*)

Varied sittellas were recorded at a single location within the LWB4-B7 Modification Area. This record comprised four individuals and was made in the south of the LWB4-B7 Modification Area in riparian vegetation. Although no evidence of breeding was observed, it is considered that a resident population exists due to the sedentary nature of this species.

White-bellied Sea Eagle (*Haliaeetus leucogaster*)

The white-bellied sea eagle was recorded on three separate occasions surrounding the large farm dam water body in the north, a nest of this species was also identified. Due to the occurrence of nesting, this species is a resident of this area, however is likely to not be exclusively reliant on the habitats present for foraging.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

Two definite records of the large-eared pied bat (*Chalinolobus dwyeri*) were made in the centre of the LWB4-B7 Modification Area. One record was from over a farm dam, and one was made from an area of Spotted Gum - Ironbark Forest along the western boundary. It is unlikely that this species would be utilising the habitats of the LWB4-B7 Modification Area for anything other than foraging habitat as this is a cave-roosting species. No cave habitats, cliffs, old mine workings or similar were identified within the LWB4-B7 Modification Area.

This species would only likely be utilising the habitats present as part of a wider habitat range that extends outside of the LWB4-B7 Modification Area.

Grey-headed flying fox (*Pteropus poliocephalus*)

Records of the grey-headed flying fox were made at two locations (**Figure 3.1**). Although no camp sites were identified in the LWB4-B7 Modification Area during surveys undertaken by Umwelt in 2016, the LWB4-B7 Modification Area would likely support low densities of this species during mass flowering of canopy eucalypts and as a stepping stone between higher quality areas of habitat.

Koala (*Phascolarctos cinereus*)

The Atlas of NSW Wildlife identifies a single record of a koala (*Phascolarctos cinereus*) occurring within the LWB4-B7 Modification Area in 2006, however the accuracy of this record is to within 10km (i.e. highly inaccurate). The sighting was made by a community group (Dan Lunney's Community Wildlife Survey) and based on the limited availability of koala feed trees present within the modification area (refer to **Section 3.2.3**), it is considered highly likely that this record consisted of an individual passing through the LWB4-B7 Modification Area travelling to areas of better quality habitat.

The *EPBC Act Referral Guidelines for the Vulnerable Koala* (DoE 2014) were considered to assist in the determination of the significance of koala habitat in the LWB4-B7 Modification Area. In accordance with the Guideline, assessment of significant impacts on the koala is undertaken primarily through the assessment of habitat critical to the survival of the koala and actions that interfere substantially with the recovery of the koala.

The habitat assessment tool was applied to the LWB4-B7 Modification Area to determine the extent of vegetation that contains at least one known koala food tree. This process identified one SEPP 44 feed resource (grey gum (*Eucalyptus punctata*)), one primary food tree resource (cabbage gum (*Eucalyptus amplifolia*)) and one secondary food tree resource (grey box (*Eucalyptus moluccana*)).

The koala habitat assessment tool (a Federal assessment tool under the EPBC Act) resulted in a score of 5 indicating that the habitat present in the LWB4-B7 Modification Area provides habitat critical to the koala. However, no koalas, or evidence of koalas (such as scats or scratchings) were identified in the LWB4-B7 Modification Area, in addition, the SEPP 44 assessment (state assessment mechanism of presence of koala habitat covered in greater detail in **Section 3.2.3**), identified that this vegetation is not considered potential koala habitat.

Squirrel Glider (*Petaurus norfolcensis*)

A single record of a squirrel glider (*Petaurus norfolcensis*) was made within the LWB4-B7 Modification Area, during surveys undertaken by Umwelt in 2015. It is considered likely that the species is resident in the LWB4-B7 Modification Area, with potential habitat present to both forage and den (in the small amount of hollow-bearing trees). However it is likely that this is only as part of a wider habitat that extends outside of the LWB4-B7 Modification Area, particularly higher quality and more dense areas of vegetation to the west and north.

Little Bentwing-bat (*Miniopterus australis*)

A single confident record of the little bentwing-bat (*Miniopterus australis*) at one location and two possible records at two other locations were made in LWB4-B7 Modification Area (all in the north-west). It is possible that this species consists of a resident population given that it is a hollow-roosting (this species also roosts in caves however none were identified) species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging.

It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the north.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

One possible record of the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) was made in the north-west of the LWB4-B7 Modification Area. For the purposes of this Ecological Assessment, this has been assumed as a positive indication. It is unlikely that this species would be utilising the habitats of the LWB4-B7 Modification Area for anything other than foraging habitat as this is a cave-roosting species. No cave habitats, cliffs, old mine workings or similar were identified within the LWB4-B7 Modification Area.

This species would only likely be utilising the habitats present as part of a wider habitat range that extends outside of the LWB4-B7 Modification Area, likely the higher quality habitats to the north.

East-coast Freetail-bat (*Mormopterus norfolkensis*)

This species was confidently recorded at two separate locations in the north-west of the LWB4-B7 Modification Area. It is possible that this species consists of a resident population given that it is a hollow-roosting species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging. It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the north.

Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)

A single confident record of the yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*) was made of this species in the north-west of the LWB4-B7 Modification Area. It is possible that this species consists of a resident population given that it is a hollow-roosting species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging.

It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the north.

Eastern Falsistrelle (*Falsistrellus tasmaniensis*)

This species was possibly recorded at three separate locations in the north-west of the LWB4-B7 Modification Area. For the purposes of this Ecological Assessment, these records have been assumed as positive identifications. It is possible that this species consists of a resident population given that it is a hollow-roosting species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging.

It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the north.

Southern Myotis (*Myotis macropus*)

This species was possibly recorded at three separate locations in the north-west of the LWB4-B7 Modification Area. For the purposes of this Ecological Assessment, these records have been assumed as positive identifications. It is possible that this species consists of a resident population given that it is a hollow-roosting species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging (particularly over water bodies).

It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the north.

Eastern Cave Bat (*Vespadelus troughtoni*)

This species was possibly recorded at three separate locations in the north-west of the LWB4-B7 Modification Area. For the purposes of this Ecological Assessment, these records have been assumed as positive identifications. It is unlikely that this species would be utilising the habitats of the LWB4-B7 Modification Area for anything other than foraging habitat as this is a cave-roosting species. No cave habitats, cliffs, old mine workings or similar were identified within the LWB4-B7 Modification Area.

This species would only likely be utilising the habitats present as part of a wider habitat range that extends outside of the LWB4-B7 Modification Area.

Greater Broad-nosed Bat (*Scoteanax rueppellii*)

A single probable record of the greater broad-nosed bat (*Scoteanax rueppellii*) was made over a farm dam in the west of the LWB4-B7 Modification Area. For the purposes of this Ecological Assessment, this has been assumed as a positive identification. It is possible that this species consists of a resident population given that it is a hollow-roosting species and appropriate hollow-bearing trees are present. This species could therefore be utilising the habitats available for both roosting and foraging.

