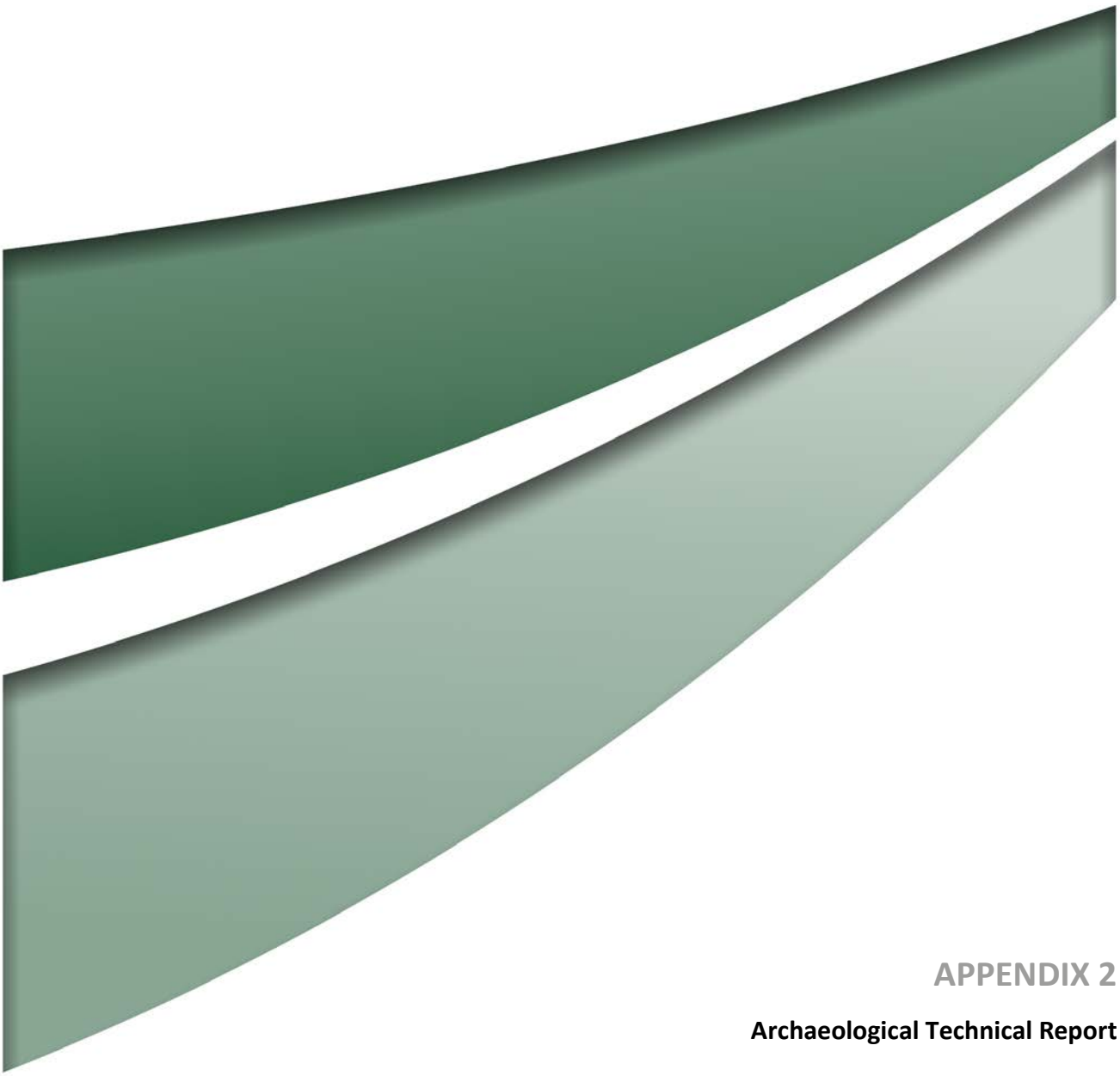

APPENDIX 2

Archaeological Technical Report

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Inspired people | Dedicated team
Quality outcomes

AUSTAR COAL MINE

LWB4-B7 MODIFICATION ARCHAEOLOGICAL TECHNICAL REPORT

Austar Coal Mine

FINAL

May 2017

AUSTAR COAL MINE

LWB4-B7 MODIFICATION ARCHAEOLOGICAL TECHNICAL REPORT

Austar Coal Mine

FINAL

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

Project Director:	Barbara Crossley
Project Manager:	Gabrielle Allan
Report No.	3900/R04/Appendix 2
Date:	May 2017

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

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ISO 9001

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Executive Summary

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. 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.

Austar is proposing to modify development consent DA29/95 (the Bellbird South Consent) under section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act). The modification is required to permit the transfer and processing of coal from four (4) additional longwall panels (LW) B4 to B7 via the existing Bellbird Mains and to extend the development consent area to encompass the four proposed longwall panels**.**

Austar engaged Umwelt (Australia) Pty Ltd (Umwelt) to work with the registered Aboriginal parties to complete an Aboriginal Cultural Heritage Assessment for the proposed modification. This report is provided as a technical report that forms an appendix to the Aboriginal Cultural Heritage Assessment Report (ACHAR) for the proposed modification and is prepared in accordance with *The Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010) (the Code of Practice). The ACHAR will inform the Environmental Assessment (EA) for the proposed modification to development consent DA 29/95.

Mining within the Bellbird South areas (Southland, Stage 1 and Stage 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. Mining is currently being undertaken in the LWB1-B3 mining area in accordance with DA 29/95. It is noted that the impacts of mining LWB1-B3 on Aboriginal cultural heritage was assessed in 2015 (Umwelt 2015) as part of a previous modification of DA29/95.

The potential impacts of the proposed LWB4-B7 Modification on Aboriginal archaeology and cultural heritage have been assessed within the 20 millimetre subsidence contour for LWB4-B7. This area is referred to as the 'LWB4-B7 Modification Area'. The LWB4-B7 Modification Area incorporates portions of the previously assessed LWB1-B3 Modification Area (Umwelt 2015), therefore the archaeological survey and cultural heritage assessment findings from the LWB1-B3 Modification have been considered in this assessment where appropriate.

A review of available environmental contextual information for the LWB4-B7 Modification Area and surrounds demonstrates that the modification area provided access to Quorrobolong Creek, which, although ephemeral, may have held water for extended periods in pools or ponds. In addition, the review of landforms and soils associated with the modification area identified the potential for alluvial landforms along Quorrobolong Creek that intersect with slope landforms, therefore establishing the potential for colluvial-alluvial interfaces, with the associated potential implications for archaeological site preservation. The LWB4-B7 Modification Area is also relatively well resourced with reference to the plant and animal resources that would have been present in the area prior to non-Aboriginal settlement and landscape modification. However, the modification area and surrounds have been settled for a relatively lengthy period of time and have been

subject to a range of impacts. These impacts are likely to be in the form of changes to erosion regimes (following vegetation clearance) and subsequent alterations in the nature and morphology of watercourses.

A review of available archaeological information pertaining to the LWB4-B7 Modification Area and surrounds was undertaken to inform the understanding of archaeological site patterning, site survival and the potential for detection of extant archaeological sites. This review identified that the LWB4-B7 Modification Area contains one previously recorded archaeological site (AHIMS #37-6-3398 – ACM35). This site is located within the area previously assessed as part of the previous LWB1-B3 Modification and is managed in accordance with the provisions of the Austar Coal Aboriginal Cultural Heritage Management Plan (Austar 2017).

Based on the review of archaeological and environmental information, a predictive model was developed for the LWB4-B7 Modification Area. This model identified that sites containing stone artefacts are the most likely site type, with the site numbers and density likely to be greatest in association with water resources, particularly Quorrobolong Creek. In addition, it was identified that there is the potential for colluvial/alluvial interfaces within the areas of valley flats bordering the watercourses, particularly Quorrobolong Creek and that sites in these contexts may retain stratigraphic integrity. Scarred trees may occur where mature native vegetation remains whilst grinding groove sites (and potentially other sites associated with sandstone such as engraving sites) may occur if suitable sandstone outcrops are exposed within the channel of Quorrobolong Creek and associated watercourses.

The methodology for the assessment was developed with reference to the predictive model and was subject to consultation with registered Aboriginal parties. The survey of the LWB4-B7 Modification Area comprised pedestrian survey in accordance with the sampling strategy and undertaken with representatives of the registered Aboriginal parties. A total of 13 new sites were identified, of which one is located outside the LWB4-B7 Modification Area. These sites consisted of isolated artefacts and artefact scatters, with only two sites (ACM38 and ACM40) containing more than five artefacts. The distribution and contents of these sites is relatively comparable to the outcomes of previous archaeological investigations within the Austar Coal Mine and surrounds. No grinding grooves or scarred trees were identified within the LWB4-B7 Modification Area and no areas of outcropping sandstone were present within Quorrobolong Creek.

Based on the criteria for the assessment of archaeological potential, the majority of the LWB4-B7 Modification Area has low archaeological potential. The exceptions to this are the valley flats bordering Quorrobolong Creek (moderate potential), slopes within 100 metres of the main channel of Quorrobolong Creek and identified overflow channels and the spur crest in Survey Unit 9 (all of which have low to moderate archaeological potential).

The archaeological significance of the identified sites was assessed as low, with the exception of sites ACM38 and ACM40, which were assessed as having low-moderate archaeological significance, largely based on their research potential.

The proposed modification does not involve any additional surface development and therefore will have no direct impact on Aboriginal archaeological sites as a result of land clearing. The potential impact of the proposed modification on archaeological sites is therefore limited to indirect impacts associated with subsidence, including the potential for surface cracking and changes to hydrology (including ponding or alterations to creekline morphology). Based on the outcomes of assessments undertaken by MSEC (2017) and Umwelt (2017c), the proposed LWB4-B7 Modification is unlikely to result in direct or indirect impacts to the identified archaeological sites or on the identified areas of low-moderate or higher archaeological potential.

The following recommendations have been developed in light of the archaeological context of the LWB4-B7 Modification Area; the findings of the current survey and the previous survey of the LWB1-B3 Modification Area; the low likelihood of impact of the proposed modification on identified archaeological sites and areas of archaeological potential and current cultural heritage legislation:

- Austar Coal Mine should continue to implement the management strategies currently in place at the Austar Coal Mine, including those in the Austar Aboriginal Cultural Heritage Management Plan (ACHMP). Consistent with existing management strategies, in the unlikely event that subsidence remediation works are required that will impact on the identified sites or areas of low-moderate or higher archaeological potential, an Aboriginal Heritage Impact Permit (AHIP) will be sought for the portion of the site or area of potential to be

impacted prior to the commencement of any remediation works in proximity to the recorded site or area of potential (noting that, in some instances, it may be necessary to undertake test excavation to inform the requirement for an AHIP). Appropriate mitigation measures for the site or area of potential to be impacted by the remediation works will be developed as part of the AHIP application process in consultation with the registered Aboriginal parties and in accordance with OEH requirements. The ACHMP includes provision for pre and post subsidence monitoring of recorded sites to provide comparative data on site condition and to allow for the identification of any unexpected subsidence impacts.

- The Austar ACHMP should be reviewed to incorporate the outcomes of this assessment and to include provisions for the monitoring of identified archaeological sites within the LWB4-B7 Modification Area in accordance with the management strategies currently implemented within the Austar Coal Mine.

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Appendices

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.

Austar is proposing to modify development consent DA29/95 (the Bellbird South Consent) under section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The modification is required to permit the transfer and processing of coal from four (4) additional longwall panels (LW) B4 to B7 via the existing Bellbird Mains and to extend the development consent area to encompass the four proposed longwall panels (refer to **Figure 1.2** and **Figure 1.3**). There will be no change to surface facilities, approved rates of mining, coal processing and handling or product transport rates as a result of the modification.

Austar engaged Umwelt (Australia) Pty Ltd (Umwelt) to work with the registered Aboriginal parties to complete an Aboriginal Cultural Heritage Assessment for the proposed modification. This report is provided as a technical report that forms an appendix to the Aboriginal Cultural Heritage Assessment Report (ACHAR) for the proposed modification and is prepared in accordance with *The Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010) (the Code of Practice). The ACHAR will inform the Environmental Assessment (EA) for the proposed modification to development consent DA 29/95.

1.1 Austar Coal Mine Background

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 being undertaken in the LWB1-B3 mining area in accordance with DA 29/95. 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 (refer to **Figure 1.3**). It is noted that the impacts of mining LWB1-B3 on Aboriginal cultural heritage was assessed in 2015 (Umwelt 2015) as part of a previous modification of DA29/95.

The potential impacts of the proposed LWB4-B7 Modification on Aboriginal archaeology and cultural heritage 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. The LWB4-B7 Modification Area incorporates portions of the previously assessed LWB1-B3 Modification Area (Umwelt 2015), therefore the archaeological survey and cultural heritage assessment findings from the LWB1-B3 Modification have been used to supplement this assessment where appropriate. The detailed survey data from the assessment of the LWB1-B3 Modification is not repeated within this report but the outcomes of the previous assessment are used to inform the current assessment (including the location of site #37-6-3398).

The LWB4-B7 Modification Area is located entirely within the Austar mining authorities CCL728 and CML 2 and no change to Austar's existing mining authorities would be required to accommodate the LWB4-B7 Modification.

1.2 Proposed Modification to DA29/95

Austar proposes to modify the Bellbird South consent to:

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

Coal will be extracted from LWB4-B7 using conventional longwall mining techniques. The existing Austar Coal Mine infrastructure is sufficient to support the mining of the four proposed longwalls and there will be no change to surface facilities, approved rates of mining, coal processing and handling or product transport rates as a result of the modification.

The proposed modification does not involve any additional surface development and therefore will have no direct impact on Aboriginal archaeological sites as a result of land clearing. The potential impact of the proposed modification on archaeological sites is therefore limited to indirect impacts associated with subsidence, including the potential for surface cracking and changes to hydrology (including ponding or alterations to creekline morphology). The potential impacts of subsidence with reference to Aboriginal archaeological sites and areas of archaeological potential are discussed in detail in **Section 7.0**. However, it is noted that the predicted levels of subsidence within the LWB4-B7 Modification Area are lower than those that have occurred in the previously approved Stage 2 and Stage 3 mining areas (refer to **Figure 1.2**), where there has been no significant or visible surface cracking observed and no requirement for remediation of any ground surface cracking (MSEC 2017).

