Austar Coal Mine

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ENVIRONMENTAL ASSESSMENT

Proposed Stage 2 Extension Project

JULY 2010

Umwelt
Environmental Consultants

Proposed Stage 2 Extension Project Environmental Assessment

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Austar Coal Mine Pty Ltd

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Report No.	2274/R56/FINAL	Date:	July 2010

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Executive Summary

Austar Coal Mine Pty Ltd (Austar) operates the former Ellalong, Southland and Bellbird South Collieries which are now named the Austar Coal Mine. These operations, including coal extraction, handling, processing and transport, collectively form the Austar Mining Complex. The underground mining component within Stage 2 of the Austar Mining Complex is currently being undertaken within Consolidated Mining Lease 2 (CML2) under development consent DA 29/95. DA 29/95 was granted by the Minister for Urban Affairs and Planning in 1996, enabling coal extraction from the Greta Seam using a conventional retreat longwall extraction method to a height of up to 4.5 metres. DA 29/95 has been modified on two occasions to enable extraction of up to 6.5 metres of coal from the Stage 1 and Stage 2 areas respectively using an enhanced form of conventional retreat longwall extraction known as Longwall Top Coal Caving (LTCC). A third modification to DA 29/95 was made in 2009 to alter the widths of longwalls and chain pillars in the Stage 2 area. A separate project approval has been granted enabling longwall mining using LTCC technology in the Stage 3 area and construction and operation of a new Surface Infrastructure Site and access road south-west of Kitchener.

To enable sufficient time to complete construction of the ventilation shaft at the Surface Infrastructure Site prior to the commencement of longwall mining in the Stage 3 area, Austar proposes to extract one additional longwall adjacent to the Stage 2 mining area. The additional longwall is known as Longwall A5a (LW A5a) and is located within the DA 29/95 approval area. In order to maximise coal resource recovery in LW A5a, Austar seeks a modification to DA 29/95 to:

- increase the maximum allowable extraction height of coal within the area to be mined by LW A5a from 4.5 metres to 6.5 metres; and
- undertake coal extraction in LW A5a using LTCC technology.

It is proposed that the same extraction equipment as is currently being used within the Stage 2 area will be used to undertake extraction in LW A5a.

The proposal set out above is a logical extension of the approved LTCC extraction of the Stage 2 area, and is referred to as the ‘Stage 2 Extension Project’ throughout this Environmental Assessment (EA). Environmental impacts of the Stage 2 Extension Project have been assessed within the 20 mm incremental subsidence contour for LW A5a. This area is referred to as the ‘Stage 2 Extension Study Area’ throughout this EA.

Extraction of the additional longwall panel is required to enable sufficient time for the completion of Surface Infrastructure Site construction prior to the commencement of longwall mining in the Stage 3 area. This extraction will make efficient use of the location of longwall equipment and mining infrastructure at the end of mining of the Stage 2 longwalls. Austar seeks a modification of DA 29/95 to use LTCC technology in the Stage 2 Extension Area to enable optimal recovery of the coal resource in accordance with the principles of ecologically sustainable development. The principal advantage of the LTCC mining method is that it allows for the optimal recovery of coal resource in the up to 7 metre thick Greta Coal Seam which is at depths of over 500 metres in the Stage 2 Extension Study Area. Through use of LTCC technology, approximately 60% more coal per unit of energy used can be extracted than by using conventional longwall mining equipment. This will also result in increased economic return for the State of New South Wales and Austar.

In achieving the increased level of recovery the LTCC method addresses a key principle of ecologically sustainable development that requires the optimising of the value of the recovery of natural resources.

Environmental Risk Assessment

An environmental risk assessment was undertaken for the Stage 2 Extension Project to review the potential environmental hazards associated with the Stage 2 Extension Project and determine what controls are required to reduce or eliminate any identified hazards to tolerable levels as far as practicable. The risk assessment was used as a screening process to determine which environmental aspects require further detailed impact assessment. The background information for the project upon which the risk assessment was based is provided in **Sections 2** to **5**, and the results of the environmental risk assessment are provided in **Section 6**. Detailed assessments of environmental aspects identified as requiring further impact assessment during the risk assessment are outlined in **Section 7** and summarised below.

An ongoing community consultation program is being undertaken by Austar regarding the Stage 2 Extension Project. The key issues raised by the community to date have been incorporated into the detailed assessments of environmental aspects set out in **Section 7** and summarised below.

Subsidence Impacts

A detailed subsidence impact assessment for the Stage 2 Extension Project has been undertaken by MSEC (2009). The assessment has been based on an Incremental Profile Method (IPM) model that has been calibrated using site specific subsidence information recorded from former mining of the Greta Coal Seam and the Branxton Formation. The data set spans several decades of subsidence monitoring. IPM modelling by MSEC (2009) has been used to produce subsidence predictions for the Maximum Predicted subsidence and Upper Bound subsidence. Maximum Predicted subsidence represents the maximum level of subsidence predicted using the IPM subsidence model that has been calibrated using measured subsidence specific to the Greta seam and Branxton Formation geology. The Upper Bound subsidence predictions have been developed for risk assessment purposes and are based on subsidence equivalent to 65% of the effective extracted seam thickness. MSEC (2007) has stated that based on the height of chain pillar, the longwall void configuration and the massive nature of the Branxton Formation that maximum Upper Bound subsidence is unlikely to be more than 50% of the effective extracted seam thickness rather than the 65% that has been adopted by MSEC (2007).

Subsidence predictions prepared by MSEC for the Stage 2 Extension Project are within the envelope of those set out in the 1995 EIS and approved in DA 29/95. The subsidence predictions indicate that all buildings and structures within the area of subsidence resulting from the Stage 2 Extension Project will remain within Safe Serviceable and Repairable criteria. Detailed assessment of infrastructure within the Stage 2 Extension Study Area including farm dams, access roads, tanks, swimming pools, tennis courts, fences, electricity and telecommunication services has been undertaken and indicates that subsidence impacts on this infrastructure will be within acceptable levels and will be readily manageable. Similarly, subsidence predictions indicate that mining will not have a significant impact on land use in the area.

New Subsidence Management Plans (SMPs) and new Property Subsidence Management Plans (PSMPs) or updates to existing PSMPs, providing details of specific management and monitoring activities on a property by property basis will be prepared in consultation with relevant government agencies and land holders prior to longwall extraction for the Stage 2 Extension Project.

Vibration

A vibration impact assessment for the Stage 2 Extension Project has been undertaken by Umwelt based on data collected by Austar using vibration monitors in the Stage 2 mining area, the subsidence impact assessment undertaken by MSEC and the original vibration assessment undertaken for the Bellbird South Colliery Environmental Impact Statement (EIS) by Renzo Tonin and Associates (Renzo Tonin, 1995). Monitoring undertaken within the Stage 2 area to date indicates that a number of minor vibration events have occurred as a result of mining within the Stage 2 area. These events have not been large enough to result in any significant structural impact to residences within the Stage 2 mining area. The range of vibration experienced in the Stage 2 area to date has been within the envelope of that set out in the Bellbird South Colliery EIS and approved under DA 29/95. On this basis it is considered that mining using LTCC technology for the Stage 2 Extension Project is unlikely to result in vibration impacts in excess of those already approved under DA 29/95.

Vibration from the Stage 2 Extension Project will be monitored via an extension of the existing Austar Stage 2 Vibration Monitoring Program (Austar, 2009). Any damage to structures as a result of the Stage 2 Extension Project will be managed in the same manner as damage to structures as a result of subsidence.

Surface Water and Groundwater

To assess the potential impacts of the Stage 2 Extension Project on flooding and drainage, a detailed flooding and drainage assessment was undertaken by Umwelt. The assessment builds on the previous flooding and drainage assessments undertaken for the Stage 2 and Stage 3 areas (Umwelt, 2007 and Umwelt, 2008) which examine the potential impacts of the flooding and drainage regime of Quorrobolong Creek and its tributaries as a result of mining within the Stage 2 and Stage 3 mining areas respectively.

The flooding and drainage assessment was undertaken using an RMA-2 flood model of the Quorrobolong Valley to investigate the impacts of the Stage 2 Extension Project on flooding and drainage for maximum predicted and upper bound subsidence cases, including its cumulative impact taking into account mining as a part of Stages 2 and 3 of the Austar Coal Mine.