It is likely, however, that this is only part of a wider habitat for this species that extends outside of the LWB4-B7 Modification Area, particularly in higher quality and more dense areas of vegetation to the west and north.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

Two definite records of the large-eared pied bat (*Chalinolobus dwyeri*) were made in the north-west of the LWB4-B7 Modification Area. One record was from over a farm dam, and one was made from an area of Spotted Gum Ironbark Forest along the western boundary. It is unlikely that this species would be utilising the habitats of the LWB4-B7 Modification Area for anything other than foraging habitat as this is a cave-roosting species. No cave habitats, cliffs, old mine workings or similar were identified within the LWB4-B7 Modification Area.

This species would only likely be utilising the habitats present as part of a wider habitat range that extends outside of the LWB4-B7 Modification Area.

Threatened Fauna Species with Potential to Occur Within LWB4-B7 Modification Area

Although not identified in the LWB4-B7 Modification Area during surveys undertaken by Umwelt in 2015 or 2016, the threatened and migratory fauna species presented in **Table 3.3** below were considered to have potential to occur based on the presence of appropriate habitat

Table 3.3 Threatened Fauna Species with Potential to occur in the LWB4-B7 Modification Area

Species	Status		Comment on Likely Occurrence in the LWB4-B7 Modification Area
	TSC Act	EPBC Act	
Green and golden bell frog (*Litoria aurea*)	E	V	There is a low potential that this species may use the areas of higher quality water bodies in the north.
green-thighed frog (*Litoria brevipalmata*)	V	-	There is a low potential that this species may use the areas of higher quality riparian habitat.
Australian bittern (*Botaurus poiciloptilus*)	E	E	There is a low potential that this species may use the areas of higher quality water bodies in the north.
Black bittern (*Ixobrychus flavicollis*)	V	-	There is a low potential that this species may use the areas of higher quality water bodies in the north.
Black-necked stork (*Ephippiorhynchus asiaticus*)	E	-	There is a low potential that this species may use the areas of higher quality water bodies in the north.
Australian painted snipe (*Rostratula australis*)	E	E	There is a low potential that this species may use the areas of higher quality water bodies in the north.
Freckled duck (*Stictonetta naevosa*)	V	-	There is a low potential that this species may use higher quality water bodies in the north of the LWB4-B7 Modification Area when areas west of the Great Dividing Range are experiencing drought.

Species	Status		Comment on Likely Occurrence in the LWB4-B7 Modification Area
	TSC Act	EPBC Act	
swift parrot (*Lathamus discolor*)	E	CE	Potential habitat identified based on the presence of winter flowering eucalypts in the Spotted Gum Ironbark Forest areas and Riparian Cabbage Gum Open Forest. This species would not be utilising the habitats available for breeding.
regent honeyeater (*Anthochaera phrygia*)	CE	CE	Potential habitat identified based on the presence of winter flowering eucalypts in the Spotted Gum Ironbark Forest areas and Riparian Cabbage Gum Open Forest. This species is not likely to use the habitats available for breeding.
Japanese snipe (*Gallinago hardwickii*)		MIG	There is a low potential that this species may use the areas of higher quality water bodies in the north as part of a wider migratory range.
Sharp-tailed sandpiper (*Calidris acuminata*)		MIG	There is a low potential that this species may use the areas of higher quality water bodies in the north as part of a wider migratory range.
Common greenshank (*Tringa nebularia*)		MIG	There is a low potential that this species may use the areas of higher quality water bodies in the north as part of a wider migratory range.

3.2.2 Habitat Assessment

Four habitat types were identified within the LWB4-B7 Modification Area, and a description of each is provided below.

3.2.2.1 Riparian Habitat

Approximately 74.8 hectares of riparian habitat occurs along the ephemeral watercourses within the LWB4-B7 Modification Area. Riparian vegetation communities identified included Riparian Swamp Oak Open Forest and Riparian Cabbage Gum Open Forest. These areas are typically quite linear and have a linking function within the landscape rather than providing areas of core habitat for a wide range of species. Riparian vegetation breaks up large expanses of grassland that would otherwise be devoid of treed vegetation.

Riparian habitat areas are typically dominated by swamp oak (*Casuarina glauca*) and subsequently have potential to provide a foraging resource for threatened species such as the glossy black-cockatoo (*Calyptorhynchus lathami*); however this would only likely be in passing between larger areas of higher quality habitat. Less common occurrences of cabbage gum (*Eucalyptus amplifolia*) are also present, these patches of eucalypt vegetation have potential to provide a foraging resources for threatened winter migrant bird species such as the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*).

The groundcover and understory in these riparian areas is typically sparse as a result of grazing. However riparian habitats have the potential to provide foraging habitat for small woodland birds, small reptiles, amphibians and arboreal mammals. These areas may also provide a water resource for micro-bats and terrestrial mammals when water is present.

Some areas of hollow-bearing trees were identified; however these were sparse, and when occurring were typically only very small (<25mm) or small (26 – 50 mm) hollows, or peeling bark/timber fissures that would generally only be suitable as denning habitat for micro-bat species such as the little bentwing-bat (*Miniopterus australis*) or eastern free-tailed bat (*Mormopterus norfolkensis*).

3.2.2.2 Open Forest Habitat

The open forest habitats occur in the north of the LWB4-B7 Modification Area, and comprise *Spotted Gum – Ironbark Forest* (and its variants), *Lower Coastal Foothils Transition Forest* (and its variant), *Planted Vegetation* and *Melaleuca Shrubland with Emergent Eucalypts*. The canopy in the open forest habitats is dominated by eucalypt species, which, when flowering, would provide foraging resources for nectarivorous species. This may include a diversity of birds, micro-bats and small mammals, including threatened species such as the squirrel glider (*Petaurus norfolcensis*) and the grey-headed flying-fox (*Pteropus poliocephalus*). The Eucalypt species would also harbour a diversity of invertebrate species, which would be utilised by insectivorous species such as micro-bats. The canopy trees comprise a predominantly young age-class, with few large, hollow-bearing trees observed (with the exception of riparian areas (particularly in the north)). As such, nesting habitat for hollow-dependent fauna species is moderate.

The open forest habitats comprise an understorey of low, prickly shrubs which provide refuge areas for small birds, mammals and reptiles. The grassy ground stratum provides foraging resources for granivorous bird species.

3.2.2.3 Grassland Habitat

Much of the LWB4-B7 Modification Area is vegetated with open grassland habitats. These areas have been heavily cleared and grazed and now support a ground stratum dominated by pasture grass species, some of which are native and some introduced. These areas provide foraging habitat for a range of fauna species, however these are more limited than those of the open forest habitat areas. The scattered trees that occur throughout the Grassland areas are important refuges for fauna, birds in particular, that use these trees for foraging, and for roost and perch sites.

It is not considered that these areas provide substantial habitat for any threatened fauna species.

3.2.2.4 Dam and Waterbody Habitats

The LWB4-B7 Modification Area contains several constructed farm dams ranging in size from approximately 10 metres by 10 metres to 40 metres by 30 metres as well as a large ponded farm dam waterbody in the far north. The LWB4-B7 Modification Area contains approximately 6.5 ha of farm dam and waterbody habitat.