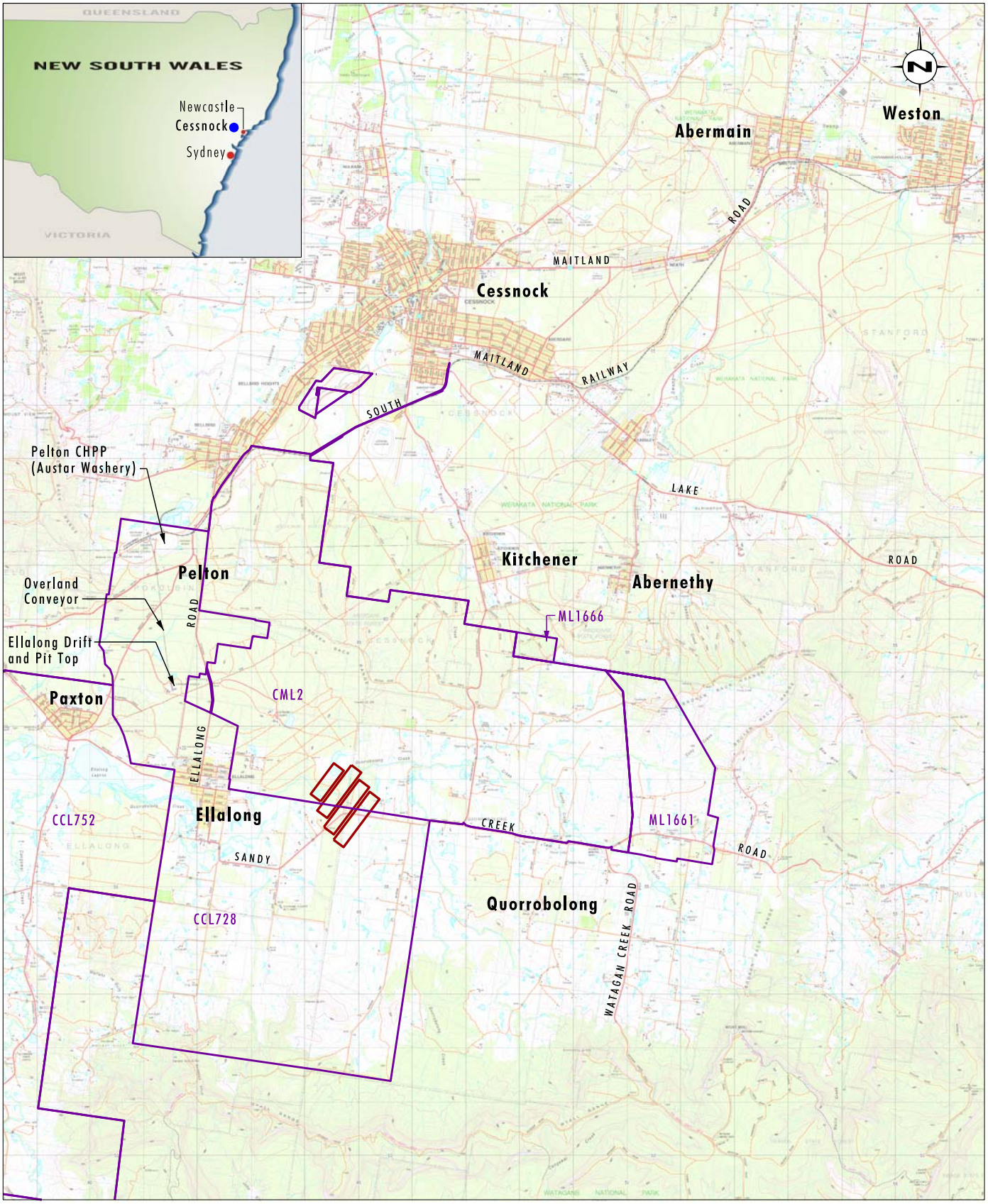

Image Source: LPI NSW (2009)
Data Source: Austar Coal Mine (2016)

0 1.0 2.5 5.0km
1:100 000

Legend

- Proposed LWB4-B7 Longwall Panels
- Mining Lease Boundary

FIGURE 1.1

Locality Plan

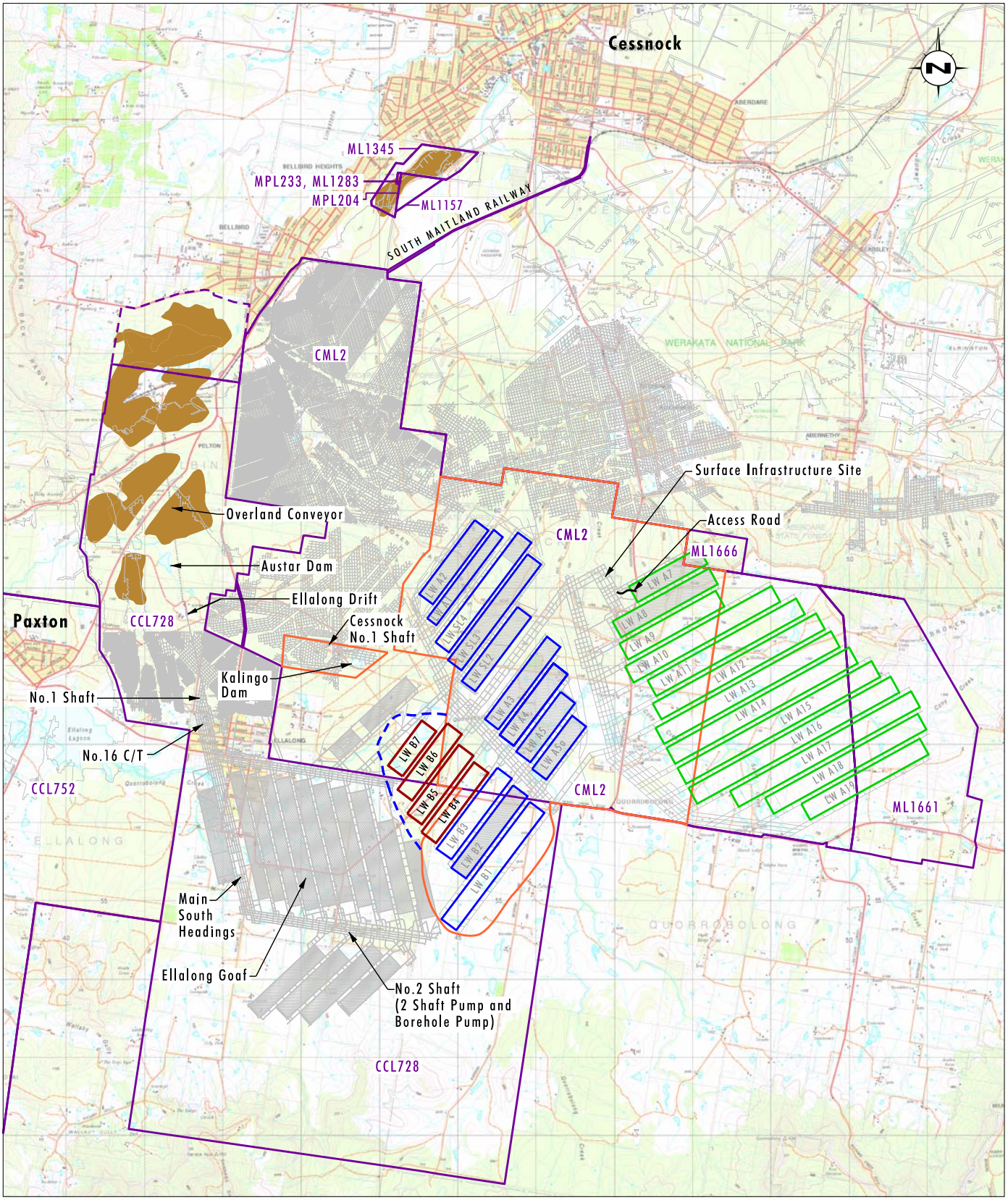

Image Source: LPI NSW (2009)
Data Source: Austar Coal Mine (2016)

0 1 2 3 km
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

File Name (A4): R04/Appendix2/3900_069.dgn
20170424 12.06

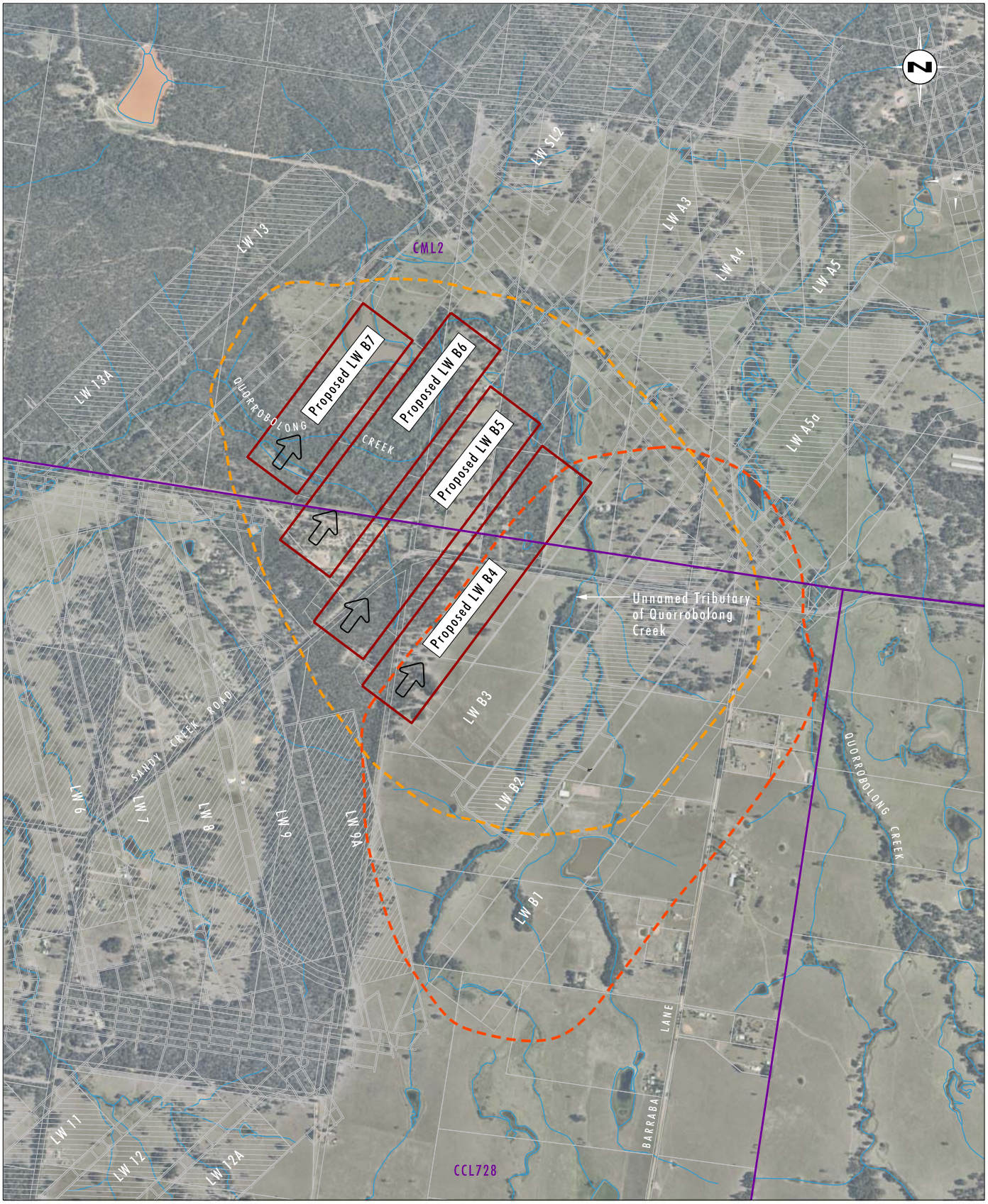

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2016)

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1:20 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area (Proposed)
- LWB1-B3 Modification Area
- Mining Lease Boundary
- Completed Underground Workings
- Direction of Mining
- Drainage Line

FIGURE 1.3

Proposed LWB4-B7 Modification

1.3 Purpose of Assessment

This report has been prepared in conjunction with, and is appended to, the ACHAR as part of the EA to support an application to modify the Bellbird South Consent. The purpose of this report is to provide evidence of the previously recorded and identified material traces of past Aboriginal occupation and land use. This report is provided as a standalone document but is appended to the corresponding ACHAR and provides an assessment of the Aboriginal archaeology to assist in informing the broader assessment of Aboriginal cultural heritage.

This report provides the following information in support of the ACHAR and in accordance with the Code of Practice (DECCW 2010):

- provide an assessment of the environmental and archaeological background of the modification area and wider region (Requirements 1a-b, 2 and 3 of the Code of Practice, refer to **Sections 2** and **3**)
- develop an archaeological predictive model for the modification area (Requirement 4, refer to **Section 3**)
- provide a detailed archaeological assessment methodology (Requirements 5a-c, refer to **Section 4**)
- report on the results of the archaeological survey of the modification area (Requirements 5a-c, 6-10, refer to **Section 5**)
- assess the impact of the proposed modification on Aboriginal archaeological sites and/or areas of Aboriginal archaeological potential (Requirement 11, refer to **Section 7**)
- develop appropriate management and mitigation measures (Requirement 11, refer to **Section 8**)
- provide recommendations as to all further archaeological and consultation requirements (Requirement 11, refer to **Section 8**).

1.4 Aboriginal Party Consultation

Consultation with Aboriginal parties forms a key component of any archaeological assessment. The ACHAR documents consultation in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010).

1.5 Report Structure

Table 1.1 below outlines the structure of this report.

Table 1.1. Report Structure

Report Section	Section outcomes
Executive Summary	Provides a plain English summary of the report.
Section 1	Provides information on the modification and the contents of this report.
Section 2	Summarises the environmental background of the modification area.
Section 3	Summarises the Aboriginal archaeological of the modification area, including an archaeological predictive model.
Section 4	Outlines assessment methodology.
Section 5	Provides the results of the survey of the modification area
Section 6	Provides an assessment of the archaeological significance of the modification area.
Section 7	Assesses the potential impact of the modification to the identified Aboriginal archaeological sites and areas of potential.
Section 8	Provides recommendations as part of the management of the archaeological resource.
Section 9	Is a list of references used within this report.
Attachment 1	AHIMS search results (basic)
Attachment 2	Plates

1.6 Legislation

Key legislation relating to the management of Aboriginal cultural heritage for the proposal is reviewed in Section 1.2 of the ACHAR.

1.7 Project Team

This Aboriginal Cultural Heritage and Archaeological Assessment was completed by Nicola Roche (Manager Cultural Heritage, BA Hons.) with support from Joshua Madden (Senior Archaeologist, BA Hons.). Both Nicola and Joshua meet the minimum qualifications to undertake assessments of this kind, as referenced in Section 1.6 of the Code of Practice (DECCW 2010).

Input from Aboriginal parties is as acknowledged in the relevant sections of this report. Field surveys were undertaken by Nicola Roche, Joshua Madden and Aboriginal party representatives as discussed in **Section 5.0**.