The flooding and drainage assessment indicates that:

- the changes to the 100 year ARI flood event as a result of the predicted subsidence of LW A5a will only marginally increase the flood extent and will not increase flood hazard categories at dwellings or along access tracks within the Quorrobolong Valley;
- maximum velocities will remain within non-scouring levels for both the 100 year and 1 year ARI storm events following the Stage 2 Extension Project and as a result no significant changes due to velocity induced scouring or erosion are predicted;
- the Stage 2 Extension Project will not have a significant impact on the flow regime of the Cony Creek and Quorrobolong Creek systems and there is minimal potential for channel realignment to occur; and
- the potential for mining to result in stream capture within these creek systems is also considered negligible predominantly due to the depth of cover and the strength and thickness of the underlying Branxton Formation.

Drainage line monitoring within the Stage 2 Extension Study Area will be undertaken as an extension to the existing Stage 2 Ecological Monitoring Program to monitor for any unforeseen or unpredicted impacts.

Analysis of the existing groundwater regime and geology of the area, undertaken by Connell Wagner (2007) indicates that the potential for vertically interconnected cracking to extend from the mining goaf (resulting from longwall extraction) to the surface is negligible.

Due to the geomorphology of the area, including broad and relatively shallow valleys and no confined gorges or deep valleys, and the massive structure of the Branxton Formation that extends from the Greta Coal Seam to the surface, the potential for upsidence or valley closure impacts to occur, or to adversely impact on groundwater in the shallow alluvium of the Stage 2 Extension Study Area is considered to be negligible. This is consistent with the findings of MSEC (2009). As a result it is considered that the proposed Stage 2 Extension Project will not adversely impact on groundwater resources in the area.

The existing Stage 2 groundwater monitoring program will continue to be utilised throughout the Stage 2 Extension Project.

Energy and Greenhouse Gas

Energy and Greenhouse Gas assessments for the Austar Mine Complex have been undertaken using available data from longwall mining in the Stage 1 area. Analysis of longwall mining using LTCC technology in the Stage 1 area indicates that in a 6.5 metre thick coal seam, mining of coal using the LTCC equipment can extract approximately 60% more coal per unit of energy used, than could be extracted using conventional longwall mining equipment. This makes the LTCC method considerably more energy efficient than conventional longwall mining techniques.

With less energy required per tonne of coal extracted compared to conventional longwall mining techniques, the LTCC method of coal extraction results in less greenhouse gas being produced in the generation of the energy required to extract coal. As a result, extraction the coal resource in LW A5a using LTCC techniques will result in significant energy and greenhouse gas savings compared to if the resource was extracted using conventional longwall mining techniques.

Heritage

European and non-European heritage assessments were undertaken in the Stage 2 Extension Study Area as a part of the original EIS for Ellalong Colliery – Extension into Bellbird South (HLA 1995a and HLA 1995b). Based on a desktop review of these assessments, there is potential that both surface and subsurface Aboriginal heritage sites are located within the Stage 2 Extension Study Area. Subsidence impact assessment and flood modelling indicates that surface impacts of subsidence will be minor and readily manageable, and that surface drainage remediation works are not likely to be required, and therefore disturbance to any surface or subsurface Aboriginal heritage sites as a result of the Stage 2 Extension Project is unlikely.

No European heritage sites were identified in the Stage 2 Extension Study Area.

Ecology

An Ecological Assessment of the Stage 2 Extension Study Area was undertaken by Umwelt to determine the potential impacts of the Stage 2 Extension Project on the ecological values of the area. Results of the assessment indicate that the potential impacts on ecological values as a result of subsidence associated with the Stage 2 Extension Project are likely to be low and will be manageable.

The existing Stage 2 Ecological Monitoring Program will be updated to include additional monitoring sites for the Stage 2 Extension Project to document the condition of riparian and other significant vegetation communities throughout the life of the Stage 2 Extension Project.

Socio-Economics

The Stage 2 Extension Project will provide additional economic benefit to the State of NSW by:

- providing continuity between underground mining in the Stage 2 and Stage 3 areas while construction of the upcast and downcast shafts at the Stage 3 Surface Infrastructure Site is completed, resulting in continuity of employment for 200 people;
- maximising the recovery of coal resource from the DA 29/95 approval area through the use of LTCC technology, which will enable recovery of up to 70% more coal than could otherwise be recovered using conventional longwall mining methods; and
- minimising energy usage and greenhouse gas emissions per tonne of coal resource extracted as discussed above.

An assessment of the subsidence impacts for properties, built features and natural features within the Stage 2 Extension Project is provided in **Section 7**. As the subsidence impacts of the Stage 2 Extension Project are within the envelope of those set out in the 1995 EIS and approved in DA 29/95, additional socio-economic impact on residents and landholders above and beyond what was originally approved under DA 29/95 is considered unlikely.

TABLE OF CONTENTS

FIGURES

APPENDICES

Submission of
environmental assessment (EA)
under Section 75H of the Environmental Planning and Assessment Act 1979

EA prepared by	
Name:	Catherine Pepper
Qualifications:	BE (Env) Hons, BA
Address:	Umwelt (Australia) Pty Limited PO Box 838 Toronto 2283
in respect of	Austar Coal Mine Stage 2 Extension Project
Applicant Name	Austar Coal Mine Pty Ltd
Applicant Address	Middle Road, Paxton NSW 2325
Land to be developed: lot no, DP/MPS, vol/fol etc	See attached Schedule of Lands
Proposed Development	Austar Coal Mine Stage 2 Extension Project
Environmental assessment	An environmental assessment (EA) is attached

Certification

I certify that I have prepared the contents of this environmental assessment and to the best of my knowledge

- it is in accordance with Sections 75E and 75F of the *Environmental Planning and Assessment Act 1979*, and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Signature: [signature]
Name: Catherine Pepper
Date: 28 July 2010

Attachment A
Austar Coal Mine – Land Details for Stage 2 Extension Properties

Lot 21 DP 1052169
Lot 1 DP 819222
Lot 2 DP 819222
Lot 11 DP 866231
Lot 12 DP 866231
Lot 13 Alt DP 866231
Lot 100 Alt DP 255530
Lot 104 DP 255530
Lot 796 DP 804896
Lot 2 DP 828916
Lot 91 DP1064579
Consolidated Mining Lease 2

Properties are also shown on Figure 5.5 of the Environmental Assessment.

1.0 Introduction

1.1 Project Overview

Austar Coal Mine Pty Ltd (Austar), a subsidiary of Yancoal Australia Pty Limited (Yancoal), operates 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 mine is an aggregate of the former Ellalong, Pelton, Cessnock No.1 and Bellbird South Collieries and is located in the South Maitland Coalfields. These operations, including coal extraction, handling, processing and transport, collectively form the Austar Mining Complex (see **Figure 1.2**).

The underground mining component within Stage 2 of the Austar Mining Complex is currently being undertaken within Consolidated Mining Lease 2 (CML2) (refer to **Figure 1.1**) under development consent DA 29/95. DA 29/95 was granted by the Minister for Urban Affairs and Planning in 1996, enabling coal extraction from the Greta Seam using a conventional retreat longwall extraction method to a height of up to 4.5 metres. The layout of the conceptual mine plan that formed part of DA 29/95 is shown in **Figure 1.3**.

A modification to DA 29/95 was granted by the Minister for Planning in September 2006 to allow extraction of up to 6.5 metres of coal from two longwall panels (Longwalls A1 and A2) in the Stage 1 area (refer to **Figure 1.1**) using an enhanced form of conventional retreat longwall extraction known as Longwall Top Coal Caving (LTCC). Extraction of coal from Longwalls A1 and A2 (LW A1 and A2) using LTCC technology was completed in November 2008. Further details regarding resource recovery using LTCC technology are provided in **Section 1.2.2**.

A second modification to DA 29/95 was approved by the Minister for Planning in June 2008 to allow extraction of up to 6.5 metres of coal using LTCC technology in the Stage 2 area (see **Figure 1.1**). Stage 2 comprises Longwalls A3 to A5 (LW A3 to A5) and is wholly located within CML2. Mining in the Stage 2 area commenced in early 2009. It is envisaged that mining in the Stage 2 area will be completed early in 2012. The Notice of Modification of DA 29/95 for Stage 2 is provided in **Appendix 1**.