These areas typically have an absence of fringing treed vegetation; however do typically have fringing riparian sedge vegetation. Typical sedges in these areas comprise *Carex appressa*, nardoo (*Marsilea muricata*) and introduced sharp acutus (*Juncus acutus*). Emergent and floating vegetation are largely absent. Grazing is likely to be the key contributor to an absence of fringing vegetation of these dams.

The large ponded farm dam waterbody in the north provides a substantial area of open water as well as muddy banks in places that could be utilised for migratory bird species.

These areas likely provide an important freshwater resource to local fauna, particularly for native birds and mammals. It is likely that these water bodies also provide foraging habitat for water birds as well as several micro-bat species. These areas also provide moderate quality refuge habitat for local amphibian species.

3.2.3 SEPP 44 Koala Habitat Assessment Results

SEPP 44 listed tree species typically comprised 5 per cent or less of treed vegetation within each vegetation community present in the LWB4-B7 Modification Area. The exception to this was in the Coastal Foothills Transition Forest, where grey gum (*Eucalyptus punctata*) comprised approximately 10 per cent of the treed vegetation and a very small pocket in the north-west of the LWB4-B7 Modification Area that also comprised approximately 10 per cent of treed vegetation. However, in accordance with SEPP 44 the total koala feed trees must comprise at least 15 per cent in order to be considered potential habitat. Subsequently none of this vegetation is considered as potential koala habitat under the SEPP 44 assessment guidelines.

Although a record of the koala exists in the LWB4-B7 Modification Area, it is likely that the LWB4-B7 Modification Area provides supplementary habitat and connectivity links across the landscape for dispersing individuals, rather than habitat that supports a population of the species. It is more likely that this species would be utilising the large areas of Grey Gum woodland to the immediate west.

The vegetation present in the LWB4-B7 Modification Area is not considered to comprise core koala habitat as there is no evidence of recent presence or breeding and the BioNet record of this species from 2006 (over ten years ago).

3.3 Connectivity

Connectivity within the LWB4-B7 Modification Area is high in a north-south alignment along the eastern boundary and low-moderate in an east-west alignment (with the majority of the area subject to historical clearing and agriculture). Vegetation occurring in the north-west shows connectivity to a large remnant of vegetation associated with Quorrobolong Creek; however internal connectivity in the south-east comprises highly fragmented riparian vegetation along the unnamed tributary of Quorrobolong Creek.

3.4 Critical Habitat

There are currently four critical habitat declarations in NSW that are listed under the TSC Act. None of these areas are within or in proximity to the LWB4-B7 Modification Area. There is no potential for the proposed modification to have an impact on any areas of declared critical habitat.

3.5 Aquatic Results

Results of aquatic surveys have been summarised in **Appendix D**. **Plates 3.8, 3.9 and 3.10** present photos of the range in quality of aquatic habitats recorded in the LWB4-B7 Modification Area.

Plate 3.8 Higher Quality Aquatic Habitats provided by Quorrobolong Creek in the North of the LWB4-B7 Modification Area

Plate 3.9 Lower Quality Aquatic Habitats provided by Unnamed Tributary of Quorrobolong Creek in the South of the LWB4-B7 Modification Area

Plate 3.10 Habitat Provided by Large Ponded Farm Dam Waterbody in the North of the LWB4-B7 Modification Area

In general the aquatic habitats provided were of a higher quality in the north than the south of the LWB4-B7 Modification Area (generally differentiated by Sandy Creek Road), as these areas are subject to fewer disturbances as a result of cattle grazing. Northern (upstream) reaches of Quorrobolong Creek had a greater diversity of native emergent as well as macrophytic aquatic vegetation as well as greater habitat diversity present (such as snags etc.). However at the time of survey these higher quality areas were not flowing and largely consisted of large standing pools.

Southern watercourses (unnamed tributary of Quorrobolong Creek mostly occurring south of Sandy Creek Road) contained moderate amounts of woody debris and tree roots which would provide moderate habitat and refugia for aquatic fauna. However are more susceptible to trampling by cattle.

All watercourses provide habitat for small aquatic fauna species and small fish (all fish identified were small (less than 10cm long)), such as the introduced mosquito fish (*Gambusia holbrooki*). The mosquito fish were identified in abundance throughout the watercourses and are likely to be impeding colonisation by native fish species.

The following additional fish species were identified, however only in the higher quality aquatic habitats in the north:

- Dwarf flathead gudgeon (*Philypnodon macrostomus*)
- Australian smelt (*Retropinna semoni*)

Invertebrate shrimp were also observed in each water course. Usage by the eastern long-neck turtle (*Chelodina longicollis*) was also common.

The unnamed tributary of Quorrobolong Creek occurring in the east of the LWB4-B7 Modification Area has several barriers to fish passage in the LWB4-B7 Modification Area, mostly in the form of sand/silt bars and was assessed as providing Class 3 or minimal fish habitat (as defined in **Section 2.5.2.1**). Quorrobolong Creek itself within the northern upstream areas of the LWB4-B7 Modification Area was considered relatively un-impeded and was classified as providing Class 2 or moderate fish habitat. All watercourses are slow-moving due to low flows and as such only riffles in general were rare. The large farm dam water body in the north of the LWB4-B7 Modification Area provides good quality fish habitat.

All watercourses are ephemeral in nature. The volume of water in all watercourses (where present) was identified as slightly lower than capacity at the times of the field investigations. The water in these watercourses was generally clear, occasionally with some minor tannins, and occasional areas of turbidity associated with disturbance by cattle.

Watercourses are all sinuous, and both banks and the substrate were comprised of silt/clay/sands with no gravel beds identified. Some bank erosion was present in the form of under-cutting; however this was minor and tended to occur along bends in areas where cattle grazing was more intense.

Out of a score of 200 (200 being high quality and 0 being low quality), the Riparian, Channel and Environmental inventory (RCE) assessments provided a score of:

- 138 for the west-most point of Quorrobolong Creek assessed
- 154 for Quorrobolong Creek as it occurs over LWB7
- 141 for northern Quorrobolong Creek over LWB6
- 119 for the unnamed tributary of Quorrobolong Creek as it occurs to the east of the LWB4-B7 Modification Area over LWB1;and
- 136 for southern reaches of the eastern-most unnamed tributary of Quorrobolong Creek north of Sandy Creek Road above LWB3.

Riparian channel condition scores of which are considered to indicate sub-optimal physical and biological conditions, with the exception of the north-western sections of Quorrobolong Creek which are in moderate condition.

Typically encountered fringing flora species included narrow-leaved typha (*Typha domingensis*) and the introduced sharp rush (*Juncus acutus)*; and typically encountered aquatic vegetation included water ribbons (*Triglochin procerum*) and nardoo (*Marsilea mutica*). Higher quality habitats in the north also included the following species:

- water plantain (*Alisma plantago-aquatica*)
- *Eleocharis* sp.
- frogsmouth (*Philydrum lanuginosum*)
- *Carex* sp.
- *Juncus* sp.