2.0 Environmental Context

The decisions that people make regarding such things as where they live, the range of resources they use and other aspects of daily life may be influenced by the environment in which they live. The preservation and visibility of sites is also affected by environmental factors such as vegetation cover, past land-use and disturbance. A review of the environmental context of the LWB4-B7 Modification Area is therefore integral to considerations of site visibility, preservation and occurrence within the modification area.

This section provides a summary of available literature for the LWB4-B7 Modification Area, within a local and regional context. This section also discusses the implications for the archaeological evaluation of the LWB4-B7 Modification Area.

2.1 Geology and Soils

The LWB4-B7 Modification Area is located within the Quorrobolong Valley, between the Broken Back Range and the Myall Range; approximately 1.5 kilometres east of the town of Ellalong and 4 kilometres south of the town of Kitchener (as shown in **Figure 1.1**). This area lies within the Central Lowlands of the Hunter Valley, one of the nine sub-regions of the Hunter Valley defined by the CSIRO (Story 1963) and is part of the larger Sydney Basin Bioregion defined by NPWS (2007).

The Austar Coal Mine is located in the South Maitland Coalfield of the Maitland Group. Throughout the Maitland Group, marine sandstones and siltstones occur, extending from the coal measures to the ground surface (HLA 1995). The LWB4-B7 Modification Area is situated along the southern extent of the Permian Branxton geological formation, with parent material consisting primarily of siltstone, sandstone, mudstone and conglomerate (Kovac and Lawrie 1991). Based on the geological description of mudstones within this formation, it is unlikely that they were of a quality suitable for the manufacture of stone artefacts (with the mudstone typically referenced in archaeological sites better technically described as an indurated rhyolitic tuff). It is possible that raw materials suitable for artefact manufacture may have been present as pebbles/cobbles within conglomerates. In addition, should sandstone outcrop within the LWB4-B7 Modification Area, it may be possible that site types such as grinding grooves or engravings may occur.

The LWB4-B7 Modification Area is underlain by the Quorrobolong Soil Landscape. Typical soil profiles vary with landform, as described in Table 2.1**Table 2.1**Table 2.1 Quorrobolong Soil Landscape Summary (from Kovac and Lawrie 1991)

(refer to Kovac and Lawrie 1991). Based on the information provided in this table, it is clear that soils within the modification area are typically relatively shallow. These soils are typically moderately erodible (Kovac and Lawrie 1991). Topsoil pH ranges between 5.5 and 6.5, and acid topsoil problems are encountered throughout the area (Kovac and Lawrie 1991:109).

Table 2.1 Quorrobolong Soil Landscape Summary (from Kovac and Lawrie 1991)

Landform	A1 soil horizon	A2 soil horizon	B soil horizon	Typical topsoil depth
Lower slopes	Dark brown to black sandy loam, clay loam or silty clay loam		Greyish brown, brown or dark brown sandy clay, yellowish brown at depth	Up to 40cm
	Brown to dark reddish brown light sandy clay loam	Brown loam with orange mottling	Orange or grey mottled medium clay	Up to 40cm
	Dark brown clay loam	Dull yellow orange sandy clay loam	Yellowish brown sandy clay	Up to 25cm
Higher slopes	Dull yellow brown/brown sandy loam	Dull yellow orange bleached sandy loam	Yellowish brown or brown medium to heavy clay	Up to 50cm
Crests	Dark brown loam	Bleached dull brown sandy loam	Brown medium clay with yellow mottling	Up to 20cm

2.2 Landforms

The majority of the LWB4-B7 Modification Area can be broadly classified as low relief rolling hills bordering Quorrobolong Creek, which is the main watercourse in the modification area. Based on the available topographic information, provisional landform mapping was undertaken within the LWB4-B7 Modification Area, as shown in **Figure 2.1**.

Within the LWB4-B7 Modification Area, Quorrobolong Creek is a 5th-6th order drainage line. Quorrobolong Creek is an ephemeral watercourse with flows only occurring as a result of prolonged or high rainfall periods. Areas of ponding do however occur along its alignment within the modification area. A 4th order unnamed tributary of Quorrobolong Creek flows in a northerly direction through the LWB4-B7 Modification Area above LWB1 to LWB4, converging with Quorrobolong Creek upstream of LWB5. Of these watercourses, Quorrobolong Creek comprises the most reliable source of water and is bordered by relatively broad valley flats formed through alluvial deposition. These flats adjoin slopes of varying inclination and there is the potential that the interface between slope and valley flat landforms could incorporate areas of overlapping colluvial and alluvial deposition, as will be discussed in relation to archaeological implications in **Section 3.2**. Quorrobolong Creek flows into Ellalong Lagoon approximately 3.5 kilometres west of the LWB4-B7 Modification Area, with Ellalong Lagoon comprising the most reliable source of water in the local area.

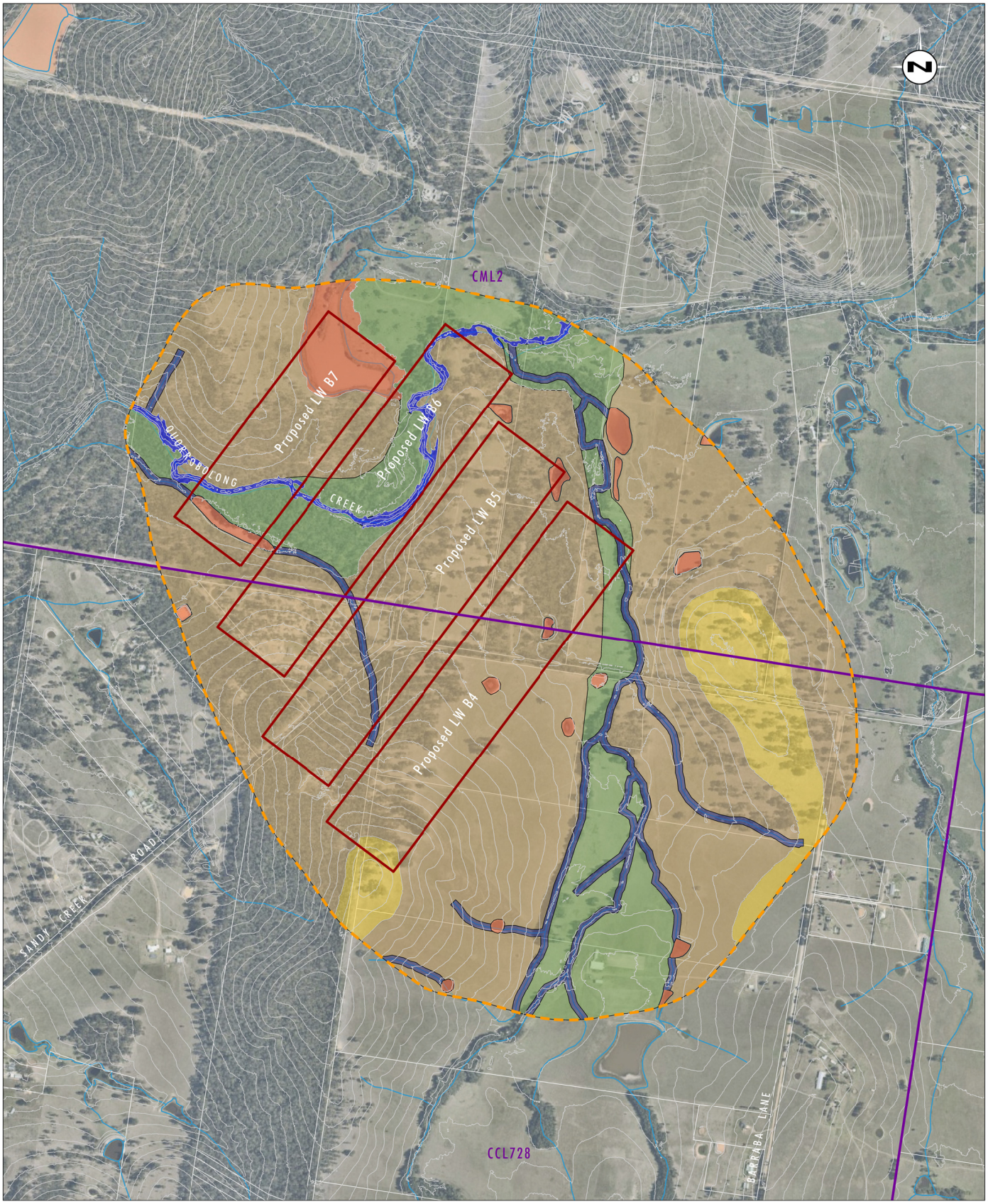

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2017)
Note: Contour Interval 2m

0 250 500 750m
1:15 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area (Proposed)
- Mining Lease Boundary
- Modified (Dam)
- Hill Crest
- Stream Channel (Quorrobolong Creek)
- Drainage Depression
- Valley Flat
- Slopes (Unspecified)

FIGURE 2.1

Preliminary Landform Mapping

2.3 Flora and Fauna

Ecological studies undertaken within the LWB4-B7 Modification Area (Umwelt 2017a:40) identified that the native vegetation communities (excluding cultivated farm land) consist primarily of River Flat Eucalypt Forest (predominantly in the northern portion of the modification area) and Lower Hunter Spotted Gum-Ironbark Forest (predominantly in the southern portion of the modification area), with a small area of potential Quorrobolong Scribbly Gum Woodland in the central portion of the modification area. A range of fauna species have also been identified within and in proximity to the modification area including possums, kangaroos, wallabies, bats, flying foxes, gliders and eagles (Umwelt 2017a:40).

It is however noted that the LWB4-B7 Modification Area has been significantly modified as result of historical land use. These vegetation communities and the range of native fauna currently present within the modification area therefore represent a modified version of the more extensive range of resources that would have been available to Aboriginal people. A list of the plant resources likely to have been available to Aboriginal people (based on current species present in the local area as referenced in Umwelt 2008a) is provided in **Table 2.2**. In addition, it is likely that the modification area would have provided habitat for a broad range of animals including (but by no means limited to) kangaroos, wallabies, wombats, snakes, lizards and birds (including waterbirds targeting the resources along Quorrobolong Creek.

Table 2.2 Flora Species and Known Aboriginal Use

Scientific Name	Name	Known Aboriginal Use	Reference
Acacia sp.	Wattle	Food and economic plant	Australian National Botanic Gardens Education Services 2000
Acacia deanei subsp. *deanei*	Green wattle, Deane's wattle	Food, economic and medicine plant	Gott 1995
Acianthus pusillus	Gnat orchid	Food plant	Flood 1980:94
Allocasuarina sp.	Sheoak	Food and economic plant	Australian National Botanic Gardens 2007
Amyema sp.	Mistletoe	Food and medicinal plant	Flood 1980:94, Zola and Gott 1992:54
Astroloma humifusum	Native cranberry	Food plant	Flood 1980:96
Banksia sp.	Various banksias	Food and economic plant	Australian National Botanic Gardens 2007
Billardiera scandens var. *scandens*	Apple berry	Food plant	Flood 1980:95
Brachychiton populneus subsp. *populneus*	Kurrajong	Food and economic plant	Low 1989: 27; MacDonald and Davidson 1998; Zola & Gott 1992:36

Scientific Name	Name	Known Aboriginal Use	Reference
Bulbine bulbosa	Bulbine lily	Food plant	Flood 1980:94. Zola and Gott 1992:43
Bursaria spinosa var. *spinosa*	Blackthorn	Food and economic plant	Flood 1980:95, Gott 1995
Caladenia sp.	Orchid	Food plant	Zola and Gott 1992:44
Callistemon linearis	Narrow-leaved bottlebrush	Food plant	Australian National Botanic Gardens Education Services 2000
Clematis glycinoides	Headache vine	Food, economic and medicine plant	Zola and Gott 1992:47, Gott 1995, Fraser & McJannett, 1993
Dianella caerulea	Blue flax-lily	Food and Economic Plant	Low 1989: 8
Dianella sp.	Flax lily	Food plant	Australian National Botanic Gardens 2007
Dioscorea sp.	Giant yams	Food plant	Brayshaw 1986:74-75
Dioscorea transversa	Native yam	Food plant	Botanic Gardens Trust 2007
Einadia hastata	Berry saltbush	Food plant	Low 1989: 129
Elaeocarpus obovatus	Hard quandong	Economic plant	Australian National Botanic Gardens Education Services 2000
Eremophila debilis	Amulla	Food plant	MacDonald and Davidson 1998
E. fibrosa spp. *Nubile*	Blue-leafed ironbarks	Economic Plant	MacDonald and Davidson 1998
Eucalypt sp.	Eucalypts	Economic plant	MacDonald and Davidson 1998
		Medicine plant	Australian National Botanic Gardens Education Services 2000
Eucalyptus crebra	Narrow-leaved ironbark	Economic plant	pers. comm. various Aboriginal people from the Dubbo Region (2000) and from AHIMS site card review
Eustrephus latifolius	Wombat berry	Food plant	MacDonald and Davidson 1998
Eucalyptus moluccana	Grey box	Economic plant	MacDonald and Davidson 1998

Scientific Name	Name	Known Aboriginal Use	Reference
Eucalyptus resinifera	Red mahogany	Economic plant	
Exocarpos cupressiformis	Native cherry	Food and economic plant	Brayshaw 1986:74-75. Zola and Gott 1992:48
		Medicinal plant	Watson 2007
Filicopsida sp.	Fern roots	Food plant	Brayshaw 1986:74-75
Gahnia aspera	Rough saw-sedge	Food and economic plant	Low 1989:105; Zola & Gott 1992:60
Geranium solanderi var. *solanderi*	Native geranium	Food and medicinal plant	Flood 1980:95. Zola & Gott 1992:47, 56
Glossodia major	Waxlip orchid	Food plant	Gott 1995
Glossodia minor	Small waxlip orchid	Food plant	Gott 1995
Grevillea montana	Mountain grevillea	Food plant	Low 1989: 171
Hardenbergia violacea	False sarsaparilla	Food plant	Cribb & Cribb 1986:207
Hovea sp.	Hovea	Food plant	Flood 1980:95
Indigofera australis	Australian indigo	Economic plant	Australian National Botanic Gardens 2007
Juncus & Cyperus sp.	Rushes and sedges	Food and/or economic plants	Low 1989:105; Zola & Gott 1992:60
Lomandra sp.	Mat-rush	Food and economic plant	Low 1989: 131, 174; MacDonald and Davidson 1998 Zola & Gott 1992:59
Macrozamia sp.	Macrozamia nuts/seeds	Food plant	Brayshaw 1986:74-75
Macrozamia communis	Burrawang	Food plant	MacDonald and Davidson 1998
Marsilea mutica	Nardoo	Food plant	Flood 1980. Cribb & Cribb 1986 83

Scientific Name	Name	Known Aboriginal Use	Reference
Melaleuca sp.	Melaleuca	Food, economic and medicine plant	ERM 2004:34. Royal Botanic Gardens 2007. Australian National Botanic Gardens Education Services 2000
Ottelia ovalifolia	Swamp lily	Medicinal plant	NSW Department of Education and Training 2007
Pandorea pandorana subsp. *pandorana*	Wonga wonga vine	Economic Plant	Cunningham et al. 1992: 602
Panicum sp.	Grass	Food plant	MacDonald and Davidson 1998
Persoonia linearis	Narrow-leaved geebung	Food plant	Low 1989: 43-44
Pimelea linifolia	Riceflower	Economic plant	Australian National Botanic Gardens 2007
Pterostylis nutans	Nodding greenhood	Food plant	Gott 1995
Rubus parvifolius	Native raspberry	Food plant	Flood 1980:95
Rumex brownii	Swamp dock	Food plant	Low 1989: 28, 30, 153-154
Styphelia triflora	Pink five-corners	Food plant	Low 1989: 43
Themeda australis	Kangaroo grass	Food and medicinal plant	Greenway 1910:16 MacDonald and Davidson 1998 Zola & Gott 1992:58
Triglochin procerum	Water ribbons	Bullet-shaped tubers roasted and eaten	Zola & Gott 1992: 12
Typha sp.	Cumbungi/ bullrush	Economic plant	Australian National Botanic Gardens 2007
Typha orientalis	Broad-leaved cumbungi	Food plant	Gott 2007
Wahlenbergia sp.	Bluebell	Food plant	Fraser and McJannett 1993:65
Xanthorrhoea sp.	Grass tree	Food and economic plant	MacDonald and Davidson 1998

2.4 Past Land Use and Disturbances

As documented in Umwelt (2017b:Section 6.7), the non-Aboriginal history of the Hunter Valley saw major settlement occurring in the Hunter Valley following the completion of Henry Dangar's survey of the region in 1826. Within the region, settlement was initially focused at Wollombi due to the proximity of this town to the key transport route from Sydney to the Hunter Valley. The Cessnock region (including the LWB4-B7 Modification Area) was settled more slowly and was primarily used for pastoral and agricultural purposes (refer to Umwelt 2008b).