A new project approval was granted by the Minister for Planning in September 2009, enabling longwall mining using LTCC technology in the Stage 3 area and construction and operation of a new Surface Infrastructure Site and access road south-west of Kitchener (refer to **Figure 1.1**). Construction of the Surface Infrastructure Site commenced in December 2009 and will take approximately 36 months to complete. Construction of the ventilation shaft at the Surface Infrastructure Site will take approximately 18 months to complete and must be completed prior to the deployment of three development units in the area by early 2011 thus allowing the commencement of longwall mining in the Stage 3 area without a discontinuity. Current programming indicates that there will be a delay between the completion of mining in the currently approved Stage 2 area and commencement of mining in the Stage 3 area due to the timeframe for construction of the ventilation shaft at the Surface Infrastructure Site.

The remainder of Austar operations utilises Austar's existing coal handling and processing infrastructure and facilities. A description of Austar's existing infrastructure and facilities is provided in **Section 2.3**.

To enable sufficient time to complete construction of the ventilation shaft at the Surface Infrastructure Site prior to the commencement of longwall mining in the Stage 3 area, Austar proposes to mine one additional longwall panel adjacent to Longwall A5. The additional longwall is known as Longwall A5a (LW A5a) and is located within the DA 29/95 approval

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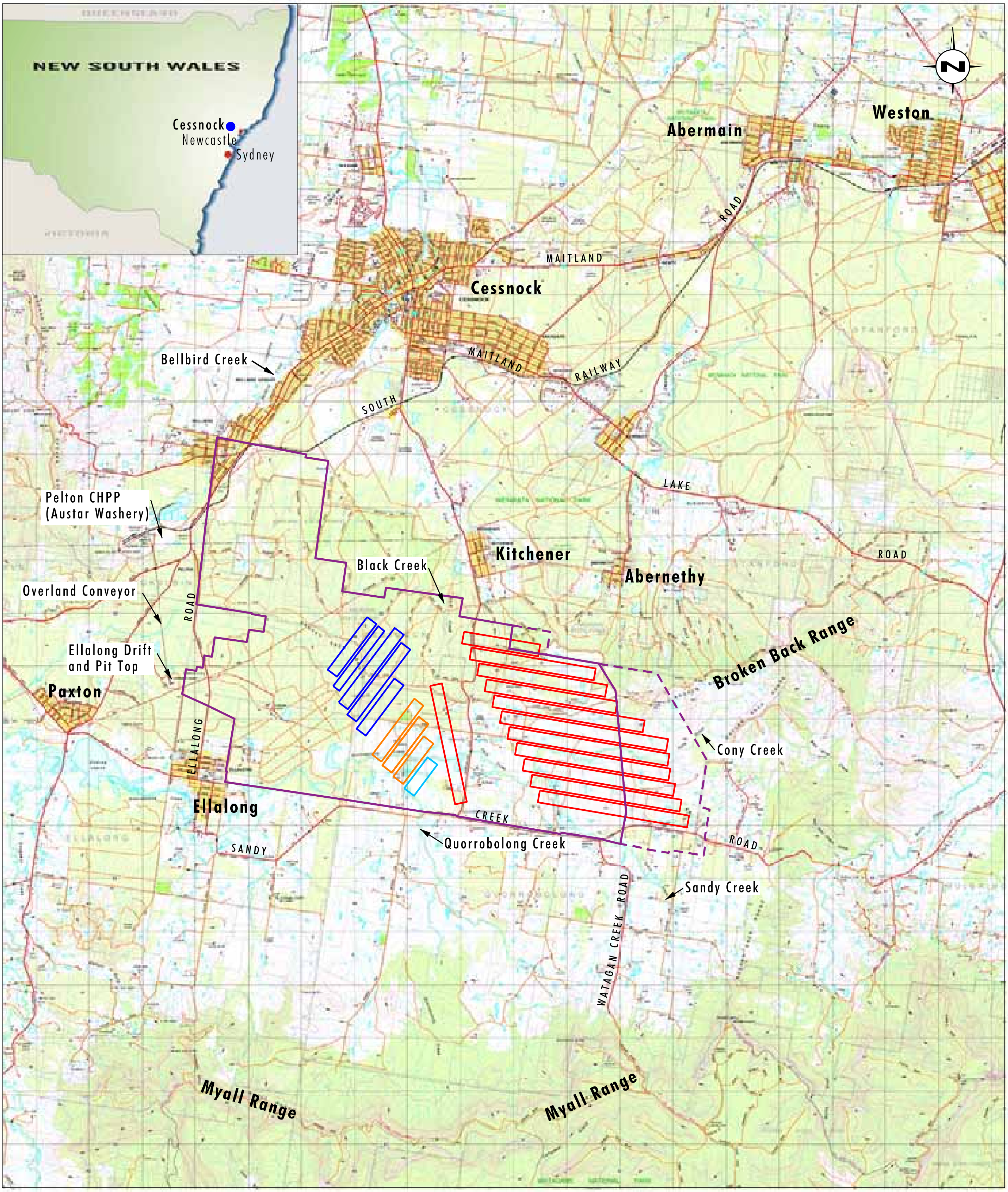

Source: Topo Maps: LPI NSW, Longwall Layout: Austar Coal Mine

0 1.0 2.0 4km
1:100 000

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Conceptual Layout for Stage 3 Longwall Panels
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary

FIGURE 1.1

Locality Plan

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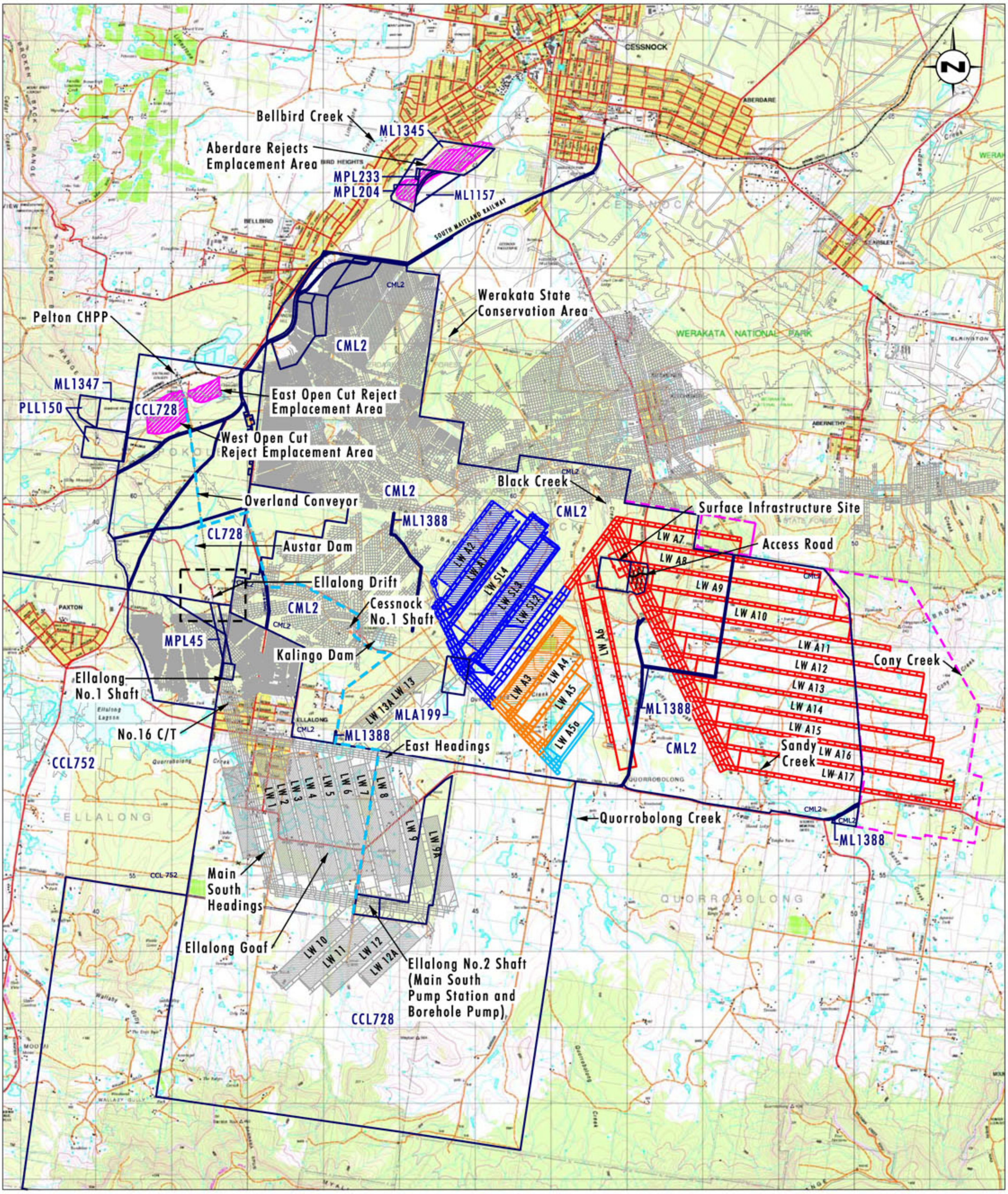