Also present were occasional infestations of introduced parrot's feather (*Myriophyllum aquaticum*).

No areas were identified in the LWB4-B7 Modification Area that were considered to have potential to provide habitat for the water rat (*Hydromys chrysogaster*) or platypus (*Ornithorhynchus anatinus*).

No threatened aquatic species listed as threatened under the TSC Act, EPBC Act or FM Act were identified or considered likely to occur.

3.6 Groundwater Dependent Ecosystems

The groundwater resources present in the LWB4-B7 Modification Area occur in the shallow alluvial aquifers associated with Quorrobolong Creek and its unnamed tributary, within shallow water bearing zones in the massive sandstones of the Branxton Formation and within the deeper Newcastle Coal Measures. There are no known GDEs within the LWB4-B7 Modification Area that rely on groundwater within the Branxton Formation or Coal Measures. However, it is highly likely that the riparian vegetation comprising Riparian Swamp Oak Open Forest and Riparian Cabbage Gum Open Forest is at least partially dependent upon shallow alluvial groundwater sources during periods of reduced surface water flow. The BOM Atlas identifies the areas north of Sandy Creek Road as comprising vegetation that has "moderate potential for groundwater interaction", these areas are reflective of the former identified vegetation communities.

The BoM Atlas identified Congewai Creek and Ellalong Lagoon as the only known GDEs (or partial GDEs) in the vicinity of the LWB4-B7 Modification Area. Ellalong Lagoon occurs approximately 4km west of the proposed LWB4-B7 Modification Area and Congewai Creek occurs more than 5km west and south of the LWB4-B7 Modification Area. Based on this mapping, Congewai Creek and Ellalong Lagoon are both classed as "Ecosystems that rely on the surface expression of groundwater"; however the southern end of Congewai Creek was classified as having a "low potential for groundwater interaction", the northern end was classified as having a "moderate potential for groundwater interaction" and Ellalong Lagoon was classified as having a "high potential for groundwater interaction". Neither of these GDEs occurs within the LWB4-B7 Modification Area and based on predictions of the subsidence, flooding and groundwater impact assessment reports, the proposed modification will not adversely impact these mapped GDEs.

4.0 Impact Assessment

4.1 Potential Impacts of the Proposed Modification

The proposed modification does not involve any additional surface development and therefore will have no direct impact on vegetation as a result of clearing. The potential impacts of the project on flora and fauna are therefore limited to impacts associated with subsidence.

Biodiversity values have the potential to be impacted by subsidence related surface cracking in the soil, and by any associated remediation of surface cracking post mining. Secondary impacts associated with hydrological changes are also possible and typically impact greatest on riparian areas. Such secondary impacts could include:

- changes to runoff and flow volumes through subsidence induced changes to catchment boundaries
- changes to bank stability and channel alignment
- changes to in-channel and out of channel ponding through changes to the bed profile of the creeks which may result in drying or waterlogging of root systems
- loss of water to near-surface groundwater flows due to subsidence-induced cracks occurring beneath a stream or other surface water body (this is of particular relevance to the large farm dam water body in the north of the LWB4-B7 Modification Area).

4.1.1 Subsidence Related Surface Cracking and Remediation

Potential changes in the ground surface resulting from subsidence have been assessed by MSEC (2017). MSEC notes that surface cracking in soils as the result of conventional subsidence movements is not commonly observed where the depths of cover are greater than 400 m, as is the case for the proposed modification. The subsidence assessment findings indicate that due to the depth of mining within the proposed modification area (minimum 400 metres), the massive nature of the Branxton Formation sandstones overlying the coal seam resulting in the small magnitudes of predicted ground curvatures and strains and the absence of steep slopes or cliffs within the modification area, the potential for surface cracking is low.

This conclusion is supported by subsidence monitoring evidence within the Stage 2, Stage 3 and LWB1-B3 areas, where there has been no significant or visible surface cracking above previously extracted longwalls A3 to A8 or LWB2. Similarly, ecological monitoring undertaken within the Stage 2 and Stage 3 areas since 2008 and 2012 respectively shows no evidence of any impacts on ecological features as a result of longwall mining (Austar 2014).

Any surface cracking that does occur is expected to be minor and isolated and unlikely to directly or adversely impact site vegetation communities and fauna habitat. Based on previous experience within the broader Austar Coal Mine, remediation of surface cracking is unlikely to be required within the LWB4-B7 Modification Area.

4.1.2 Subsidence Related Hydrological Changes

The proposed modification will result in the undermining of the main channel of Quorrobolong Creek. Quorrobolong Creek has been directly undermined previously by LWSL1 and LW1 to 5 in the Ellalong Colliery area and LWA3 to A5a in the Stage 2 area, with a total length of approximately four kilometres located directly above these previously extracted longwalls. No significant surface cracking or loss of surface water flow has been observed within Quorrobolong Creek or other streams within the Austar Coal Mine following undermining. MSEC (2017) considers it is unlikely, therefore, that there would be a net loss of water from the streams within the LWB4-B7 Modification Area resulting from the extraction of the proposed longwalls.

In the unlikely event that surface cracking does occur within drainage lines, this surface cracking would tend to be naturally filled with the natural surface soils during subsequent flow events, especially during times of heavy rainfall. If the surface cracks were found not to fill naturally, remedial measures may be required at the completion of mining.

Flood modelling has been undertaken by Umwelt (2017) to assess the changes in flooding and surface water flows resulting from predicted subsidence associated with the extraction of LWB4-B7. The flooding and drainage assessment concludes that the proposed modification is unlikely to have a significant impact on runoff regimes, bank stability or channel alignment and will result in only minor changes to flood depths and velocities. The assessment predicts minor changes to remnant ponding around some existing flow paths and farm dams. The locations of existing and proposed remnant ponding locations relative to vegetation communities and threatened species records are provided on **Figure 4.1**.

Figure 4.1 identifies two key areas where the extent of remnant ponding is predicted to increase from current levels, being:

- approximately 1.5 hectares of additional ponding upstream of an overflow channel from Quorrobolong Creek at the southern end of LWB6 and LWB7 within an area of Riparian Cabbage Gum Open Forest (River-flat Eucalypt Forest EEC (TSC Act)), and

- Approximately 0.1 hectares of ponding to the north-west of LWB5 occurring around an existing farm dam within an area of Introduced Grassland.

It is not anticipated that there will be any impacts to ecological values resulting from increased ponding within the Introduced Grassland and as such, no further assessment of the potential impacts to this community has been undertaken.

Further assessment was undertaken to determine the potential impacts on the ecological values of the area of Riparian Cabbage Gum Open Forest subject to additional ponding. This included additional analysis of ponding frequency and duration and additional survey effort within this community.

Analysis of ponding frequency and duration was undertaken based on historical meteorological data in order to provide an estimate of the number of days that the predicted additional ponding area may be inundated annually. The results of this analysis are provided in **Table 4.1**.