The majority of the LWB4-B7 Modification Area was originally within the Barraba Estate, granted in 1834 (refer to Umwelt 2008b). From this time up until the development of the mining industry in the early 1900s, the primary use of the modification area would have been for grazing and potentially for the establishment of crops although given the relatively undulating nature of much of the modification area, it is likely that any areas of cropping would have been discrete and confined to lower slopes bordering watercourses. This land use would have been associated with significant vegetation clearance, the establishment of fencing and other 'general improvements', as required to justify retention of the grant. From the early 1900s, mining commenced within the local area, with the establishment of the Pelton, Ellalong, Bellbird and Southland Collieries resulting in increased activity within the local area, noting that grazing and agriculture remained a key land use.

As a result of the land use history described above, a relatively large proportion of the LWB4-B7 Modification Area has been subject to modification as a result of grazing and agricultural land use, including clearance of large portions of native vegetation and the introduction of pasture grasses, with mining related activity also occurring in the local area. The ongoing clearance of the landscape, the introduction of hard hoofed animals and attempts at water conservation (in the form of construction of dams and works such as contour banks) would have had significant impacts on stream morphology and hydrology. Throughout the Hunter Valley, these changes have resulted in incision of tributary streams and extension of gullies, erosion and sedimentation during major floods, and in some places, increases in water salinity (Dean-Jones and Mitchell 1993:4). Other areas of localised impacts visible within the modification area include a former quarry south of Sandy Creek Road and a number of houses and associated outbuildings (as visible in **Figure 1.3**).

2.5 Summary

A review of available environmental contextual information for the LWB4-B7 Modification Area and surrounds demonstrates that the modification area provided access to Quorrobolong Creek, which, although ephemeral, may have held water for extended periods in pools or ponds. In addition, the review of landforms and soils associated with the modification area identified the potential for alluvial landforms along Quorrobolong Creek that intersect with slope landforms, therefore establishing the potential for colluvial-alluvial interfaces, with the associated potential implications for archaeological site preservation. The LWB4-B7 Modification Area is also relatively well resourced with reference to the plant and animal resources that would have been present in the area prior to non-Aboriginal settlement and landscape modification. However, the modification area and surrounds have been settled for a relatively lengthy period of time and have been subject to a range of impacts. These impacts are likely to be in the form of changes to erosion regimes (following vegetation clearance) and subsequent alterations in the nature and morphology of watercourses. The extent and location of such disturbances has implications for the likely preservation and visibility of archaeological sites, as will be discussed further in **Section 3.0**.

3.0 Aboriginal Archaeological Context

A review of available archaeological information is crucial to the archaeological assessment process, as it informs our understanding of archaeological site patterning, site survival and the potential for detection of extant archaeological sites. This information is discussed with reference to the outcomes of a search of the Aboriginal Heritage Information Management System (AHIMS) database (which documents the location and nature of sites for which site cards have been lodged with OEH) and a summary of the outcomes of previous archaeological investigations in the local area. This information is then considered with reference to key environmental characteristics discussed above to establish a predictive archaeological model for the LWB4-B7 Modification Area.

3.1 Aboriginal Heritage Information Management System

A search of the OEH administered AHIMS database was undertaken on 7 February 2017 (Client Service ID: 265382) for an area of approximately 14 kilometres (east-west) by 11 kilometres (north-south), as bounded by MGA E3384000 – 352341, N6349919 - 6361183. In accordance with requirements, the result of the basic AHIMS search is provided in **Attachment 1**. The results of the extensive AHIMS search are reviewed below and site locations are shown in **Figure 3.1** but individual site coordinates are not provided.

The extensive search identified 84 previously recorded Aboriginal cultural heritage sites and/or objects, of which one is located within the LWB4-B7 Modification Area. **Table 3.1** provides a summary of the sites identified on the AHIMS register. Of these sites, seven are identified as having been destroyed in accordance with an applicable Aboriginal Heritage Impact Permit (AHIP).

Table 3.1 Result of AHIMS searches

Site Type	Site Frequency (#)
Isolated artefact/artefact scatter	52
Art (Pigment or Engraved)	16
Potential Archaeological Deposit (PAD)	7
Scarred tree	2
Art (Pigment or Engraved) with grinding groove and artefacts	1
Art (Pigment or Engraved) with artefacts	1
Isolated artefact/artefact scatter and grinding groove	1
Isolated artefact/artefact scatter and PAD	1
Open Camp Site and midden	1
Grinding Groove	1
Aboriginal Ceremony and Dreaming	1

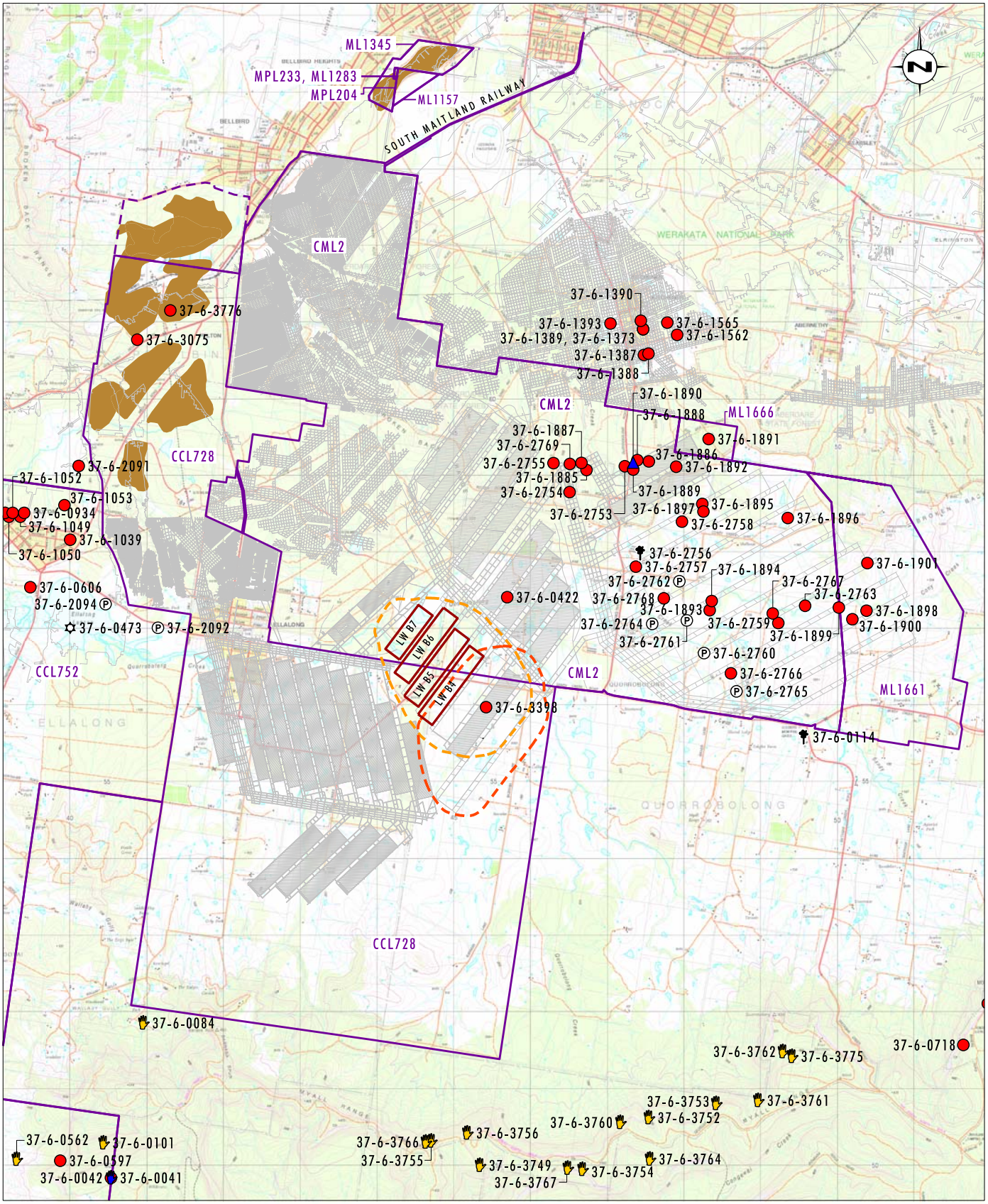

Image Source: LPI NSW (2009)
Data Source: Austar Coal Mine (2016), AHIMS (2017)

0 1 2 3 km
1:70 000

Legend

- Proposed LWB4-B7 Longwall Panels (DA 29/95)
- LWB4-B7 Modification Area (Proposed)
- LWB1-B3 Modification Area
- Approved Reject Emplacement Areas
- Completed Underground Workings
- Mining Lease Boundary
- Austar owned CHPP Land
- Artefact
- PAD
- Artefact/Grinding Groove
- Art
- Aboriginal Ceremony and Dreaming
- Art/Grinding Groove/Artefact
- Modified Tree

FIGURE 3.1

Location of AHIMS Registered Sites

File Name (A4): R04/Appendix2/3900_071.dgn
20170413 16.45

As shown in **Figure 3.1**, there is one site recorded within the LWB4-B7 Modification Area. This site (AHIMS #37-6-3398) is located within the area previously assessed as part of the previous LWB1-B3 Modification, as will be discussed further below.

It is also recognised that the number of sites exhibiting art (typically rockshelters containing art) is relatively high within the context of the Hunter Valley. The majority of these sites are located over 4 kilometres to the south of the LWB4-B7 Modification Area and are concentrated in the elevated sandstone outcrops of the Watagans National Park. The terrain in this area (located to the south) is very different to that within the LWB4-B7 Modification Area.

3.1.1 Previous Archaeological Investigations in the Local Area

Umwelt has undertaken a number of archaeological investigations and due diligence assessments in proximity to the LWB4-B7 Modification Area (refer to Umwelt 2008a; 2008b; 2013; 2015). As part of these previous assessments (primarily Umwelt 2008a), an extensive overview of prior archaeological investigations in the local area including the outcomes of prior studies conducted in the vicinity of the LWB4-B7 Modification Area has been undertaken. The results of this review are summarised in **Table 3.2**.

Table 3.2 Summary of Previous Archaeological Assessments in the vicinity of the modification area (adapted from Umwelt 2008a)

Author	Date	Assessment Type	Assessment Area	Results
Appleton, J.	1993	Survey	Paxton to Bellbird via Ellalong	Survey of 8 km cable route. One site recorded: an isolated find.
McCardle, Cultural Heritage	2005	Desktop	Ellalong to Millfield	Evaluation of pipeline alignment. Footslopes and valley floors with duplex soils may be archaeologically important – interaction between colluvial and alluvial soils can result in the formation of sealed deposits. Site density predicted to be greatest in undisturbed areas with access to concentrated water resources.
Brayshaw	1987	Survey	Southland Colliery (within Austar Mine Complex)	Survey of <100 ha. Two sites recorded: a small artefact scatter (7 artefacts) and one isolated find.
HLA-Envirosciences	1995	Survey	Ellalong Colliery (Austar Stage 1)	Survey of 16 ha area, within 95 ha surface infrastructure areas. One site recorded: an isolated find.

More recently, Aboriginal cultural heritage and archaeological assessments have been conducted in relation to the Austar Coal Mine, including the Stage 3 area (PA08_0111 – refer to Umwelt 2008a, 2011 and 2013) and the LWB1-B3 area (DA 29/95 – refer Umwelt 2015). The location of these assessment areas is shown in **Figure 1.2**, with the LWB1-B3 mining area immediately adjoining and in part overlapping the LWB4-B7 Modification Area. The results of these investigations are discussed below.

3.1.1.1 Stage 3 Area – PA08_0111 (Umwelt 2008a, 2011 and 2013)

Previous investigations in the Stage 3 area (PA08_0111) involved the survey of 1028 hectares (84%) of the approved Stage 3 area and were undertaken in accordance with the relevant legislative standard required at the time of survey. These surveys also took into account the outcomes of consultation with Aboriginal parties and were designed with reference to detailed predictive models, as provided by Umwelt (2008a, 2011, 2013).

The previous surveys were conducted on foot by a field team consisting of up to two archaeologists and representatives from the registered Aboriginal parties. Inspections of key known sites were conducted by all field team members, and survey coverage was determined by the inherent conditions of individual survey transects. In accordance with the requests from the registered Aboriginal parties, the surveys attempted to cover 100 per cent of accessible properties. Survey methodologies, survey coverage details, participation registers, general survey results and any cultural information provided by representatives of the registered Aboriginal parties are detailed in the relevant reports.

These assessments resulted in the identification of 17 sites, comprising isolated artefacts (9), artefact scatters (7) and one site (ACM6) containing a single grinding groove associated with an artefact. Of the artefact scatters, only three sites (ACM14, ACM24, ACM28) contained more than ten artefacts. Artefacts recorded consisted predominantly of flakes and broken flakes, with comparatively smaller numbers of cores and retouched artefacts identified. Silcrete and mudstone were the dominant raw materials, with smaller quantities of quartzite, chert and quartz also present.