Source: Topo Maps: LPI NSW, Longwall Layouts: Austar Coal Mine

0 1 2 3km
1:70 000

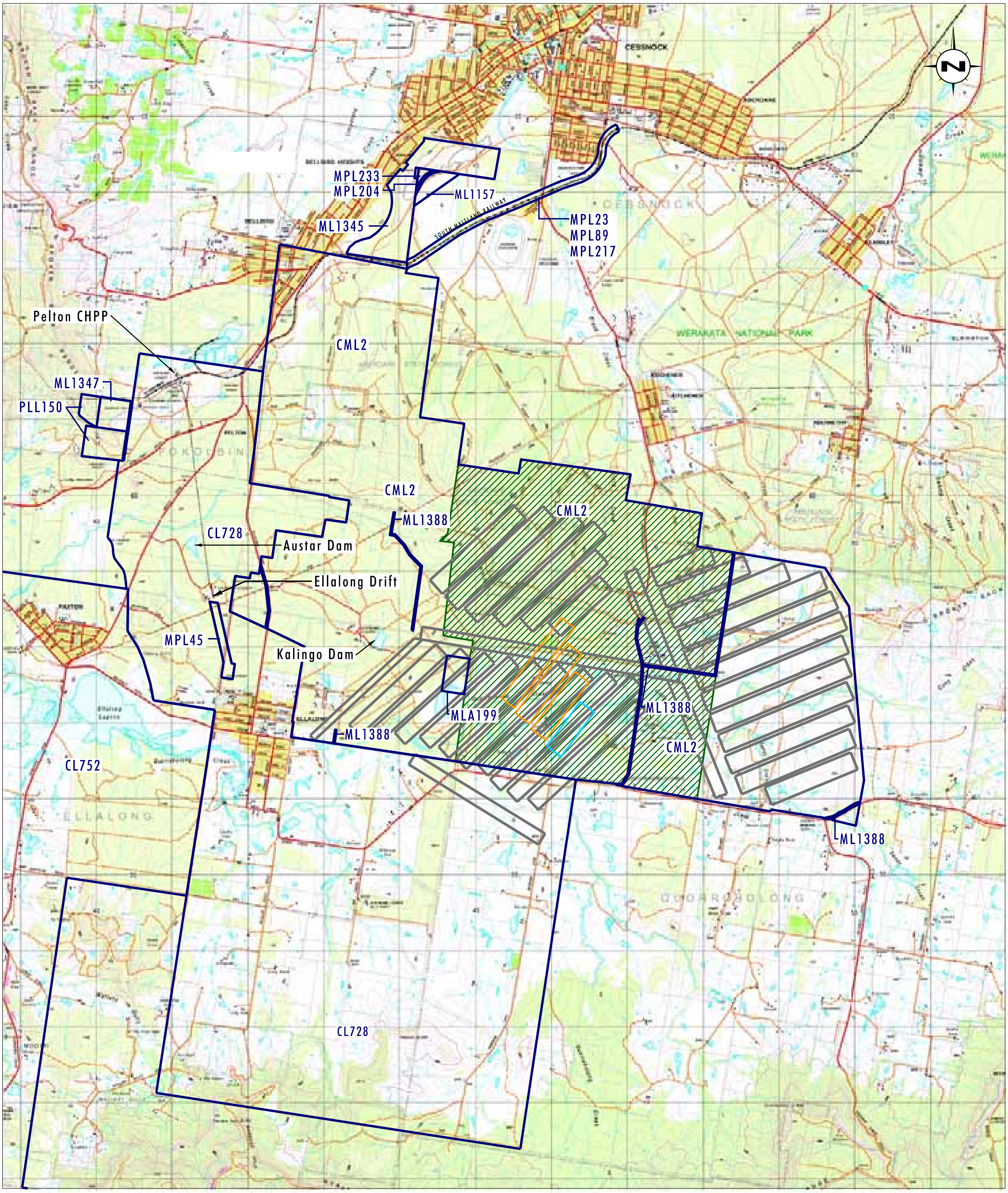
Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Conceptual Layout for Stage 3 Longwall Panels
- Proposed Stage 3 Extension Boundary
- Reject Emplacement Areas
- Old Workings
- Mining Leases
- Water Pipeline

FIGURE 1.2

Austar Mine Complex

File Name (A4): R56_V1/2274_722.dgn



Source: Topo Maps: LPI NSW, Mine Leases: Austar Coal Mine

0 1 2 3km
1:70 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Mining Leases
- DA 29/95 Subsurface Application Area
- 1995 EIS Conceptual Longwall Layout

FIGURE 1.3

DA 29/95 1996 EIS Application Area

area with LW A5a being located in the same position as Longwalls 20 and 21 of the conceptual mine plan (**Figures 1.3** and **1.4**). In order to maximise coal resource recovery in LW A5a, Austar seeks a modification to DA 29/95 to:

- increase the maximum allowable extraction height of coal within the area to be mined by LW A5a from 4.5 metres to 6.5 metres; and

- undertake coal extraction in LW A5a using LTCC technology.

It is proposed that the same extraction equipment as is currently being used within the Stage 2 area will be used to undertake extraction in LW A5a.

The proposal set out above is a logical extension of the approved LTCC extraction of the Stage 2 area, and is referred to as the ‘Stage 2 Extension Project’ throughout this Environmental Assessment (EA). Environmental impacts of the Stage 2 Extension Project have been assessed within the 20 mm incremental subsidence contour for LW A5a (shown on **Figure 1.4**). This area is referred to as the ‘Stage 2 Extension Study Area’ throughout this EA.