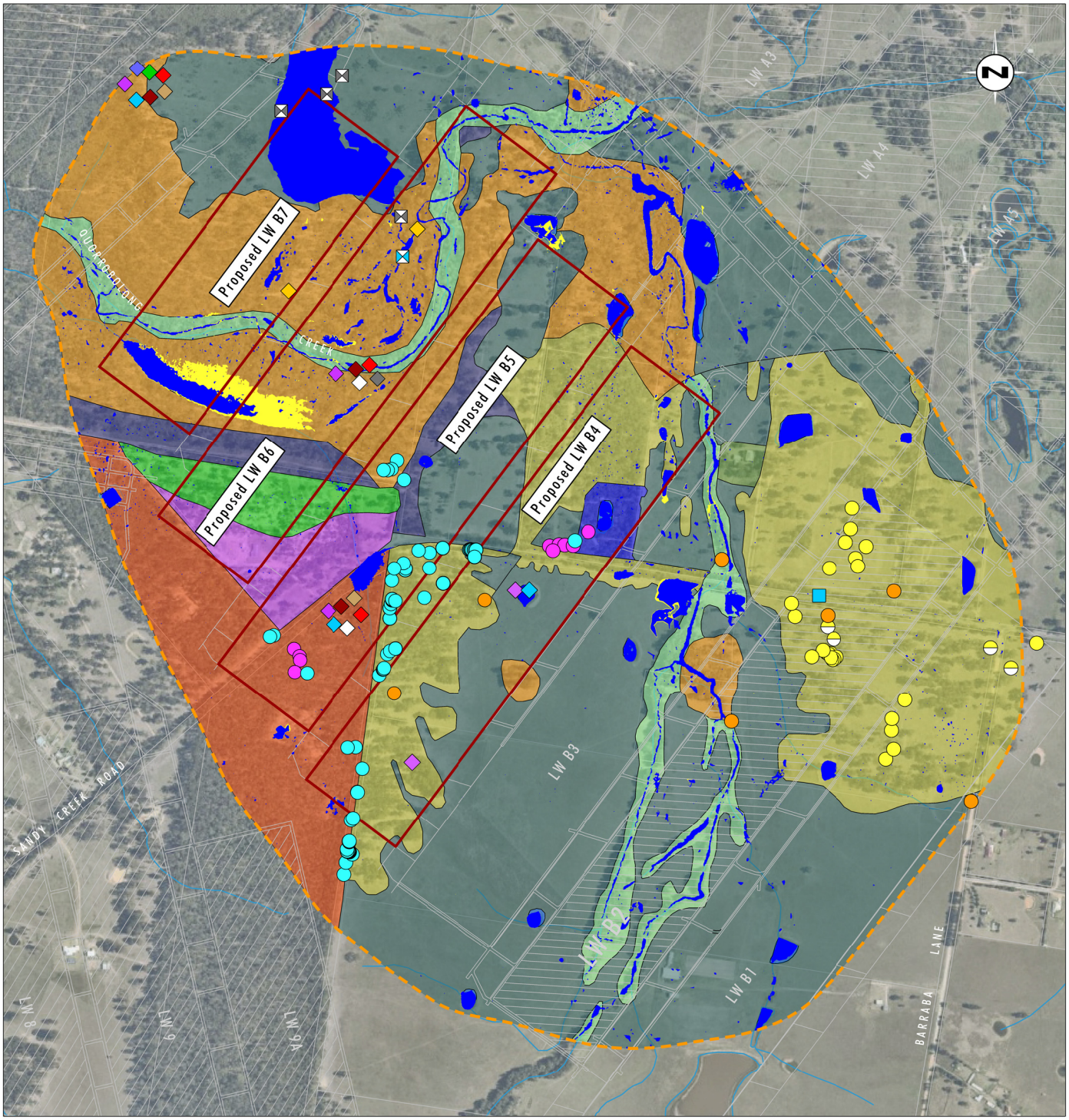

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)
Note: PR - Probable, SG - Species Group, D - Definite

0 200 400 600m
1:12 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area
- Completed Underground Workings
- Remnant Ponding Approved Mining Scenario
- Remnant Ponding Proposed Mining Scenario
- Modified Grassland
- Planted Vegetation
- Water Body
- Riparian Swamp Oak Open Forest

River Flat Eucalyptus Forest EEC:

- Riparian Cabbage Gum Open Forest

Lower Hunter Spotted Gum-Ironbark Forest EEC:

- Coastal Foothills Transition Forest
- Coastal Foothills Transition Forest - underscrubbed
- Spotted Gum Ironbark Forest
- Modified Spotted Gum Ironbark Forest
- Spotted Gum Ironbark Forest - underscrubbed

Potential Quorrobolong Scribbly Gum Woodland EEC:

- Melaleuca Shrubland with Emergent Eucalypts
- East-coast freetail-bat (Definite)
- Eastern bentwing-bat (Species Group)
- Eastern cave bat (Species Group)
- Eastern false pipistrelle (Species Group)
- Grey-crowned babbler (eastern subspecies)
- Grey-crowned babbler nests
- Grey-headed flying-fox
- Large-eared pied bat
- Greater broad-nosed bat (Species Group)
- Little bentwing-bat (Species Group)
- Little bentwing-bat (Probable)
- Squirrel glider
- Southern myotis (Species Group)
- Varied sittella
- White-bellied sea eagle
- White-bellied sea eagle Nest
- Yellow-bellied sheathtail-bat (Probable)
- *Callistemon linearifolius*
- *Grevillea parviflora* subsp. *parviflora*
- *Rutidosis heterogama*

FIGURE 4.1

Ponding Impacts to Ecological Values

File Name (A4): R02/3900_065.dgn
20170516 12.48

Table 4.1 Predicted Ponding Duration - Riparian Cabbage Gum Open Forest

Rainfall	Percentile	Estimated Number of Days of Inundation per Year
Dry year [1]	10	30
Average year	50	85
Wet year	90	156

Note 1: Based on Bureau of Meteorology data 1976-2006

As noted in **Table 4.1**, based on the analysis of historical meteorological data, the area of remnant ponding predicted within Riparian Cabbage Gum Open Forest to the south of Quorrobolong Creek is expected to be present between 30 and 156 days per year, depending on rainfall, with ponding to a depth of approximately 0.5 metres expected.

In the final determination for River-flat Eucalypt Forest (NSW Scientific Committee 2004), this community is described as having the following relevant attributes:

> *Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.*
>
> and
>
> *The composition of River-flat Eucalypt Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil.*

By its definition, this vegetation community naturally occurs on areas subject to periodic inundation and can have a variable floristic composition dependent upon the level of waterlogging that the particular site is subject to. The proposed alteration to ponding duration remains consistent with the definition of "periodic inundation". Although the localised ponding will increase in duration and frequency in this area, this vegetation type is well-suited to coping with periods of regular water inundation. It is anticipated that increased ponding will have some implications for the understorey vegetation composition, which will likely increase with time towards species that are more capable of enduring sustained periods of inundation, such as sedges and rushes, however will not change the actual vegetation community itself. While some changes in understory composition and structure may be expected as a result of the modification, the overall quality should remain broadly consistent and no tree death is anticipated to occur.