ACM6 is located approximately three kilometres north of the modification area and consisted of a single grinding groove on a sandstone conglomerate platform within a first order stream, with a single artefact (mudstone broken flake) located 10 metres north of the groove and within the stream bed. Evidence of historical quarrying works was noted within the rock platform.

In summarising the key outcomes of these assessments, it is noted that all sites containing more than ten artefacts were identified in landforms bordering Cony Creek, including adjacent to a former terrace on Cony Creek (a creek that feeds into Quorrobolong Creek) on a creek flat.

The landforms bordering Cony Creek and Sandy Creek (both of which flow into Quorrobolong Creek) were considered to have higher archaeological potential based on the likely resource availability within these areas when considered with reference to the pattern of site distribution in the local area, although it was acknowledged that these landforms were likely to have been subject to disturbance. Based on the location of sites ACM9, ACM10, ACM14 and ACM16 within these landforms, these sites were assessed as having moderate archaeological potential. In addition, four areas of Potential Archaeological Deposit (PAD) were identified in association with potential terrace landforms bordering Cony Creek. These locations (ACM25, ACM26, ACM29 and ACM30) were assessed as having low to moderate archaeological potential on the basis of their location in a sensitive landforms but recognising that they had been subject to disturbance.

Based on the outcomes of these assessments, it was suggested that the Austar area is archaeologically typified by low site and artefact densities, representing relatively low intensity use of the assessed areas by Aboriginal people (Umwelt 2008a, 2011, 2013).

3.1.1.2 LWB1-B3 Area – DA29/95 (Umwelt 2015)

This assessment was undertaken as part of an application to modify the Bellbird South Consent (DA29/95) to allow the transfer and processing of coal from LWB1-B3. As discussed, this assessment incorporated the southern portion of the LWB4-B7 Modification Area, as shown on **Figure 1.3.** The survey of LWB1-B3 Modification Area was conducted in accordance with a methodology subject to review by Aboriginal parties. The survey resulted in the identification of one Aboriginal site - an artefact scatter (#37-6-3398, ACM35) located on the eastern bank of the unnamed tributary of Quorrobolong Creek above LWB2. It contained two artefacts located adjacent to a vehicle access track in an area subject to periodic inundation. Based on the impact of ongoing erosion within the area, it was assessed as having low archaeological potential.

Umwelt (2015), with reference to information provided by MSEC (2015), identified that due to the depth of mining and the small magnitude of predicted subsidence, the extraction of LWB1-B3 was unlikely to result in surface impacts and recommended that site #37-6-3398 be subject to ongoing monitoring, in accordance with the monitoring provisions in place for other sites within the Austar Coal Mine and defined by the Austar Coal Mine Aboriginal Cultural Heritage Management Plan. The Aboriginal Cultural Heritage Management Plan was updated to incorporate the findings of the LWB1-B3 Modification Aboriginal Cultural Heritage Assessment (refer to Austar 2017).

This assessment was completed in accordance with current assessment standards, was completed in consultation with the registered Aboriginal parties and relates to an activity that is now approved under DA29/95. Consequently, the portion of the modification area included within the current DA29/95 approval area is not subject to re-survey as part of this assessment and the recommendations provided by Umwelt (2015) and included in the current Aboriginal Cultural Heritage Management Plan (Austar 2017) will continue to apply for this assessment.

3.2 Predictive model

Based on the outcomes of the previous archaeological investigations undertaken within the locality (particularly those undertaken within the Austar Coal Mine), a range of extensive predictions have been made and reassessed based on the outcomes of previous assessments (as undertaken in Umwelt 2008a, 2011, 2013). The key aspects of these predictions, with reference to the environmental context of the LWB4-B7 Modification Area, are provided below.

- Artefact scatters and isolated artefacts are the most likely site type to occur within the LWB4-B7 Modification Area. These sites may occur in any landform within the modification area but are most likely to occur in proximity to watercourses (noting that it must be taken into account that watercourse morphology may have been subject to significant change, as will be discussed below). Elevated areas (such as spur crests or ridge crests) that provide access to water resources may also be associated with higher numbers of sites and densities of sites.

- For sites containing stone artefacts, site numbers and artefact densities will typically be relatively low, with the majority of sites likely to contain less than 10 artefacts. However site and artefact densities may increase in proximity to the main channel of Quorrobolong Creek based on the more reliable nature of this watercourse when compared to others within the general locality (with the exception of Ellalong Lagoon).

- While pre-survey landform mapping did not identify any areas of terracing within the LWB4-B7 Modification Area, previous assessments have identified small areas of potential terracing along Cony Creek and the channel of Quorrobolong Creek (outside the LWB4-B7 Modification Area). In addition, it was identified that there is the potential for colluvial/alluvial interfaces within the areas of valley flats

bordering the watercourses, particularly Quorrobolong Creek. Terraces and areas of alluvial-colluvial interface have the potential to contain archaeological deposit at depth, with the subsequent deposition of alluvial and/or colluvial material potentially introducing an element of stratigraphic integrity to any such deposits. Landforms of these types, should they occur within the modification area, may have higher archaeological potential than the surrounding landforms within which deposits have been subject to higher levels of impact and are unlikely to retain stratigraphic integrity.

- Scarred trees may occur in portions of the LWB4-B7 Modification Area where mature native vegetation remains. Based on the land use history of the modification area, the majority of the vegetation may comprise regrowth however consideration should be given to the potential for scarred trees to remain.

- Grinding groove sites (and potentially other sites associated with sandstone such as engraving sites) may occur in the LWB4-B7 Modification Area if suitable sandstone outcrops are exposed within the channel of Quorrobolong Creek and associated watercourses. However, given the relatively sandy nature of much of the soils within the local area, the potential for sandstone outcrops (and therefore sites found on sandstone outcrops) is relatively low.

- Levels of disturbance across the LWB4-B7 Modification Area are likely to have impacted the visibility and integrity of sites that may be present. The extent of these impacts will depend on the nature of the disturbance and the likely depth of any archaeological deposits that may be present.

4.0 Methodology

This section documents the key methodologies underlying the completion of the archaeological component of survey works, including the methodologies used to calculate survey coverage and the criteria applied in consideration of archaeological potential within the LWB4-B7 Modification Area.

4.1 Sampling Strategy

In accordance with the Code of Practice, a survey sampling strategy was developed for the LWB4-B7 Modification Area. This strategy was developed with reference to the environmental and archaeological context of the modification area and the archaeological predictions discussed in **Section 3.2**. The registered Aboriginal parties were consulted regarding the survey strategy, as outlined in Section 3 of the ACHAR.

The survey strategy was designed to ensure that a representative sample of all landforms within the LWB4-B7 Modification Area (comprising approximately 300 hectares) was surveyed. As discussed previously, the southern portion of the LWB4-B7 Modification Area (comprising approximately 140 hectares) has been subject to a previous archaeological survey and assessment (Umwelt 2015) and therefore was excluded from the survey area, leaving a total of approximately 160 hectares subject to the current survey. However, parts of the LWB4-B7 Modification Area are located on privately owned land for which the landholder has refused access. These areas (comprising approximately 25 per cent of the current survey area) were therefore unable to be surveyed however landforms comparable to those within these areas were included within the surveyed area.

Due to the presence of dense vegetation in some portions of the LWB4-B7 Modification Area, it was identified prior to the survey that visibility across much of the area was likely to be relatively low. During the survey, areas of visibility and exposure were targeted in order to obtain maximum benefit from survey effort. Consideration of the potential for additional deposits to be present but not visible was a key component of the survey, as will be discussed further in **Section 4.4**.

4.2 Information recorded during survey

Survey units were defined and named with reference to Requirement 5c of the Code of Practice, including recording track logs for the area walked by each archaeologist within the survey units using a hand-held GPS receiver (set to allow recording of data with datum MGA94) and topographic mapping (where relevant). Start and finish points/boundaries for survey units were defined based on landforms, modification area boundaries and property boundaries. The location of survey transects and the distribution of survey participants across the survey transects was discussed in the field with survey participants. Survey participants were generally spaced between 5-20 metres apart dependent on ground surface visibility, topography and vegetation.

Photographs were taken for landforms/survey units (where informative). Information recorded for each survey unit included:

- landform (in units based on those established by McDonald et al. 2009)
- gradient (where relevant)
- vegetation

- geology and soils (where suitable areas of exposure/visibility are present)
- identified Aboriginal resources
- levels of average ground surface visibility within the survey unit (in accordance with the Requirement 9 of the Code of Practice)
- extent and type of exposures within the survey unit (with reference to the factors leading to the exposure such as erosion, earth-moving activities, track establishment etc.)
- any site or area of identified archaeological potential present within the survey unit.

Aboriginal archaeological sites identified during the survey were assessed with reference to the site boundaries. Factors that were taken into consideration in defining and mapping site boundaries included the distribution of surface artefacts, landforms or physical boundaries and cultural information. Sufficient information was recorded for all sites to meet Requirement 7 of the Code of Practice.

4.3 Survey Coverage

In accordance with the Code of Practice, the survey coverage description includes landform units, the total area surveyed within a landform unit and the quantification of the level of ground surface visibility and exposure. Ground surface visibility is defined as "the amount of bare ground (or visibility) on the exposures which might reveal artefacts or other archaeological materials" (DECCW 2010:13). Exposure is defined as "the percentage of land for which erosion and exposure was sufficient to reveal archaeological material on the surface of the ground" (DECCW 2010:13). As such, exposure refers to the potential for an area to reveal subsurface artefacts or deposits rather than the mere observation of the amount of bare ground.

The calculation of effective survey coverage is undertaken in order to designate the proportion of the modification area in which it is possible to accurately assess the presence or absence of archaeological material. Survey coverage is calculated by multiplying the total survey area by the percentage of ground surface visibility and exposure within the survey unit. The survey coverage is then expressed as a percentage for the whole survey unit.

4.4 Assessment of Subsurface Archaeological Potential

The assessment was undertaken with reference to factors including the archaeological context of the local area, the evaluation of the soil profile (based on soil landscape mapping, exposed soil profiles identified during the survey and geomorphic understandings of the area) and the identification of landforms that may have greater archaeological sensitivity (such as alluvial fans, terraces, colluvial/alluvial interfaces etc.). For the purposes of consistency, the criteria for differing levels of archaeological potential utilises the definitions applied to previous assessments (refer to Umwelt 2011). The following terms will be employed to classify the archaeological potential of specific locations:

- **no archaeological potential**: areas where the natural soil profile has been removed through geomorphic processes or human action, thereby removing any archaeological resource of the location. Examples of this category would include a landslide or industrial quarry sites
- **low archaeological potential**: landscape areas that may have been utilised by Aboriginal people in the past, but at a lower intensity than all surrounding landforms. The density of artefacts deposited within these areas would therefore be low. This category also includes landscape areas of low terrain integrity, where geomorphic processes or human action may have redistributed artefacts from their deposited locations, resulting in site disturbance or destruction

- **moderate archaeological potential**: landscape areas that are predicted to have been utilised by Aboriginal people in the past, but not intensively or repeatedly. There is therefore potential for artefactual deposition, but at a lower frequency and density than in areas of high archaeological potential. Terrain integrity in these areas may be variable, but the majority of open camp sites are expected to be of low to moderate integrity only, with geomorphic processes not acting to bury deposits *in situ*

- **high archaeological potential**: landscape areas predicted to have been intensively or repeatedly utilised by Aboriginal people in the past, such as creek confluences or elevated terraces above major watercourses. Terrain integrity in these areas may be variable, but the majority of open camp sites are expected to be of low to moderate integrity only, with geomorphic processes not acting to bury deposits *in situ*

- **very high archaeological potential**: landscape areas predicted to have been more intensively or repeatedly utilised than all surrounding landforms by Aboriginal people in the past, such as major creek confluences or lagoons. Terrain integrity in these areas may be variable, but these landforms may include areas of high terrain integrity, where geomorphic processes may have acted to bury deposits *in situ*. Sites may therefore be of very high archaeological potential.

5.0 Survey Results

The survey of the LWB4-B7 Modification Area was conducted by Umwelt archaeologists and registered Aboriginal party representatives (accompanied by an Austar representative) on 9 and 10 February and 21 March 2017. Participants in the survey are listed in **Table 5.1**.

Table 5.1 On-site meeting and site visit attendees

Date	Organisation	Name
9/02/17	Austar	Josh Chadwick
	Umwelt	Nicola Roche
	Umwelt	Joshua Madden
	Culturally Aware	Maree Waugh
	Hunter Valley Cultural Surveying	Luke Hickey
	Wattaka Wonnarua	Rod Hickey
	Lower Hunter Wonnarua Consultancy Services	Tom Miller
	Lower Wonnarua Tribal Council	Barry Anderson
	Mindaribba Local Aboriginal Land Council	Jason Brown
	Awabakal Local Aboriginal Land Council	Peter Townsend
	Kawul TA Wonn1	Arthur Fletcher
	Yinarr Cultural Services	Kathy Steward Kinchela
10/02/17	Austar	Josh Chadwick
	Umwelt	Nicola Roche
	Umwelt	Joshua Madden
	Culturally Aware	Maree Waugh
	Hunter Valley Cultural Surveying	Luke Hickey
	Wattaka Wonnarua	Rod Hickey
	Lower Hunter Wonnarua Consultancy Services	Tom Miller
	Lower Wonnarua Tribal Council	Barry Anderson
	Mindaribba Local Aboriginal Land Council	Jason Brown
	Awabakal Local Aboriginal Land Council	Peter Townsend

Date	Organisation	Name
	Kawul TA Wonn1	Arthur Fletcher
21/03/17	Austar	Josh Chadwick
	Umwelt	Nicola Roche
	Tocomwall	Danny Franks

5.1 Description of Survey Transects

The information required to calculate effective coverage for survey units is provided in **Table**. Survey units and tracked survey transects (based on areas walked by archaeologists) are shown in **Figure 5.1** with reference to the identified landforms within the survey unit. This approach is undertaken as a meaningful way of identifying landforms associated with each survey unit. Plates showing views within the identified survey transects are provided as **Attachment 2**. In addition to the information presented in **Table 5.2,** key factors that affect the detectability of sites and the archaeological potential of the survey units are discussed below. The majority of landform mapping within **Figure 5.1** is consistent with the preliminary landform mapping undertaken during the development of the survey methodology, except as discussed below.

5.1.1 Landform variance – Survey Units 2, 8 and 9

Landforms that warrant further discussion include the overflow channel from Quorrobolong Creek within Survey Unit 2 (as shown in **Attachment 2**, Plate 3). This channel is bordered to the south by lower slopes exhibiting A_2 soils subject to sheetwash erosion (within which site ACM38 was identified) and to the north by an area of minor elevation bordering Quorrobolong Creek.