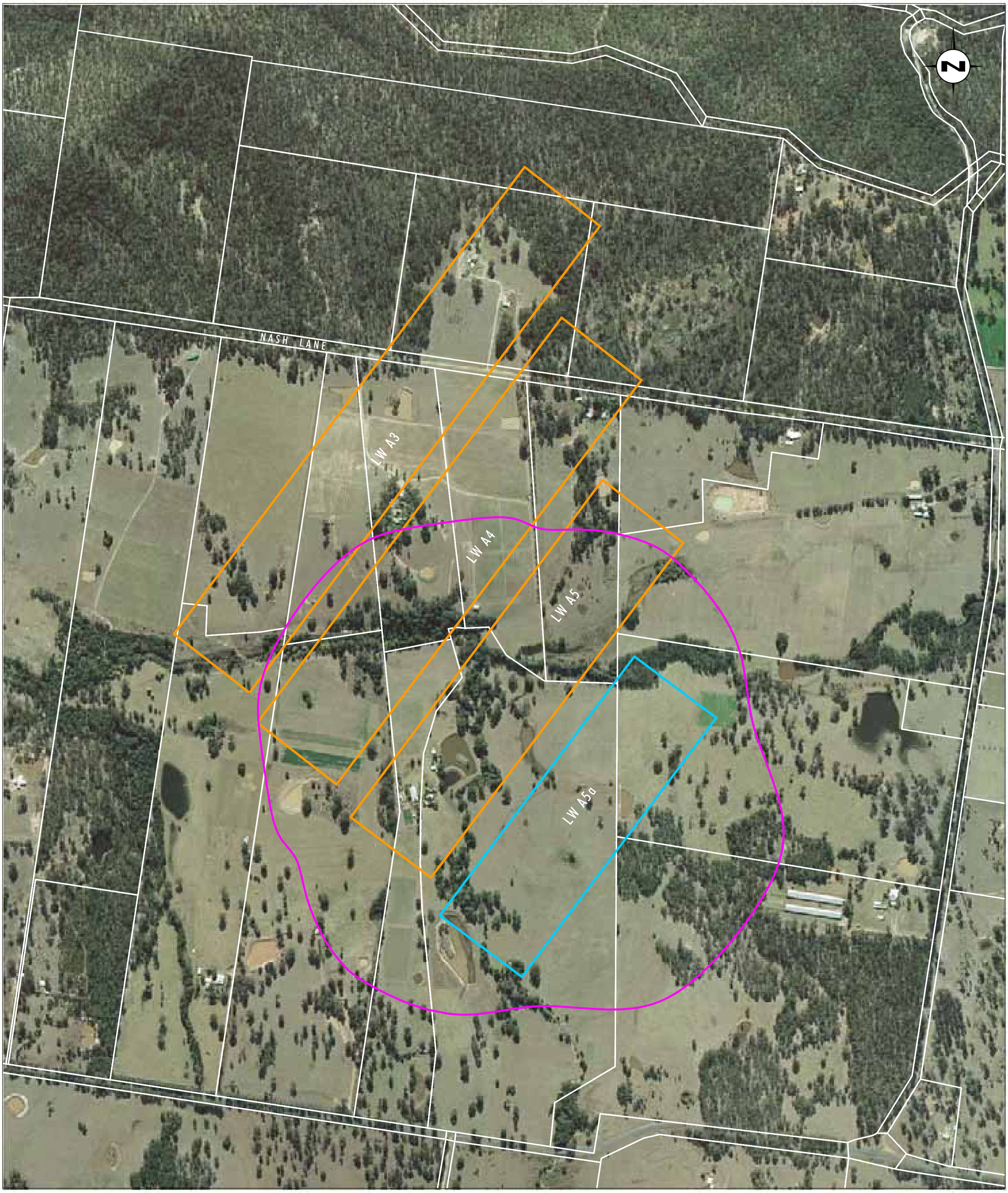
The Stage 2 Extension Project is located wholly within the DA 29/95 approval area and will not require the construction of any new surface infrastructure. It is proposed to extract 1.03 million tonnes (Mt) of product coal from LW A5a as a part of the Stage 2 Extension Project, taking the total amount of coal extracted from the DA 29/95 approval area to 12 Mt, compared to the approved extraction amount of up to 63 Mt of product coal. Subsidence impacts on the land surface will also be minor and impacts will be within the envelope of that originally approved by DA 29/95.

Approval is sought for the proposed Stage 2 Extension Project as a modification to DA 29/95. As DA 29/95 was granted prior to 1 July 1998 under Section 100A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), the modification to DA 29/95 must occur under Section 75W of the EP&A Act in accordance with Section 8J(8) of the Environmental Planning and Assessment Regulation 2000. The Minister for Planning will be the consent authority for the modification application.

1.2 Project Justification

Austar currently has planning approval under DA 29/95 to extract coal from the Stage 2 Extension Study Area using conventional longwall mining methods (refer to **Section 2.3** for further details of the operations currently approved under DA 29/95). Extraction of the additional longwall panel is required to enable sufficient time for the completion of Surface Infrastructure Site construction prior to the commencement of longwall mining in the Stage 3 area. This extraction will make efficient use of the location of longwall equipment and mining infrastructure at the end of mining of the Stage 2 longwalls. Austar seeks a modification of DA 29/95 to use LTCC technology in the Stage 2 Extension Area to enable optimal recovery of the coal resource in accordance with the principles of ecologically sustainable development. This will also result in increased economic return for the State of New South Wales and Austar.

The principal advantage of the LTCC mining method is that it allows for the optimal recovery of coal resource in the up to 7 metre thick Greta Coal Seam which is at depths of over 500 metres in the Stage 2 Extension Study Area. LTCC technology has the capacity to recover up to 85% of the coal resource located above the reach of conventional longwall technology. Prior to 2006, longwall equipment used at Austar mine was limited to an extraction height of 3.5 metres. In a panel by panel comparison, this would equate to a recovery of approximately 60% of resource that can otherwise be extracted by LTCC



Source: AAM Hatch, 2006
Base Source: Austar Coal Mine

0 200 400 600m
1:12 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- LWA5a 20mm Incremental Subsidence Contour (Stage 2 Extension Study Area)
- Cadastral Boundary

FIGURE 1.4

Stage 2 Extension Conceptual Longwall Layout technology based on an average seam thickness of 6.5 metres. In addition, analysis indicates that mining of coal using the LTCC equipment can extract approximately 60% more coal per unit of energy used, than could be extracted using conventional longwall mining equipment. As a result the LTCC process is highly energy efficient and results in less greenhouse gas being emitted per tonne of coal extracted than conventional longwall mining.

In achieving the increased level of recovery the LTCC method addresses a key principle of ecologically sustainable development that requires the optimising of the value of the recovery of natural resources.

1.3 Austar Coal Mine Pty Limited

As discussed in **Section 1.1**, Austar Coal Mine Pty Ltd is a subsidiary of Yancoal Australia Pty Limited (Yancoal). Yancoal is a subsidiary of Yanzhou Coal Mining Company Limited (Yanzhou) and is one of the largest coal mining companies in China. Yanzhou has significant experience in the application of LTCC technology in thick seam recovery and longwall mining in China, and has brought this technology and application to Australia.

1.4 Stage 2 Extension Project Environment

1.4.1 Overview of Environmental Features

The Stage 2 Extension Study Area is located to the south of Broken Back Range, a major landform extending from west of Pokolbin to Mulbring. The area encompasses the gentle south facing lower slopes of the Broken Back Range and the extensive creek flat of the Quorrobolong Creek system. The landform above the Stage 2 Extension Study Area is within the Quorrobolong Creek catchment area, with Quorrobolong Creek and one major tributary, Cony Creek, running through the area.

The climate of the region is classified as warm temperate, characterised by seasonal variations from hot wet summers to mild dry winters. Rainfall is summer dominant, often occurring as short duration high intensity storms, with an average of 800 to 950 mm of rain falling in the region per annum. A more detailed description of the environmental features of the proposed Stage 2 Extension Study Area is provided in **Sections 5** to **7**.

1.4.2 Land Ownership and Tenure

Land ownership within and proximate to the Stage 2 Extension Study Area includes rural land holdings. The dominant land uses within and adjacent to the Stage 2 Extension Study Area include grazing, forestry and mining. The Stage 2 Extension Study Area is located entirely within CML2 (refer to **Figure 1.1**). Land in the northern section of the mining lease forms part of the Werakata State Conservation Area. Land use in the south of the mining lease consists of rural cattle grazing and poultry production. The villages of Kitchener, Abernethy, Bellbird, Paxton, Pelton and Ellalong (refer to **Figure 1.1**) are located in proximity to the Stage 2 Extension Study Area.

2.0 Overview of Existing Operations

2.1 Mine History

Austar Coal Mine is an amalgamation of several older mines and operates within a number of mining leases under 12 separate development consents issued by Cessnock City Council between 1974 and 2002 and development consent DA 29/95 granted by the NSW Minister for Urban Affairs and Planning in 1996 and was modified in 2006 and 2008 to provide for LTCC mining in Stage 1 and 2 areas. A full listing and description of current operations and the various consent and approvals under which the mine operates is provided in **Appendix 2**.

Austar mine and its associated infrastructure has a long and productive history. A chronology of mining within the Greta Coal Seam at the site and related activities is presented in **Table 2.1**. The locations of previous underground workings in the area are shown on **Figure 2.1**. The location of infrastructure currently used in the handling and processing of coal from the Austar is shown on **Figure 1.2**. Mining leases currently held by Austar are shown in **Figure 2.2** and listed in **Appendix 2**.