An assessment of potential impacts on groundwater has also been undertaken by Dundon Consulting (2017). The groundwater assessment concludes that given the depth of mining, the geomorphology of the area and the geology overlying the coal seam, the potential for the LWB4-B7 Modification to adversely impact on groundwater availability or quality within the alluvium is negligible. This is supported by monitoring of shallow groundwater levels within the Stage 2 and LWB1-B3 mining areas that indicate no detectable impact on the alluvium as a result of mining (Auercon 2013, Dundon 2017). Potential impacts on groundwater dependent ecosystems are considered further in **Section 4.5**.

Based on the findings of the surface water and groundwater assessments, the potential for the proposed modification to result in secondary impacts on ecological values as a result of changes in hydrology is therefore considered low.

4.2 Impact on Biodiversity Values

Based on the assessment provided in **Section 4.1** above, there is little potential for longwall mining to significantly adversely impact vegetation communities and terrestrial fauna habitat identified in the LWB4-B7 Modification Area.

Similarly aquatic fauna habitats are considered to have little potential to be impacted as surface cracking and subsequent loss of surface flows are not predicted to occur. The proposed modification is not likely to result in an adverse impact to the biodiversity values identified in the LWB4-B7 Modification Area and therefore negligible changes to flora and fauna species diversity, vegetation community extent and aquatic species and habitat complexity is predicted. The only change likely to occur to overall biodiversity is a minor alteration in the understorey vegetation occurring within an approximately 1.5ha area directly above the proposed LWB6-LWB7 associated with remnant ponding. This is anticipated to remain native and consistent with the current River-flat Eucalypt Forest EEC community, with potential to increase in composition to vegetation capable of sustaining more prolonged periods of inundation (such as sedges and reeds).

4.3 Impact on Threatened Species, Endangered Populations and Communities under the TSC Act

4.3.1 Threatened Species

The following threatened flora and fauna species listed under the TSC Act were assessed in accordance with Section 5A of the EP&A Act (provided in **Appendix E**) as they were identified within the LWB4-B7 Modification Area or were considered to be potentially affected as a result of the proposed modification:

- heath wrinklewort (*Rutidosis heterogama*) – listed as vulnerable under the TSC Act
- small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) – listed as vulnerable under the TSC Act
- netted bottle brush (*Callistemon linearifolius*) – listed as vulnerable under the TSC Act
- green-thighed frog (*Litoria brevipalmata*) – listed as vulnerable under the TSC Act
- green and golden bell frog (*Litoria aurea*) – listed as endangered under the TSC Act
- Australasian bittern (*Botaurus poiciloptilus*) – listed as endangered under the TSC Act
- black bittern (*Ixobrychus flavicollis*) – listed as vulnerable under the TSC Act
- black-necked stork (*Ephippiorhynchus asiaticus*) – listed as endangered under the TSC Act
- Australia painted snipe (*Rostratula australis*) – listed as endangered under the TSC Act
- freckled duck (*Stictonetta naevosa*) – listed as vulnerable under the TSC Act
- white-bellied sea eagle (*Haliaeetus leucogaster*) – listed as vulnerable under the TSC Act
- regent honeyeater (*Anthochaera phrygia*)- listed as critically endangered under the TSC Act
- swift parrot (*Lathamus discolor*) – listed as endangered under the TSC Act

- grey-crowned babbler (*Pomatostomus temporalis temporalis*) – listed as vulnerable under the TSC Act
- varied sittella (*Daphoenositta chrysoptera*) – listed as vulnerable under the TSC Act
- grey-headed flying fox (*Pteropus poliocephalus*) – listed as vulnerable under the TSC Act
- squirrel glider (*Petaurus norfolcensis*) - listed as vulnerable under the TSC Act
- koala (*Phascolarctos cinereus*) – listed as vulnerable under the TSC Act
- large-eared pied bat (*Chalinolobus dwyeri*) listed as vulnerable under the TSC Act
- southern myotis (*Myotis macropus*) – listed as vulnerable under the TSC Act
- east-coast freetail bat (*Mormopterus norfolkensis*) – listed as vulnerable under the TSC Act
- little bentwing bat (*Miniopterus australis*) – listed as vulnerable under the TSC Act
- eastern bentwing bat (*Miniopterus schreibersii oceanensis*) – listed as vulnerable under the TSC Act
- greater broad nosed bat (*Scoteanax rueppellii*) – listed as vulnerable under the TSC Act
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*) – listed as vulnerable under the TSC Act
- eastern falsistrelle (*Falsistrellus tasmaniensis*) – listed as vulnerable under the TSC Act
- eastern cave bat (*Vespadelus troughtoni*) – listed as vulnerable under the TSC Act.

As discussed in **Sections 4.1** and **4.2**, the proposed modification will not result in any direct clearing of vegetation and the potential impacts associated with subsidence are not predicted to impact adversely on vegetation communities or fauna habitat. Given the mobile nature of the fauna species assessed, that most of these species would only be likely to be utilising the habitats present as part of a wider habitat range and that only negligible change to the overall landscape is predicted as a result of the proposed modification, it was not considered likely that there would be a significant impact on any threatened fauna species listed under the TSC Act as a result of the proposed modification.

4.3.2 Endangered Populations

There are no endangered flora or fauna populations identified or likely to occur within the LWB4-B7 Modification Area. The proposed modification will not result in a significant impact on endangered populations.

4.3.3 Endangered Ecological Communities

Two EECs and one potential EEC were recorded within the LWB4-B7 Modification Area being River-flat Eucalypt Forest EEC, Lower Hunter Spotted Gum – Ironbark Forest EEC and potential Quorrobolong Scribbly Gum Woodland EEC. Each of these communities is listed under the TSC Act, no EECs are present that are listed under the EPBC Act. These were present in the vegetation communities identified in **Table 4.2** below.

Table 4.2 Vegetation Communities within the LWB4-B7 Modification Area that Conform to EECs

Community Name	Status	Approximate Extent (ha)
Riparian Cabbage Gum Open Forest	River-flat Eucalypt Forest EEC (TSC Act)	56.7
Coastal Foothills Transition Forest	Lower Hunter Spotted Gum – Ironbark Forest EEC (TSC Act)	7.4
Coastal Foothills Transition Forest – underscrubbed		4.9
Spotted Gum - Ironbark Forest		24.3
Modified Spotted Gum - Ironbark Forest		62.0
Spotted Gum Ironbark forest - Underscrubbed		5.6
Melaleuca Shrubland with Emergent Eucalypts	Potential Quorrobolong Scribbly Gum Woodland EEC (TSC Act)[1]	1.6

[1] Potential EEC however could not be confirmed without further detailed sampling.