On the northern side of Quorrobolong Creek, this survey unit contained relatively deep alluvial deposits. Within areas of disturbance within the alluvial deposit (resulting from minor excavations undertaken as part of land management activities, as shown in **Attachment 2**, Plate 6), substantial sections of soil profile were exposed. The soil profile in this portion of Survey Unit 2 comprises undifferentiated alluvium up to one metre deep, with no evidence of stratification or the presence of buried soil profiles. On this basis, it is suggested that alluvial deposits in this landform are relatively deep but may be relatively recent (due to the lack of differentiation within the deposit). This landform continues within the adjoining section of Survey Unit 9 where it is bordered by Quorrobolong Creek and a large ponded farm dam water body. Based on the topography of the area, the presence of a former post and rail fence through the deepest section of the water body (as shown in **Attachment 2**, Plate 23) and the presence of visible earthworks, it was identified during the survey that this water body has most likely formed as a result of a former overflow channel of Quorrobolong Creek being dammed at its eastern end (where it formerly would have joined Quorrobolong Creek). Whilst the current water body is significantly larger than the overflow channel would have been prior to modification, the presence of a former overflow channel implies that that water resources may have been accessible outside the main channel of Quorrobolong Creek in this area and in Survey Unit 2.

Table 5.2 Description of Survey Units

Survey Unit	Landforms	Survey unit area (m^2) approx.	Area accessible (m^2) approx.	Visibility %	Exposure %	Effective Coverage (m^2)	Effective Coverage (%)	Sites	Archaeological potential rating	Disturbance factors
1	Gently inclined slopes (modified)	26500	26500	10%	5%	132.5	0.5%	ACM37 ACM40 (partial)	Low	House and outbuildings, dam, vehicle access tracks
2	Gently inclined slopes, overflow channel, Quorrobolong Creek main channel, valley flat	69000	69000	10%	5%	345	0.5%	ACM38 ACM39	Moderate	Vegetation clearance and use for grazing, erosion, vehicle access tracks
3	Gently inclined slopes (modified) bordering Quorrobolong Creek	19000	19000	25%	10%	475	2.5%	ACM40 (partial)	Low	Outbuildings, use for grazing, vehicle access tracks, erosion
4	Predominantly gently inclined slopes, with area of moderate inclination bordering Quorrobolong Creek	30400	30400	10%	5%	152	0.5%	ACM41	Low to moderate	Vegetation clearance and use for grazing, erosion, vehicle access tracks

Survey Unit	Landforms	Survey unit area (m^2) approx.	Area accessible (m^2) approx.	Visibility %	Exposure %	Effective Coverage (m^2)	Effective Coverage (%)	Sites	Archaeological potential rating	Disturbance factors
5	Gently inclined slopes	71000	71000	5%	5%	177.5	0.25	ACM42, ACM43	Low	Vegetation clearance and use for grazing, erosion, vehicle access tracks
6	Gently inclined slopes from minor spur crest	149000	149000	5%	10%	745	0.5%	None	Low	Former area of quarrying (modern) with observed evidence of illegal dumping, vehicle access, vegetation clearance
7	Minor spur crest and moderate to gently inclined slopes	68000	68000	5%	10%	340	0.5%	None	Low	Vegetation clearance and use for grazing, vehicle access tracks
8	Undulating landform with a creek line	442000	442000	10%	5%	2210	0.5%	ACM44, ACM46, ACM47, ACM48, ACM49	Moderate	Vegetation clearance, construction of former motorbike track, installation of powerlines (including service easement), vehicle access tracks

Survey Unit	Landforms	Survey unit area (m^2) approx.	Area accessible (m^2) approx.	Visibility %	Exposure %	Effective Coverage (m^2)	Effective Coverage (%)	Sites	Archaeological potential rating	Disturbance factors
9	Gently inclined slopes, valley flats bordering Quorrobolong Creek and former overflow channel	210000 (of which 37000 is large water body)	173000	5%	5%	432.5	0.25	None	Moderate	Vegetation clearance and use for grazing, vehicle access tracks, damming of former overflow channel
10	Gently inclined slopes	91000	91000	5%	5%	227.5	0.5%	None	Low	House and outbuildings, dam

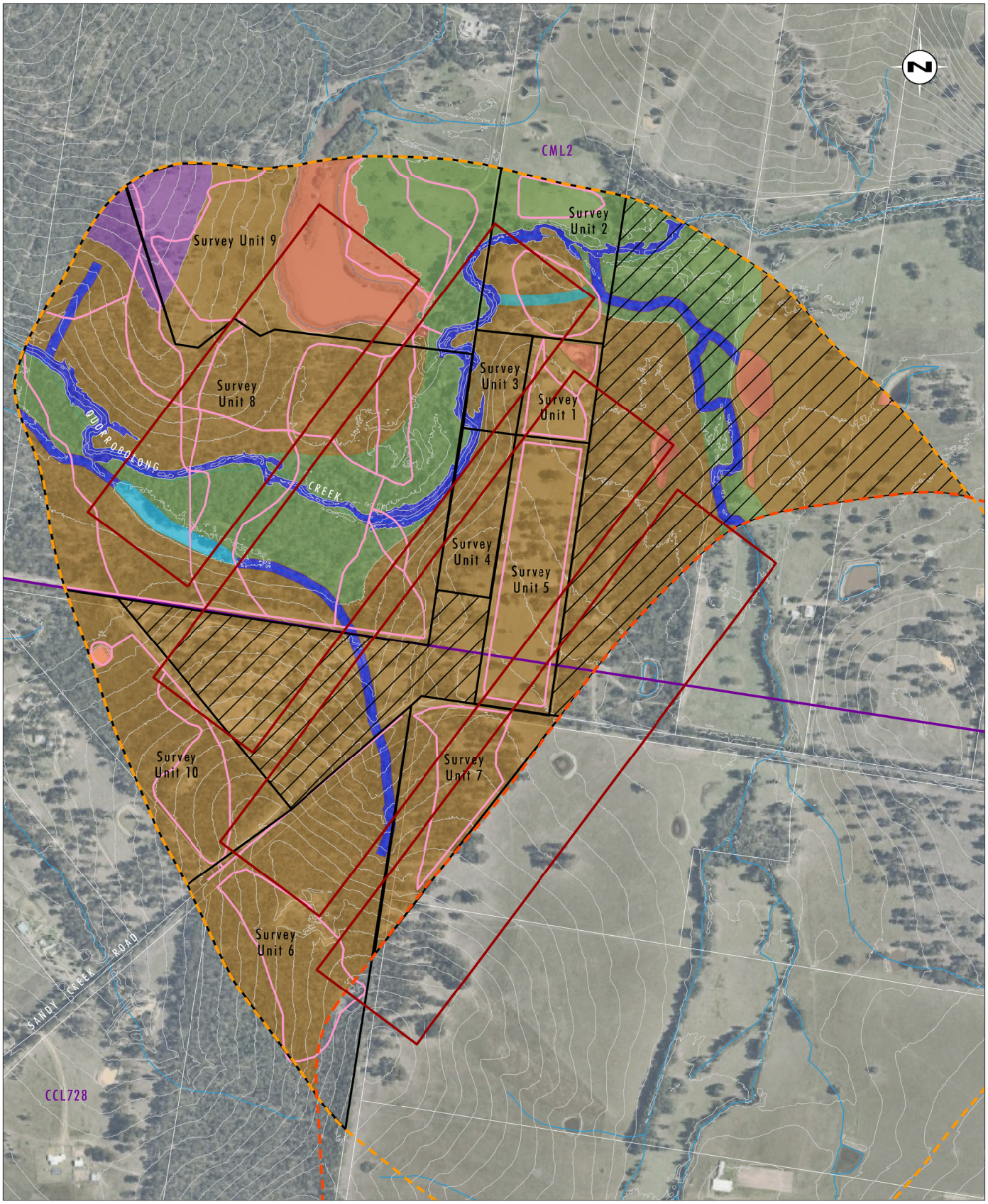

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2017)
Note: Contour Interval 2m

0 100 250 500m
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Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area (Proposed)
- LWB1-B3 Modification Area
- Mining Lease Boundary
- Modified (Dam)
- Hill Crest
- Overflow Channel
- Stream Channel (Quorrobolong Creek)
- Valley Flat
- Slopes (Gently Inclined)
- Minor Spur Crest
- Survey Transect
- Survey Unit
- Area not accessible for survey

FIGURE 5.1

Survey Units

File Name (A4): R04/Appendix2/3900_072.dgn
20170516 13.09

Within Survey Unit 9, visibility within the valley flat landform was relatively limited with no significant exposures other than those in the banks of Quorrobolong Creek (as is discussed further below). It is possible that the extent of valley flat deposits within this survey unit is narrower and more directly confined to the banks of Quorrobolong Creek however a conservative approach has been adopted and the preliminary landform mapping has been retained for assessment purposes.

The minor first order drainage channel south of Quorrobolong Creek within Survey Unit 8 is associated with an area of ponded water, as shown in **Attachment 2**, Plate 19. Based on the topographic mapping and aerial photography, this area was initially mapped as a dam however there was no evidence identified during the survey to indicate that this area has been subject to modification. Rather, there is a higher bank bordering the main channel of Quorrobolong Creek, with the mapped drainage comprising a low-lying area to the south of the creek bank within which water ponds before eventually flowing along a short section of channelling (less than 50 metres in length) into Quorrobolong Creek. This low-lying area is bordered by gently inclined slopes to the south within which significant modification has occurred as part of the former dirt bike activities, as shown in **Attachment 2**, Plate 21.

5.1.2 Quorrobolong Creek

In order to adequately assess the potential for sandstone outcrops to occur in Quorrobolong Creek, the survey strategy was designed to allow adequate access to the main channel of Quorrobolong Creek. Due to the extensive vegetation along the creek, it was not possible to survey along the entire length of the creekline but rather the main channel of the creek was accessed via a number of survey transects (refer to **Figure 5.1**). At these locations, the channel of Quorrobolong Creek was deeply incised into alluvial material, had a sandy base and did not exhibit any exposures of sandstone, as shown in **Attachment 2**, Plate 18. No exposures of sandstone were identified in any other watercourses within the LWB4-B7 Modification Area. A small section of outcropping coarse sandstone (possibly the exposed section of a boulder) was identified in Survey Unit 4 on a section of more steeply inclined slope leading to Quorrobolong Creek. There was no evidence that this sandstone was utilised for grinding and based on erosion patterns, it may only have been exposed as a result of modern erosion.

5.1.3 Effective Coverage

As documented in **Table 5.2**, the overall level of effective coverage within the survey units was low and did not exceed 2.5 per cent in any one survey unit. This reflects the fact that levels of visibility and exposure were typically low across all survey units. This is largely due to the presence of vegetation (grass and/or leaf litter) across the majority of the survey units, which in turn obscured visibility. The exception to this was Survey Unit 3. This survey unit contained holding yards for goats which had been intensively used, resulting in increased visibility and subsequent sheetwash erosion. Levels of exposure within the survey units did not exceed 10% and primarily reflected the effects of sheetwash erosion and the presence of vehicle access tracks.

Due to the low level of effective coverage within the survey units, the assessment of archaeological potential in **Section 5.4** is a key aspect of this assessment of the LWB4-B7 Modification Area. However, despite the low levels of visibility and exposure, archaeological sites were identified within the survey units. These sites are additional to site #37-6-3398 (ACM35), which was previously identified within the LWB4-B7 Modification Area.

5.2 Newly Identified Archaeological Sites

All newly identified archaeological sites within the LWB4-B7 Modification Area consist of artefact scatters or isolated artefacts. A total of 13 new sites were identified, as described below and shown in **Figure 5.2,** with images of sites and artefacts provided in **Attachment 2**. AHIMS site cards have been submitted for all sites in accordance with OEH requirements.

5.2.1 ACM37

ACM37 is an artefact scatter consisting of two artefacts identified at two loci on privately owned land, as described in **Table 5.3**. The artefacts are present within an exposure bordering a small farm dam that includes the overflow channel from the dam leading towards Quorrobolong Creek. The loci within AC37 are 40 metres apart and despite good visibility and consistency of exposure between the loci, no further artefacts were visible. The area has been modified by the construction of the dam and ongoing erosion, resulting in the exposure of B horizon soils within the site area. Based on the absence of additional artefacts despite good visibility, the high level of exposure and the level of disturbance within the site area, it is assessed that the potential for additional artefacts to be present within a sub-surface context is low.

5.2.2 ACM38

ACM38 is an artefact scatter consisting of 37 artefacts identified within an area of approximately 40 metres east-west by 30 metres north-south located on privately owned land. Based on the relatively consistent distribution of artefacts across this area, it was assessed as a single locus centred on MGA 345040 6357110. Individual artefacts within ACM38 are documented in **Table 5.3** and include a broken grindstone and three broken backed flakes**.** Artefacts are manufactured from a range of raw materials, of which silcrete is the most common.

Artefacts within ACM38 are all present within an area of increased visibility and exposure resulting from ongoing sheetwash erosion on a gently inclined lower slope bordering a former overflow channel of Quorrobolong Creek. Exposed soils consist of a compacted and bleached yellowish sandy loam (A_2 soil horizon) overlying a brown to red sandy clay (B horizon). While the depth of A horizon soils within the portion of this landform containing artefacts appears to be relatively shallow, it is considered likely that the remaining portion of the landform (which currently has lower levels of exposure and visibility), has potential for additional artefacts that are currently not visible or exposed. However, the likely limited depth of A horizon soils within the landform dictates that it is unlikely that any such deposits will be extensive or will retain stratigraphic integrity. On this basis, the site boundary is extended to cover the remainder of the landform, which is assessed as having low-moderate archaeological potential, as will be discussed further in **Section 5.4**.