Table 2.1 – History of Mining Activities at Austar Coal Mine

Year	Historical Details
1916	Underground mining commenced at Pelton Colliery.
1918	The Pelton Railway was constructed in 1918.
1921	Underground mining commenced at Cessnock No. 1 (Kalingo) Colliery
1960/1961	Pelton CHPP constructed.
1961	Underground mining ceased at Cessnock No. 1 Colliery.
Late 1960s	Cessnock No. 1 Colliery amalgamated into Pelton Colliery.
1978	Underground mining commenced at Ellalong Colliery with coal being delivered by overland conveyor to the coal preparation plant, raw and washed coal handling systems and train loading facilities at Pelton Colliery.
1983	Longwall production commenced at Ellalong Colliery.
1992	Underground mining ceased at Pelton Colliery.
1994	High levels of gas (primarily carbon dioxide) encountered in the underground workings at Ellalong Colliery, preventing further mining of additional seams to the south-east.
1995	Pelton Open Cut Coal Mine established.
1996	DA 29/95 approved by the Minister for Urban Affairs and Planning and underground operations from the Ellalong Colliery extended into the Bellbird South Colliery area.
1998	Ellalong and Pelton Collieries amalgamated with Bellbird South Colliery and re-named Southland Colliery.
2003	Spontaneous combustion event resulting in a fire in the underground workings in Bellbird South. Mine placed in 'care-and-maintenance' for approximately 18 months.
2004	Yancoal purchased Southland Colliery and changed the name to Austar Coal Mine.
2005	Austar recommenced underground mining in the former Bellbird South Colliery area.
2006	DA 29/95 modified to allow Austar to commence underground mining using LTCC technology in the Stage 1 area.

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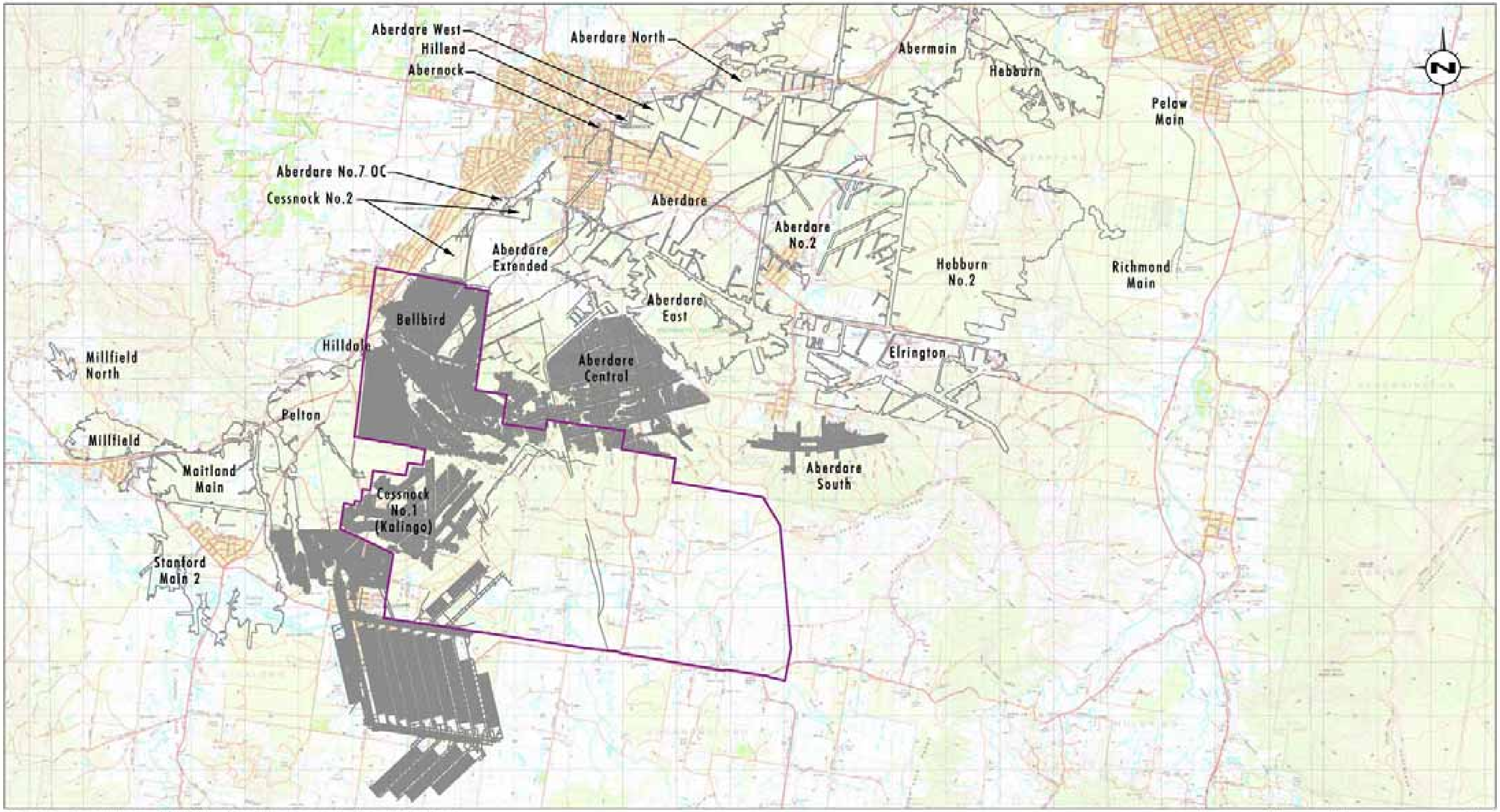

Source: Topo Maps: LPI NSW, Mine Workings: Austar Coal Mine

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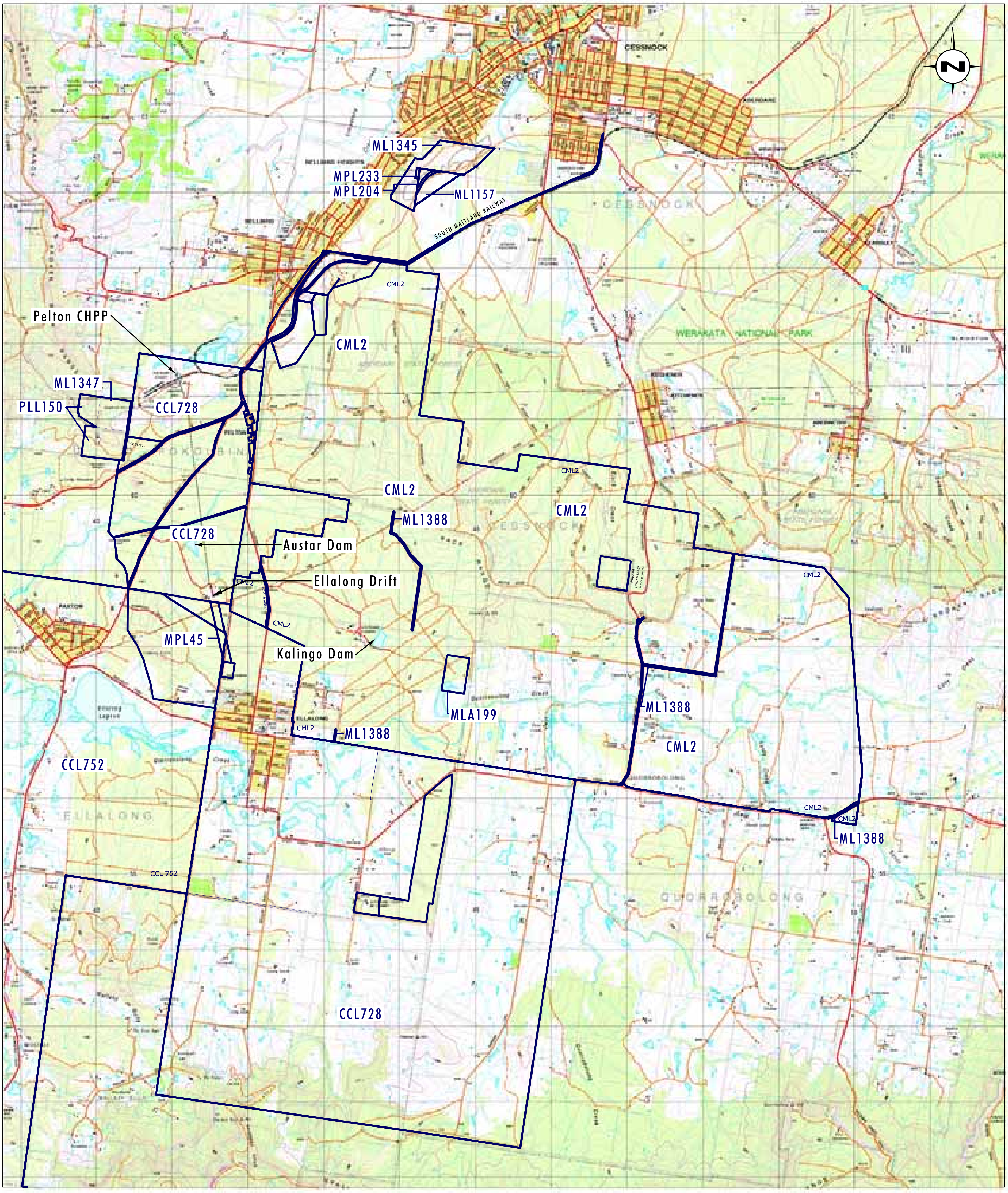
1:100 000

Legend

Consolidated Mining Lease (CML) 2
Previous Underground Workings

FIGURE 2.1

Previous Underground Workings



Source: Topo Maps: LPI NSW, Mine Leases: Austar Coal Mine

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1:70 000

Legend

Mining Leases

FIGURE 2.2

Existing Austar Mining Leases

Table 2.1 – History of Mining Activities at Austar Coal Mine (cont)

Year	Historical Details
2008	DA 29/95 modified to allow Austar to commence underground mining using LTCC technology in the Stage 2 area.
2009	DA 29/95 modified to increase the size and dimensions of Longwalls A4 and A5 in the Stage 2 area.
2009	DA 08_0111 for underground mining using LTCC in the Stage 3 area approved by the Minister for Planning.