The predicted subsidence, surface cracking and surface and groundwater impacts of the proposed modification are not expected to result in a significant impact on the floristic diversity, condition or extent of EECs occurring in the LWB4-B7 Modification Area. A small increase in the extent of remnant ponding (approximately 1.5 hectares) within the River-flat Eucalypt Forest EEC is predicted; however as this vegetation is already subject to and resilient to periodic water inundation, it is expected that there will be no significant impact to the condition and quality of this EEC.The significance of any potential impacts on the River-flat Eucalypt Forest EEC, Lower Hunter Spotted Gum – Ironbark Forest EEC and potential Quorrobolong Scribbly Gum Woodland EEC, were assessed in accordance with the requirements of the EP&A Act. This assessment, provided in **Appendix E**, concludes that the proposed modification will not have a significant impact on the River-flat Eucalypt Forest, Lower Hunter Spotted Gum – Ironbark Forest and potential Quorrobolong Scribbly Gum Woodland EECs such that it would place the local occurrence of the EECs at risk of extinction.

4.3.4 Threatened Aquatic Species and Ecosystems

The Darling River Hardyhead Endangered Population is the only species listed under the FM Act that occurs within the Hunter Catchment. This species is usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pool. This species is rarely recorded in the Hunter catchment but has been found in the headwaters of the Hunter system near Pages River. The species is not expected to occur in the LWB4-B7 Modification Area due to a lack of suitable habitat and the species will not be significantly impacted as a result of the proposed modification.

4.4 Matters of National Environmental Significance

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

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

The LWB4-B7 Modification Area includes the following

- listed threatened species and communities
- listed migratory species
- a water resource, in relation to coal seam gas development and large coal mine development.

The EPBC Act lists criteria which are used to determine whether an action is likely to have a significant impact on the MNES relevant to the proposed modification, that is, listed threatened species and communities; and listed migratory species. These criteria are addressed in the Assessment of Significance provided in **Appendix F** and included the EPBC Act listed species identified below.

- regent honeyeater (*Anthochaera phrygia*) - listed as critically endangered under the EPBC Act
- swift parrot (*Lathamus discolor*) – listed as critically endangered under the EPBC Act
- Australian painted snipe (*Rostratula australis*) – listed as endangered under the EPBC Act
- Australasian bittern (*Botaurus poiciloptilus*) – listed as endangered under the EPBC Act
- green and golden bell frog (*Litoria aurea*) – listed as vulnerable under the EPBC Act
- grey-headed flying fox (*Pteropus poliocephalus*) - listed as vulnerable under the EPBC Act
- koala (*Phascolarctos cinereus*) – listed as vulnerable under the EPBC Act
- large-eared pied bat (*Chalinolobus dwyeri*) – listed as vulnerable under the EPBC Act
- heath wrinklewort (*Rutidosis heterogama*) – listed as vulnerable under the EPBC Act
- small-flower grevillea(*Grevillea parviflora* subsp. *parviflora*) – listed as vulnerable under the EPBC Act
- Japanese snipe (*Gallinago hardwickii*) - listed as migratory under the EPBC Act

- sharp-tailed sandpiper (*Calidiris acuminata*) - listed as migratory under the EPBC Act
- common greenshank (*Tringa nebularia*) - listed as migratory under the EPBC Act.

The assessments of significance undertaken for threatened and migratory species listed under the EPBC Act determined that the proposed modification would be unlikely to result in a significant impact on these species. Subsequently, referral of the proposed modification to the Minister of the Environment on the basis of impacts on listed threatened species or listed migratory species is not required.

4.5 Groundwater Dependent Ecosystems

It is considered likely that the approximately 74.8 ha of Riparian Swamp Oak Forest and Riparian Cabbage Gum Open Forest present in the modification area is at least partially dependent on alluvial groundwater flows. As outlined in **Section 3.5** these areas are considered to have at least some dependence on shallow alluvial groundwater resources during periods of reduced surface water flow.

An assessment of the potential impacts of the proposed modification on the alluvial groundwater resources within the modification area has been undertaken by Dundon Consulting (2017). This assessment identifies that the predicted heights of either connected or discontinuous fracturing above the Greta Seam as a result of subsidence are significantly less than the depth of cover above the Greta Seam. Therefore, impacts on either the shallow alluvial groundwater or on stream baseflows as a result of the LWB4-B7 Modification will be negligible. Accordingly, no impacts on any GDEs dependent on the alluvial groundwater or on groundwater baseflow are predicted to occur (Dundon 2017).

This conclusion is supported by the results of previous monitoring of the impacts of mining on shallow aquifers within the Austar Coal Mine has identified no observable impact on alluvial aquifers as a result of mining (Austar 2014). Fluctuations in groundwater level within these shallow aquifers have reflected rainfall conditions, with groundwater levels trending higher during periods of above average rainfall and lower during periods of below average rainfall. No noticeable divergence in this trend has occurred over time within alluvial monitoring bores, suggesting no mining related impacts have occurred (Dundon 2017).

The potential impacts of changes in flooding and remnant ponding behaviour on riparian vegetation has also been assessed (refer to **Section 4.1.2**) and found that any changes to surface water hydrology within the modification area is unlikely to result in significant adverse impacts to these communities.

Therefore groundwater dependent ecosystems occurring in the LWB4-B7 Modification Area, including the Riparian Swamp Oak Open Forest and Riparian Cabbage Gum Open Forest identified, are unlikely to be adversely impacted as a result of the proposed modification.

4.6 Key Threatening Processes

A number of Key Threatening Processes (KTPs) listed under the Schedules of the TSC Act, the EPBC Act and the FM Act, are relevant to the proposed modification. A discussion of the implications of the relevant KTPs under each Act is detailed below.

4.6.1 Threatened Species Conservation Act 1995 Listed KTPs

There are four KTPs listed under the TSC Act that are potentially relevant to the LWB4-B7 Modification, being:

Alteration of habitat following subsidence due to longwall mining

This KTP is most relevant to the proposed modification. Subsidence as a consequence of longwall mining is recognised as potentially altering habitats as well as the species and communities dependent on these habitats. Some habitats such as aquatic and riparian areas are considered to be particularly susceptible to subsidence (as a result of subsidence, tilt, curvature, cracking and subsequent hydrological changes).

Three threatened species are identified within this KTP determination as being susceptible to subsidence as a result of longwall mining that are considered to have potential to occur within the LWB4-B7 Modification Area, being the southern myotis (*Myotis macropus*), black bittern (*Ixobrychus flavicollis*) and grey-headed flying fox (*Pteropus poliocephalus*). As such these three species have been included within the relevant assessments of significance.

Longwall mining has the potential for surface movement (change to surface tilt and curvature) to cause habitat tree fall and the potential for disruption to natural water flow regimes and retention capacity in water bodies.

The subsidence predictions prepared by MSEC (2017) indicate that subsidence experienced over LWB4-B7 are expected to be less than those experienced elsewhere within the Stage 2 and 3 areas, where longwall top coal caving methods were used, and similar to the predicted levels within the adjacent LWB1-B3 area. The overall magnitude of predicted subsidence parameters is also relatively small given the depth of cover (between 400 and 505 metres), the geology of the area and local topography. It is anticipated that longwall mining will result in a similar final land surface to that currently present with some minor overall lowering. If any surface cracking were to result these are expected to be of a minor nature that could be readily remediated by infilling with appropriate materials by locally regarding and recompacting the surface

Given the small magnitude of predicted tilts and curvatures, tree fall as a result of subsidence is highly unlikely. There is also considered to be a low potential for any significant hydrological alterations such that there will be an impact on threatened flora, fauna or TECs.