5.2.3 ACM39

ACM39 is an isolated artefact (silcrete flake) located within a small exposure on a small localised rise to the north of the former overflow channel of Quorrobolong Creek and south of the main channel of Quorrobolong Creek on privately owned land. Exposed soils consist of a mid-brown sandy loam (A soil horizon) however based on the limited visibility and exposure, it was not possible to further assess the depth of soil within this landform. The archaeological potential of this landform is further discussed in **Section 5.4.**

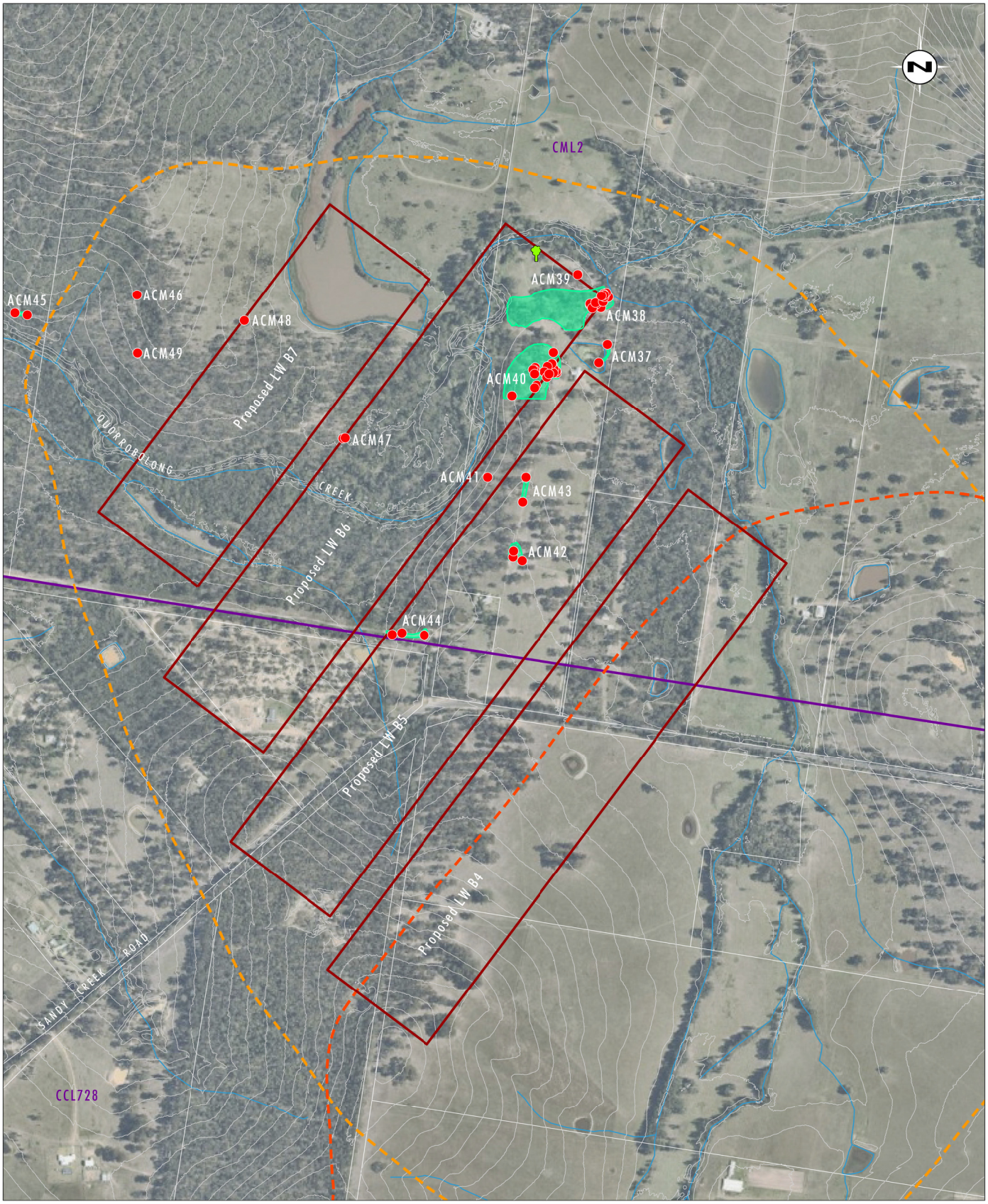

Image Source: Nearmap (2017)
Data Source: Austar Coal Mine (2017)
Note: Contour Interval 2m

0 100 250 500m
1:10 000

Legend

- Proposed LWB4-B7 Longwall Panels
- LWB4-B7 Modification Area (Proposed)
- LWB1-B3 Modification Area
- Mining Lease Boundary
- Archaeological Site Area
- Artefact Location
- Tree with Non-cultural Scarring

FIGURE 5.2

Location of Newly Identified Sites

File Name (A4): R04/Appendix2/3900_073.dgn
20170516 13.10

5.2.4 ACM40

ACM40 is an artefact scatter containing 29 artefacts dispersed across three loci over an area of approximately 40 metres east-west by 25 metres north-south on a gently inclined mid slope landform. Individual artefacts within ACM40 are documented in **Table 5.3** and include two broken backed flakes. Artefacts are manufactured from a range of raw materials of which mudstone and silcrete are the most common.

The site is located on privately owned land within fenced yards used for grazing goats and has been subject to significant disturbance as a result of construction of outbuildings, vehicle traffic and ongoing sheetwash erosion due to grazing and trampling by goats. The majority of artefacts are located in a large locus centred on MGA 344935 6356985, with this area exhibiting the greatest amount of exposure. The additional two loci are also within areas of minor exposure. Exposed soils consist of a very thin layer of yellow-brown sandy loam (A_2 soil horizon) overlying a brown to red sandy clay (B horizon).

Based on the identification of relatively high numbers of artefacts in areas of enhanced visibility and exposure, it is assessed that additional artefacts may be present within the adjoining sections of the mid slope landform. On this basis, the site boundary is extended to cover the remainder of the landform, which is assessed as having low-moderate archaeological potential (outside disturbed exposures), as will be discussed further in **Section 5.4**.

5.2.5 ACM41

ACM41 is an isolated artefact (quartzite flake) in an area of low visibility and exposure on a very gently inclined slope approximately 30 metres from Quorrobolong Creek. The archaeological potential of the landform containing this artefact will be discussed further in **Section 5.4** however based on limited nature of the visible evidence; site boundaries have not been extended.

5.2.6 ACM42

ACM42 is an artefact scatter containing four artefacts in an area of exposure associated with a vehicle track on a gently inclined slope approximately 150 metres from the main channel of Quorrobolong Creek. The site has been subject to significant disturbance as a result of vehicle traffic, grazing and trampling by goats and ongoing sheetwash erosion. Exposed soils consist of a very thin layer of yellow-brown sandy loam (A_2 soil horizon) overlying a brown to red sandy clay (B horizon).

The site boundary has been established to include the recorded artefacts. Based on the absence of additional artefacts within the adjoining portions of the landform (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

5.2.7 ACM43

ACM43 is an artefact scatter containing four artefacts in a vehicle track exposure on a gently inclined slope approximately 100 metres from the main channel of Quorrobolong Creek. The artefacts include a broken cobble that exhibits evidence of grinding on one surface and is a possible muller (top grindstone).

The site has been subject to significant disturbance as a result of establishment and use of the vehicle track. Exposed soils consist of a very thin layer of yellow-brown sandy loam (A_2 soil horizon) overlying a brown to red sandy clay (B horizon).

As with ACM42, the site boundary has been established to include the recorded artefacts. Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

5.2.8 ACM44

ACM44 is an artefact scatter containing four artefacts (including a broken retouched flake) located in a vehicle track exposure within a powerline easement on a gently inclined slope approximately 200 metres from the main channel of Quorrobolong Creek and 100 metres from the ephemeral drainage line containing the area of ponding.

The site has been subject to significant disturbance as a result of establishment and use of the vehicle track and the associated establishment of powerlines. Exposed soils consist of a very thin layer of yellow-brown sandy loam (A_2 soil horizon) overlying a yellow-brown sandy clay (B horizon).

As with ACM42 and ACM43, the site boundary has been established to include the recorded artefacts. Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

5.2.9 ACM45

ACM45 is an artefact scatter located on a vehicle track outside the LWB4-B7 Modification Area. This site was identified whilst attempting to find a suitable location to cross Quorrobolong Creek. The site consists of three artefacts on a lower slope landform approximately 50 metres from the main channel of Quorrobolong Creek. Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

As this site is located outside the LWB4-B7 Modification Area, it is not subject to further consideration in this report.

5.2.10 ACM46

ACM46 is an isolated artefact (mudstone flake) located on a vehicle track on a gently-moderately inclined section of slope leading to the minor spur crest on the northern border of the modification area. The track has been heavily eroded, with a very thin layer of sandy loam overlying B horizon soils.

Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

5.2.11 ACM47

ACM47 is an artefact scatter containing three artefacts within a vehicle track on a lower slope approximately 100 metres from the main channel of Quorrobolong Creek. The site has been subject to disturbance as a result of establishment and use of the vehicle track. Exposed soils consist of a very thin layer of bleached and compacted yellow-brown sandy loam (A_2 soil horizon).

The site boundary has been established to include the recorded artefacts. Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

5.2.12 ACM48

ACM48 is an isolated artefact (silcrete flake) in an area of low visibility and exposure on a gently inclined section of slope leading to the minor spur crest on the northern border of the modification area. The archaeological potential of the landform containing this artefact will be discussed further in **Section 5.4** however based on limited nature of the visible evidence; site boundaries have not been extended.

5.2.13 ACM49

ACM49 is an isolated artefact (silcrete flaked piece) located on a vehicle track on a gently inclined section of slope approximately 100 metres from the main channel of Quorrobolong Creek. The track has been heavily eroded, with a very thin layer of sandy loam overlying B horizon soils.

Based on the absence of additional artefacts within the adjoining portions of the vehicle track (despite comparable levels of visibility and exposure) and the relatively thin nature of A horizon soils, it is assessed that it is unlikely that this site is associated with sub-surface deposits and it is assessed as having low archaeological potential.

Table 5.3 Artefacts within newly identified sites

Site Name	Locus	E_MGA	N_MGA	Raw material	Artefact class
ACM37	1	345058	6357038	Mudstone	Flake
	2	345042	6357004	Quartz	Flake
ACM38		345046	6357107	Sandstone	Broken grindstone
		345051	6357120	Quartz	Flake
		345051	6357120	Silcrete	Broken flake
		345031	6357114	Tuff	Flake
		345026	6357112	Silcrete	Broken flake
		345026	6357114	Silcrete	Broken backed flake
		345036	6357112	Mudstone	Broken flake

Site Name	Locus	E_MGA	N_MGA	Raw material	Artefact class
		345044	6357118	Silcrete	Broken flake
		345041	6357119	Silcrete	Broken flake
		345041	6357119	Silcrete	Broken flake
		345041	6357119	Silcrete	Flake
		345041	6357117	Mudstone	Flake
		345037	6357113	Mudstone	Flake
		345037	6357113	Silcrete	Broken flake
		345030	6357106	Silcrete	Broken flake
		345036	6357116	Silcrete	Broken backed flake
		345050	6357118	Silcrete	Broken backed flake
		345060	6357127	Mudstone	Flake
		345056	6357135	Quartz	Broken flake
		345052	6357127	Silcrete	Flaked piece
		345051	6357133	Silcrete	Heat shatter
		345052	6357131	Mudstone	Flake
		345047	6357129	Quartz	Flake
		345047	6357129	Silcrete	Flaked piece
		345047	6357129	Quartz	Flake
		345047	6357129	Silcrete	Broken flake
		345047	6357129	Silcrete	Flake
ACM39		345003	6357169	Silcrete	Flake
ACM40	1	344958	6357023	Mudstone	Broken backed flake
		344958	6357023	Quartz	Broken flake
	2	344956	6357002	Silcrete	Broken flake
		344950	6356998	Quartz	Flaked piece
		344950	6356998	Mudstone	Flake

Site Name	Locus	E_MGA	N_MGA	Raw material	Artefact class
		344950	6356998	Silcrete	Flake
		344948	6356994	Silcrete	Flake
		344948	6356994	Mudstone	Broken flake
		344950	6356983	Mudstone	Flake
		344964	6356985	Mudstone	Retouched flake
		344963	6356988	Silcrete	Broken backed flake
		344963	6356988	Mudstone	Flake
		344963	6356988	Silcrete	Flake
		344963	6356988	Chert	Broken flake
		344959	6356992	Quartzite	Flake
		344959	6356992	Mudstone	Broken flake
		344958	6356985	Silcrete	Broken flake
		344955	6357002	Quartz	Flake
		344955	6357002	Silcrete	Broken flake
		344947	6356997	Silcrete	Broken flake
		344941	6356987	Mudstone	Broken flake
		344923	6356995	Mudstone	Flake
		344946	6356977	Quartzite	Flake
		344922	6356990	Mudstone	Broken flake
		344919	6356991	Silcrete	Broken flake
		344922	6356983	Petrified wood	Retouched flake
		344926	6356962	Mudstone	Flake
		344922	6356957	Quartz	Flake
	3	344880	6356942	Quartz	Core
ACM41		344835	6356790	Quartz	Flake
ACM42	1	344899	6356634	Quartzite	Flake

Site Name	Locus	E_MGA	N_MGA	Raw material	Artefact class
	2	344882	6356641	Quartzite	Broken flake
		344882	6356641	Silcrete	Broken flake
	3	344883	6356652	Quartzite	Core
ACM43	1	344900	6356744	Unknown	Grindstone (muller)
		344900	6356744	Silcrete	Retouched flake
		344900	6356744	Silcrete	Broken flake
	2	344906	6356790	Silcrete	Broken flake
ACM44	1	344675	6356500	Silcrete	Retouched flake
	2	344657	6356497	Quartzite	Broken flake
	3	344717	6356496	FGS	Broken retouched flake
ACM45	1	343977	6357093	Mudstone	Retouched flake
		343977	6357093	Silcrete	Broken flake
	2	343954	6357097	Silcrete	Broken flake
ACM46		344182	6357131	Mudstone	Flake
ACM47	1	344566	6356862	Mudstone	Broken flake
	2	344570	6356863	Silcrete	Broken flake
	3	344570	6356863	Silcrete	Broken flake
ACM48		344382	6357083	Silcrete	Flake
ACM49		344183	6357022	Silcrete	Flaked piece

5.3 Tree exhibiting scarring

During the survey, a large living red gum exhibiting two large scars was identified on the bank of Quorrobolong Creek at MGA 344925 6357211. One scar is located approximately two metres from the base of the tree, is not symmetrical in shape and exhibits uneven scar margins, as shown in **Attachment 2**, Plate 56. Based on the lack of symmetry to the scar, the uneven margins, the height of the scar on the tree and the presence of another minor scar higher up the tree that had resulted from limb tear, this scar is considered highly unlikely to be of Aboriginal cultural origin. This conclusion was discussed and agreed with Aboriginal party representatives present during survey.

The second scar on the tree is generally symmetrical (sub-ovoid) in shape, is located approximately 3.5 metres from the base on the tree, exhibits an estimated 15-20 centimetres of callus regrowth (not measurable due to height from ground surface) and is approximately 1.5-2 metres in length by 0.8 metres in width (refer to **Attachment 2**, Plate 57). No evidence of scarring associated with the cutting of footholds was present on the tree trunk below the scar and there were no disconformities (such as burls) that would render the section of the tree trunk accessible from the ground unsuitable for use. This scar exhibits some characteristics associated with Aboriginal scarred trees (namely that it is a suitable species, is a mature tree, has a scar that is symmetrical and is relatively old based on the extent of callus regrowth). However, the scar is located a considerable distance off the ground surface, meaning that if it was made by an Aboriginal person, he or she would have been required to climb up to 5-5.5 metres to reach the top of the scar. The absence of footmarks in the tree truck indicates that this climbing would have been done by some other means (which is not unknown within accounts of Aboriginal scarring practices). In contrast the tree trunk immediately below the scar and directly accessible from the ground does not exhibit any evidence that it would have been unsuitable for use. In addition, the tree exhibits other clear evidence of damage from limb tears.