As set out in **Table 2.1**, underground mining commenced at Pelton Colliery in 1916. Pelton Coal Handling and Preparation Plant (CHPP) was constructed in about 1960-61 for the washing of Pelton Colliery coal. No development consent or other planning approval for the initial construction of Pelton Colliery or the Pelton CHPP has been located. As Pelton Colliery was commenced in 1916 and the CHPP was constructed in 1960-61 before the commencement of planning controls in all likelihood no planning approval for the initial construction exists or was required. Pelton Colliery was amalgamated with the neighbouring Cessnock No.1 Colliery in the late 1960s.

In 1975 development consent for Ellalong Colliery was granted under Part X11 of the *Local Government Act 1919* and the mine was officially opened in July 1979. The 1975 development consent envisaged that coal from Ellalong Colliery would be transported by conveyor from the Ellalong Drift and Pit Top to Pelton CHPP. Longwall production commenced at Ellalong Colliery in 1983.

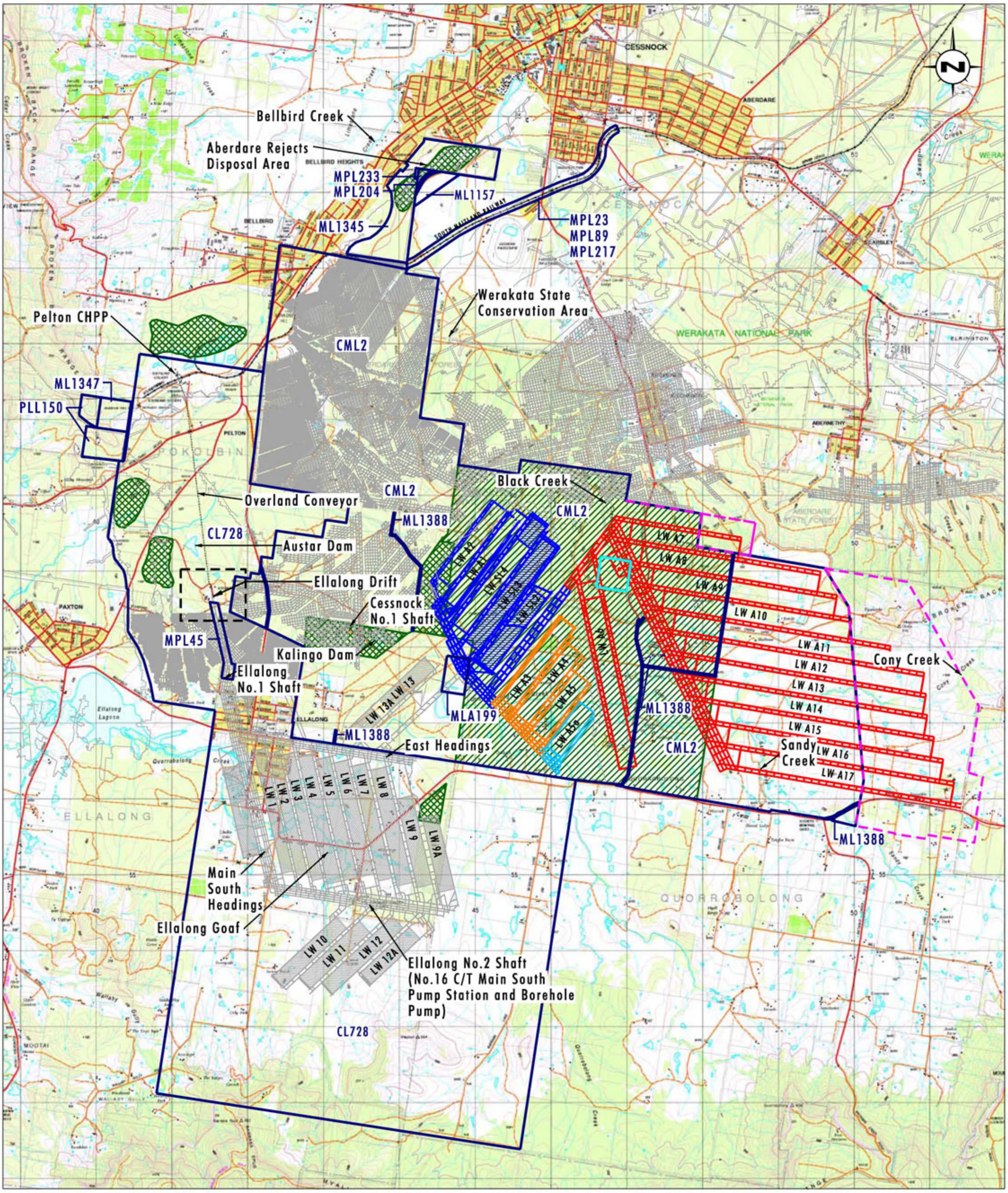
In early 1994 high gas levels were encountered in the southern part of Ellalong Colliery. In 1996 development consent (DA 29/95) was granted by the Minister for Urban Affairs and Planning to extend Ellalong Colliery to the north-east into the Bellbird South area to allow development in an area not affected by high levels of coal seam gas.

The Minister for Urban Affairs and Planning granted development consent (DA 29/95) for mining within CML2 by conventional retreat longwall mining to produce up to 3 Mtpa of product coal with an approved extraction height of up to 4.5 metres. Approximately 98 Mt of coal was identified in the approved Bellbird South Colliery Extension. The approved mining area that formed part of DA 29/95 is shown in **Figure 2.3**.

The key activities that were approved under the 1996 consent include:

- mining of up to 3 Mt of coal per annum within CML2 (refer to **Figure 1.2**);
- transfer of the coal by underground conveyor to the surface;
- washing and preparation of coal at Pelton CHPP;
- stockpiling of raw and washed coal at Pelton CHPP;
- reject emplacement in accordance with the Austar Mining Operations Plan (MOP);
- transport of 3 Mtpa of product coal by rail to the Port of Newcastle; and
- transport of up to 60,000 tonnes per annum of specialty coal product by road.

Further discussion of DA 29/95 is provided in **Section 2.3**.



Source: Topo Maps: LPI NSW, Longwall Layouts: Austar Coal Mine

Legend

- Layout for Stage 1 Longwall Panels
- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Conceptual Layout for Stage 3 Longwall Panels
- Surface Infrastructure Site
- Proposed Stage 3 Extension Boundary
- Old Workings
- Mining Leases
- Surface Application Area (DA 29/95)
- Subsurface Application Area (DA 29/95)

FIGURE 2.3

Mining Area Approved under DA 29/95

In 1998 Southland Coal Pty Limited acquired Ellalong and Pelton Collieries and amalgamated them with Bellbird South Colliery. Ellalong, Pelton and Bellbird South Collieries became known as the Southland Colliery. Southland Colliery was operated until 2003 when fire broke out in the underground workings. Subsequently, the mine was placed into receivership and operations were placed on care and maintenance.

Southland Colliery and its associated infrastructure was acquired by Yancoal in December 2004 and was renamed Austar Coal Mine.