Minor changes to the extent of remnant ponding are predicted to occur in the areas indicated in **Figure 4.1**. These changes occur within areas that are already subject to periodic inundation and are not anticipated to substantially alter the vegetation community present.

Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands

Based on the predicted subsidence expected as a result of the project described above, no significant changes to the natural flow regime of the surface water and groundwater regimes currently operating in the LWB4-B7 Modification Area is predicted.

Minor changes to the extent of remnant ponding are predicted to occur. This additional ponding (approximately 1.5ha) is located within areas currently subject to inundation. The inundation will continue to be periodic and is not anticipated to have long-term ecological implications to overall biodiversity values in these areas.

Anthropogenic climate change

As an indirect impact of the proposed modification, greenhouse gas emissions will contribute to anthropogenic climate change as part of the energy production from the coal extracted from the LWB4-B7 Modification Area. This will not occur directly as a result of the proposed modification and the extent of this contribution is considered to be minor (see the Greenhouse Gas Assessment undertaken within the main text of this Environmental Assessment).

Loss of hollow-bearing trees

The predicted alterations to the topography of the land in terms of tilt and curvature are not predicted to be substantially modified to the extent that they will result in tree-fall and subsequent hollow-bearing tree loss.

4.6.2 Environment Protection and Biodiversity Conservation Act 1999 Listed KTPs

There is one KTP listed under the EPBC Act that is potentially relevant to this project, being:

Loss of climactic habitat caused by anthropogenic emissions of greenhouse gases

Greenhouse gas emissions will be generated both directly and indirectly as a result of the proposed modification. The vast majority of these emissions (95 per cent) will be indirect emissions attributable to third party emissions as a result of use of the coal extracted from the LWB4-B7 Modification Area. Direct emissions attributable to the LWB4-B7 Modification will contribute approximately 0.00019 per cent to global emissions per annum, the extent of this contribution is considered to be minor (see the Greenhouse Gas Assessment undertaken within the main text of this Environmental Assessment).

4.6.3 Fisheries Management Act Listed KTPs

There are two KTPs listed under the FM Act that are potentially relevant to this project, being:

Human-caused climate change

As an indirect impact of the proposed modification, greenhouse gas emissions will contribute to human-caused climate change as part of the energy production from the coal extracted from the LWB4-B7 Modification Area. This will not occur directly as a result of the proposed modification and the extent of this contribution is considered to be minor (see the Greenhouse Gas Assessment undertaken within the main text of this Environmental Assessment).

Degradation of native riparian vegetation along NSW water courses

Increased ponding in an approximate 1.5 ha area above the southern end of LWB6 and LWB7 will likely result in some minor changes to the composition of the understorey vegetation in this area due to greater periods of water inundation, however it is not anticipated that these changes will result in tree death and changes to composition will most likely comprise a gradual change to native flora species with a higher tolerance to prolonged inundation such as sedges and reeds (which are already present).

5.0 Mitigation and Management

5.1 Biodiversity Management Plan

Prior to the commencement of secondary extraction of LWB4-B7, an Extraction Plan will be prepared for the proposed longwalls. A Biodiversity Management Plan (BMP) will be prepared as a component plan of this Extraction Plan to manage any potential impacts from secondary extraction of LWB4-B7 on biodiversity values within the extraction plan area. The BMP will identify baseline information on ecological values within the extraction plan area, and the potential impacts to those aspects by predicted subsidence as identified in this assessment report (particularly in relation to increased ponding). The BMP will identify specific monitoring recommendations as outlined in **Section 5.2** below. Any monitoring on private lands is subject to landowner access.

Subsidence predictions are such that there is not predicted to be any significant adverse impact to ecological features within the LWB4-B7 Modification Area, however, in the unlikely event that subsidence remediation works are required, it is proposed that contingency measures for subsidence remediation works will be provided in the BMP.

5.2 Recommended Ecological Monitoring

The Biodiversity Management Plan to be prepared for the LWB4-B7 Modification should include a detailed ecological monitoring program. The ecological monitoring program should include baseline monitoring to allow identification of any subsidence or required land remediation impacts on threatened species, populations, their habitats or EEC. The ecological monitoring program should be designed in a manner consistent with the existing ecological monitoring program for the LWB1-B3 area (Austar 2016) and with current OEH policy.

In order to ensure subsidence predictions are accurate and that there will be no significant impacts to EECs, it is recommended that the ecological monitoring program include ecological monitoring of:

- River-flat Eucalypt Forest EEC vegetation (occurring within the predicted 1.5 ha area of ponding)
- Lower Hunter Spotted Gum – Ironbark Forest EEC vegetation
- Potential Quorrobolong Scribbly Gum Woodland EEC vegetation (although it is understood that access to this area is not currently available).

At least one monitoring site will be established in each EEC, subject to landholder access.

Given the results of vegetation monitoring undertaken within subsidence affected areas of the Austar Coal Mine since 2007 do not show any evidence of adverse impacts on vegetation, the monitoring of threatened flora species, including the netted bottlebrush (*Callistemon linearifolius*) population, heath wrinklewort (*Rutidosis heterogama*) population, and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) population, is not proposed. Should the results of EEC monitoring surveys reveal sufficient reason to conduct further surveys of threatened species populations, the monitoring program should be appropriately adapted.

Specific surveys targeting fauna groups is also not deemed necessary given the minimal surface disturbances predicted and the extensive effort required to collect sufficient data on fauna species to allow reliable comparisons to be made. Should the results of vegetation monitoring surveys reveal sufficient reason to conduct fauna surveys, the monitoring program should be appropriately adapted.

Ecological monitoring should be undertaken as mining proceeds to ensure that any actual impacts are discovered quickly and managed appropriately. In the event that monitoring does reveal impacts, mitigation and management measures will be implemented in accordance with procedures to be outlined in the BMP. In addition, monitoring should ensure that any mitigation measures recommended are successfully implemented.

In line with current monitoring requirements, it is proposed that monitoring be undertaken on an annual basis for areas of Lower Hunter Spotted Gum – Ironbark Forest and areas of potential Quorrobolong Scribbly Gum Woodland. Bi-annual (six monthly) monitoring is recommended for the River-flat Eucalypt Forest monitoring site in order to more closely monitor the influence of any changes in ponding on the understorey vegetation composition of this community.

A baseline survey should be undertaken at each site prior to the commencement of subsidence impacts in a manner consistent with the current ecological monitoring regime at Austar Coal Mine. The cessation of monitoring will be linked with the results of the subsidence monitoring. The timeframe for completion of monitoring will depend strongly on whether any impacts are observed and whether subsidence remediation works are required. Monitoring will need to continue for a longer period of time if subsidence remediation works are required or if changes to the ecological values are observed that are linked to subsidence impacts, in which case monitoring would continue until the condition of the site is found to be stable.

The monitoring program would incorporate survey methods such as: permanent vegetation plots, vegetation condition assessment, habitat assessment and photo monitoring, where relevant.

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