Based on the available evidence, this scar does not present sufficient evidence to warrant the recording of the tree as an archaeological site. This conclusion was discussed with the Aboriginal party representatives present during survey. Several of the Aboriginal party representatives indicated that they felt that the scar may be of cultural origin and requested that the above information be included within the report.

5.4 Assessment of Archaeological Potential

As discussed throughout this section, levels of visibility and exposure within the LWB4-B7 Modification Area were low. This fact, along with the presence of landforms within which artefactual deposits may be present at considerable depth and not detectible during survey, dictates that it is critical to consider the archaeological potential of the LWB4-B7 Modification Area with reference to the criteria established in **Section 4.4**.

The valley flat landforms that adjoin Quorrobolong Creek within the modification area include areas containing alluvial deposits that may extend deeper than 1.5 metres (particularly within Survey Unit 9) and it is anticipated that alluvial deposits (of varying depth) may be present within these landforms. Based on the nature of alluvial deposition, it is possible that archaeological deposits may be capped by subsequent layers of alluvial material, potentially resulting in the formation of stratified or partially stratified deposits (should artefacts be present) below depths of current disturbance and recent alluvium deposition.

The valley flat landforms also provide direct access to Quorrobolong Creek and its current and past overflow channels. Aboriginal people using these areas would have had access to water resources within Quorrobolong Creek, with the potential that water was retained within pools along this watercourse for considerable periods of time following rain. However, it is recognised that Ellalong Lagoon (which is and would have been a permanent or near permanent source of water and associated animal and plant resources) is located within 3-4 kilometres of the modification area and is likely to have been the focus of occupation in the local area. On this basis, the valley flat landforms bordering the main channel of Quorrobolong Creek are assessed as having moderate archaeological potential. It is noted that this excludes the valley flat landforms bordering the unnamed tributary of Quorrobolong Creek within the LWB1-B3 modification area as these have been previously assessed as having low archaeological potential (Umwelt 2015).

The slopes within 100 metres of the main channel of Quorrobolong Creek and the overflow channels identified in this assessment provide a similar resource context to the valley flats. In addition, the minor spur crest with Survey Unit 2 provides similar access to water resources (within overflow channel) with an excellent vantage point. However, A horizon soils within these landforms have been subject to substantial

erosion, therefore reducing the potential that any artefacts that may be present will be in their original depositional context. Thus while additional artefactual deposits may be present, the level of integrity and intactness within any such deposits is likely to be low. These landforms (including sites ACM38, ACM39 and ACM40) are therefore assessed as having low to moderate potential.

The remaining portions of the LWB4-B7 Modification Area are assessed as having low archaeological potential due to the levels of disturbance, lack of access to suitable water resources and the skeletal nature of A horizon deposits.

5.5 Discussion

The survey of the LWB4-B7 Modification Area comprised pedestrian survey in accordance with the sampling strategy. During the survey, it was noted that the modification area has been subject to a range of disturbance factors associated with historical land use however the potential for deep alluvial soils to exist in areas along Quorrobolong Creek was identified. A total of 13 new sites were identified, of which one is located outside the LWB4-B7 Modification Area. These sites consisted of isolated artefacts and artefact scatters, with only two sites (ACM38 and ACM40) containing more than five artefacts. The distribution and contents of these sites is relatively comparable to the outcomes of previous archaeological investigations within the Austar Coal Mine and surrounds, as documented in **Section 3.0**. No grinding grooves or scarred trees were identified within the LWB4-B7 Modification Area and no areas of outcropping sandstone were present within Quorrobolong Creek.

Based on the criteria for the assessment of archaeological potential, the majority of the LWB4-B7 Modification Area has low archaeological. The exceptions to this are the valley flats bordering Quorrobolong Creek (moderate potential), slopes within 100 metres of the main channel of Quorrobolong Creek and identified overflow channels and the spur crest in Survey Unit 9 (all of which have low to moderate archaeological potential).

6.0 Scientific Value Significance Assessment

The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance (Australia ICOMOS 2013) (the Burra Charter) defines cultural significance as the sum of the qualities or values that a place embodies. The Burra Charter identifies the values – aesthetic, historic, archaeological, social or cultural and spiritual – that contribute to cultural significance.

- **Aesthetic** value refers to the sensory and perceptual experience of a place. It may consider form, scale, texture and material of the fabric or landscape and may also include smell and sounds associated with the place (OEH 2011:9).

- **Historic** value encompasses all aspects of history and as such is often underlying other values. A place may have historic value because it has influenced, or been influenced by, an historic event, phase, movement or activity, person or group of people.

- **Archaeological** value refers to the potential physical remains and the ability of those remains to provide an understanding about an aspect of the past.

- **Social** or **cultural** value refers to the spiritual, traditional, historical and contemporary associations and attachments of a place (OEH 2011:8). It is noted that a consensus as to the cultural value of an object or place is not always possible as people experience places and events differently.

- **Spiritual** value refers to the intangible values embodied in a place, which give it importance in the spiritual identity.

In accordance with the Code of Practice and the Burra Charter, this section assesses the archaeological significance of the LWB4-B7 Modification Area only. The ACHAR, to which this report is appended, addresses the cultural significance of the LWB4-B7 Modification Area.

6.1 Archaeological Significance Assessment

Archaeological significance is determined by the assessment against a number of archaeological criteria as set out by the OEH in the Code of Practice, with the key criteria for the assessment of archaeological assessment outlined in below.

Table 6.1 Criteria for the Assessment of Archaeological Significance

Criterion	Low	Moderate	High
Rarity	The site within the surrounding landscape, its integrity, contents and/or potential for subsurface artefacts, are common within the local and regional context.	The site within the surrounding landscape, its integrity, contents and/or potential for subsurface artefacts, are common within the local context but not the regional context.	The site within the surrounding landscape, its integrity, contents and/or potential for subsurface artefacts, are rare within the local and regional context.
Representativeness	This site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts is common within a local and regional context and sites of similar nature (or in better condition) are already set aside for conservation within the region.	This site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts, is uncommon within a local context but common in a regional context and sites of similar nature (or in better condition) are already set aside for conservation within the region.	This site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts is uncommon within a local and regional context and sites of similar nature (or in better condition) are not already set aside for conservation within the locality or region.
Research potential	The site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts has limited potential to contribute to a greater understanding of how Aboriginal people lived within this area or region.	The site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts has moderate potential to contribute to a greater understanding of how Aboriginal people lived within this area or region.	The site, when viewed in relation to its integrity, contents and/or potential for subsurface artefacts has high potential to contribute to a greater understanding of how Aboriginal people lived within this area or region.

Criterion	Low	Moderate	High
Education potential	The site is not readily accessible and/or when viewed in relation to its contents, integrity and location in the landscape has limited suitability to be used for educational purposes. Other sites with higher education potential are known to be present in the local area and region.	The site is not readily accessible and/or when viewed in relation to its contents, integrity and location in the landscape provides a tangible example that is suitable to assist in educating people regarding how Aboriginal people lived in this area or region. However, other sites with higher education potential are known or expected to be present in the local area or region.	The site is readily accessible and/or when viewed in relation to its contents, integrity and location in the landscape, provides a very good tangible example that is suitable to assist in educating people regarding how Aboriginal people lived in this area or region. Other sites of higher education potential are generally not known to exist in the local area or region.
Integrity	Stratigraphic integrity of the site has clearly been destroyed due to major disturbance/loss of topsoil. The level of disturbance is likely to have removed all spatial and chronological information.	The site appears to have been subject to moderate levels of disturbance, however, there is a moderate possibility that useful spatial information can still be obtained from subsurface investigation of the site, even if it is unlikely that any useful chronological evidence survives.	The site appears relatively undisturbed and there is a high possibility that useful spatial information can still be obtained from subsurface investigation of the site, even if it is still unlikely that any useful chronological evidence survives.

6.1.1 Assessment of Archaeological Significance

The assessment of archaeological significance for all sites within the LWB4-B7 Modification Area is presented in **Table 6.2**. To provide context to this assessment, all sites identified within the LWB4-B7 Modification Area are within landscape contexts and have contents that are common within the local context and are represented at other locations within the Austar Coal Mine. Consequently, all sites have low value for rarity and representativeness. This has some flow on effect for educational value. In addition, all sites other than ACM38 and ACM40 contain less than five artefacts. ACM38 and ACM40, while containing slightly higher numbers of artefacts, are located on privately owned land with no public access. All sites are therefore assessed as having low educational potential.

In terms of research potential, ACM38 and ACM40 are identified as having potential to be associated with additional sub-surface deposits however the extent of disturbance within these sites is such that it is unlikely that these deposits will retain stratigraphic integrity. These sites are therefore assessed to have low-moderate potential to contribute to our understanding of how Aboriginal people lived in this area.

On this basis, all sites within the LWB4-B7 Modification Area are assessed as having low archaeological significance, with the exception of ACM38 and ACM40, which have low to moderate significance.

Table 6.2 Assessment of Archaeological Significance

Site	Rarity	Representativeness	Research Potential	Education Potential	Integrity	Overall
ACM35[1]	Low	Low	Low	Low	Low	Low
ACM37	Low	Low	Low	Low	Low	Low
ACM38	Low	Low	Low-moderate	Low	Low	Low-moderate
ACM39	Low	Low	Low	Low	Low	Low
ACM40	Low	Low	Low-moderate	Low	Low	Low-moderate
ACM41	Low	Low	Low	Low	Low	Low
ACM42	Low	Low	Low	Low	Low	Low
ACM43	Low	Low	Low	Low	Low	Low
ACM44	Low	Low	Low	Low	Low	Low
ACM46	Low	Low	Low	Low	Low	Low
ACM47	Low	Low	Low	Low	Low	Low
ACM48	Low	Low	Low	Low	Low	Low
ACM49	Low	Low	Low	Low	Low	Low

[1] Site identified and assessed by Umwelt (2015)

The assessment of significance for areas of archaeological potential (within which there are no visible Aboriginal objects) is inherently difficult as any such assessment can only be based on the nature of the evidence that the area may contain. For this reason, the assessment of significance of areas of archaeological potential remains a provisional assessment of potential significance only and is linked almost entirely to the research potential of the site. That is, areas of moderate archaeological potential have a provisional assessment of moderate archaeological significance, with areas of low-moderate potential having low to moderate significance.

7.0 Impact Assessment

The purpose of this section is to identify whether there is risk of harm to the identified Aboriginal sites within the LWB4-B7 Modification Area.

7.1 Subsidence Predictions

The maximum predicted subsidence parameters for all identified Aboriginal archaeological sites within the LWB4-B7 Modification Area have been determined by MSEC (2017) and are summarised in **Table 7.1**. The values presented in **Table 7.1** represent the maximum cumulative subsidence associated with the extraction of approved LWB1-B3 and proposed LWB4-B7.

Table 7.1 Maximum predicted subsidence parameters for Aboriginal archaeological sites within the LWB4-B7 Modification Area

Longwall	Max. Predicted Total Subsidence (mm)	Max. Predicted Total Tilt (mm/m)	Max. Predicted Total Hogging Curvature (km^{-1})	Max. Predicted Total Sagging Curvature (km^{-1})
After LWB4	125	1.5	0.03	<0.01
After LWB5	400	3.0	0.03	0.01
After LWB6	1025	3.5	0.03	0.04
After LWB7	1225	4.5	0.04	0.04

The subsidence predictions outlined in **Table 7.1** for the LWB4-B7 Modification Area are less than those for the previously approved Stage 2 and Stage 3 mining areas, where there has been no significant or visible surface cracking observed and no requirement for remediation of any ground surface cracking.

7.2 Potential Impacts of the Proposed Modification

The LWB4-B7 Modification does not involve any additional surface development and therefore will have no direct impact on archaeological sites as a result of land clearing or disturbance. The potential impacts of the proposed modification on archaeological sites are therefore limited to indirect impacts associated with subsidence, including potential surface cracking, subsidence remediation works or hydrological changes.

7.2.1 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 metres, 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 mining areas, where there has been no significant or visible surface cracking above previously extracted longwalls A3 to A8 or LWB2.

Any surface cracking that does occur is expected to be minor and isolated and unlikely to directly or adversely impact the Aboriginal archaeological sites or areas of archaeological potential identified within the LWB4-B7 Modification Area. 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.

7.2.2 Hydrological Changes

Flood modelling has been undertaken by Umwelt (2017c) to assess the potential 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 not result in scouring or increased erosion of the landscape. The assessment predicts minor changes to remnant ponding around some existing flow paths and farm dams. These minor changes to the extent of remnant ponding occur within low lying areas that are already subject to periodic inundation during periods of high rainfall. Therefore additional periods of inundation in these locations are highly unlikely to result in any additional impact to Aboriginal archaeological sites or areas of archaeological potential that may be present.

7.2.3 Summary

Based on the outcomes of assessments undertaken by MSEC (2017) and Umwelt (2017c), the proposed LWB4-B7 Modification is unlikely to result in direct or indirect impacts to the identified archaeological sites or on the identified areas of low-moderate or higher archaeological potential.

8.0 Recommendations

The following recommendations have been developed in light of the archaeological context of the LWB4-B7 Modification Area; the findings of the current survey and the previous survey of the LWB1-B3 Modification Area; the low likelihood of impact of the proposed modification on identified archaeological sites and areas of archaeological potential and current cultural heritage legislation.

- The Austar Coal Mine should continue to implement the management strategies currently in place at the Austar Coal Mine, including those in the Austar Aboriginal Cultural Heritage Management Plan (ACHMP). Consistent with existing management strategies, in the unlikely event that subsidence remediation works are required that will impact on the identified sites or areas of low-moderate or higher archaeological potential, an Aboriginal Heritage Impact Permit (AHIP) will be sought for the portion of the site or area of potential to be impacted prior to the commencement of any remediation works in proximity to the recorded site or area of potential (noting that, in some instances, it may be necessary to undertake test excavation to inform the requirement for an AHIP). Appropriate mitigation measures for the site or area of potential to be impacted by the remediation works will be developed as part of the AHIP application process in consultation with the registered Aboriginal parties and in accordance with OEH requirements. The ACHMP includes provision for pre and post subsidence monitoring of recorded sites to provide comparative data on site condition and to allow for the identification of any unexpected subsidence impacts.

- The Austar ACHMP should be reviewed to incorporate the outcomes of this assessment and to include provisions for the monitoring of identified archaeological sites within the LWB4-B7 Modification Area in accordance with the management strategies currently implemented within the Austar Coal Mine.

9.0 References

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