Mining proceeded in the reconfigured Stage 1 area (consisting of LW A1 and A2 as shown on **Figure 1.2**) following a modification of the 1996 Minister's Consent to allow for the extraction of coal to a height of 6.5 metres using LTCC technology. A further section 96 Modification (Stage 2) was approved by the Minister of Planning in 2008 to allow LTCC extraction of Longwall panels A3 to A5 in Stage 2 (see **Figure 1.2**). An additional minor section 96 (1a) modification to vary the length and widths of Longwalls A4 and A5 was approved in 2009 (refer to **Table 2.1**). Extraction of coal using LTCC technology is currently occurring in Longwall A3 within the Stage 2 area.

A new project approval was granted by the Minister for Planning in September 2009, enabling longwall mining using LTCC technology in the Stage 3 area and construction and operation of a new Surface Infrastructure Site and access road south-west of Kitchener (refer to **Figure 1.2**). Construction of the Surface Infrastructure Site commenced in December 2009 and will take approximately 36 months to complete. Longwall mining in the Stage 3 area is scheduled to commence in 2012.

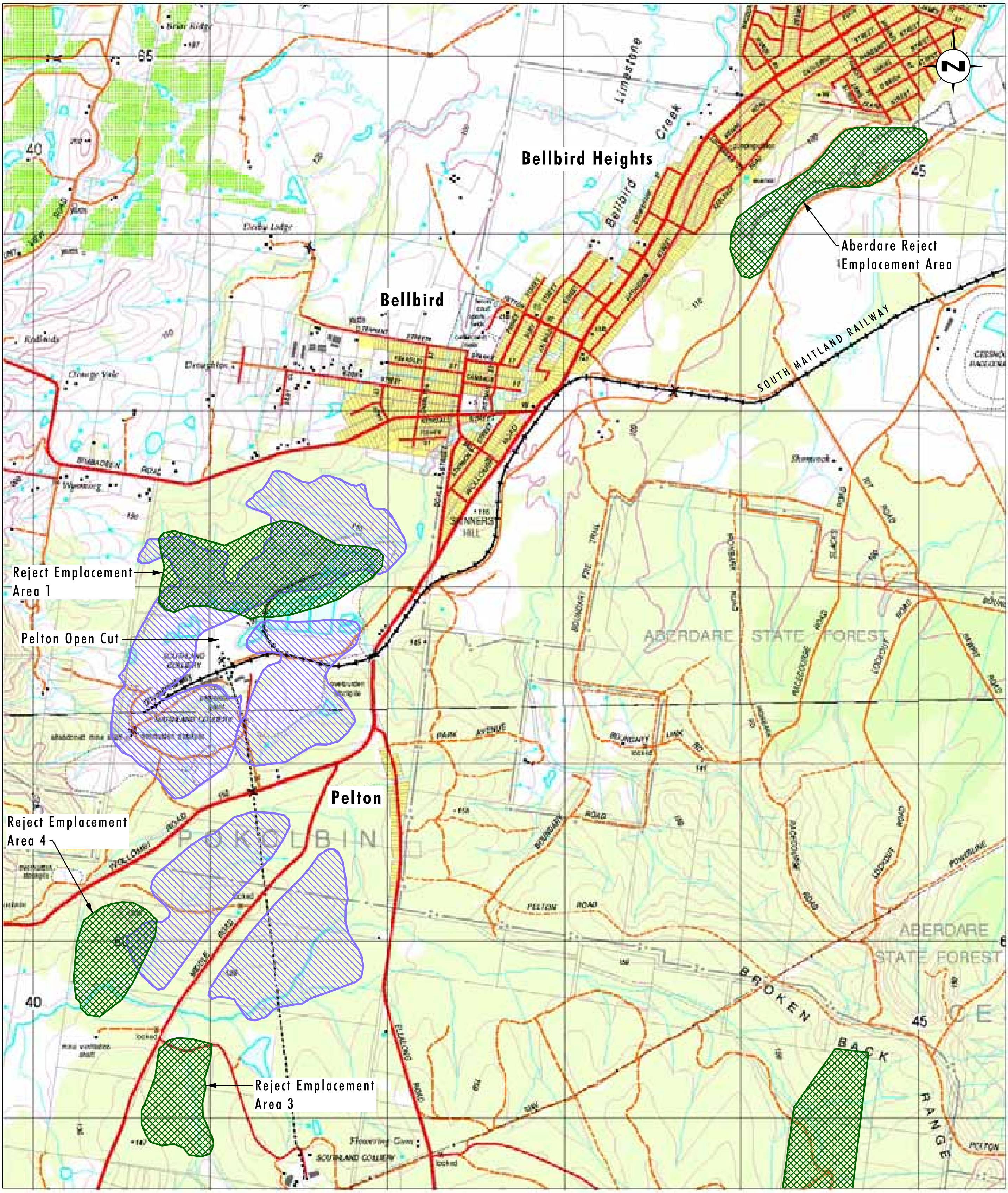
The Austar Mine Complex is located south of the old Aberdare Extended, Cessnock No.2 and Bellbird mine workings (refer to **Figure 2.1**) and works within the parameters of the Austar MOP using established infrastructure (refer to **Figure 1.2**). The Abermain No.2, Hebburn No. 2 and Elrington mine workings are all located north-east of Austar, whilst the Maitland Main and Stanford Main workings are located to the west (refer to **Figure 2.1**).

2.2 Current Operations, Consents and Approvals

Coal from Austar Coal Mine is bought to the surface at the Ellalong Drift and Pit Top via an underground conveyor through the Ellalong East Headings. Coal is then conveyed to the Pelton CHPP via an overland conveyor system, processed and handled at Pelton CHPP and railed to the Port of Newcastle via Austar Rail Line, the South Maitland Railway and the Main Northern Rail Line. Up to 60,000 tonnes of specialty coal product is also transported by road from Pelton CHPP.

Reject from Pelton CHPP is emplaced at approved emplacement areas at Pelton CHPP and Aberdare Extended. The location of current project emplacement areas is shown on **Figure 1.2**. Additional approved reject emplacement areas are shown on **Figure 2.4**.

Full details of Austar's current operations are provided in **Appendix 2**. A summary of current operations is provided in **Table 2.2**.



Source: Topo Maps: LPI NSW

0 0.5 1.0 1.5km
1:30 000

Legend

Reject Emplacement Area (DA 29/95)
Reject Emplacement Area (DA 74/75/79)

FIGURE 2.4

Reject Emplacement Areas

Table 2.2 – Summary of Approved Operations

	Approved Operations
Approved Production	• Production of 3 Mtpa of coal per year
Operating Hours	• 24 hours, 7 days per week
Number of Employees	• 200 to 275
Mining Methods	• Conventional retreat long wall mining and LTCC
Infrastructure	• Drift sites at Ellalong and Pelton Collieries; • CHPP at Pelton; • Overland conveyor from Ellalong to Pelton CHPP; • Rail loading facility and rail spur adjacent to Pelton Colliery; • Various ventilation and access shafts – (including Ellalong No.1 Shaft, Ellalong No.2 Shaft, an upcast ventilation fan at Shaft No. 3 and Downcast at Shaft No. 4 both located at the Kalingo infrastructure site, and new upcast and downcast shafts under construction at the Stage 3 Surface Infrastructure Site) (refer to **Figure 1.2**); • Offices and amenity buildings at Ellalong and Pelton Collieries, No. 1 and No. 2 shafts, and new offices and amenities to be constructed at the Stage 3 Surface Infrastructure Site; • Water management systems including: drains, diversion banks, sedimentation, treatment and clean water dams, lime treatment plant and water treatment plant; • Electrical sub-stations and compressors; • Nitrogen inertisation plant; and • Diesel and emulsion fluid storage area and dispatch system.
Coal Processing	• All coal is processed at the Pelton CHPP which has a nameplate capacity of 600 tonnes per hour. The plant currently processes up to approximately 520 tonnes per hour giving it a functional production capacity of approximately 4.2 million tonnes per year.
Tailings and Reject Management	• Reject and tailings are emplaced at the disused Aberdare Extended Open Cut voids, and at Pelton Colliery in approved areas shown in **Figure 1.2**. As shown on **Figure 2.4**, additional reject emplacement areas have development consent and may be utilised if required.
External Coal Transport	• Product coal can be transported by rail to the Port of Newcastle at a rate of up to 3.0 Mtpa (using up to 6 trains per day). Up to 60,000 tonnes per annum can be transported by road.
Underground Access	• Main mine entrance is at the Ellalong Drift and Pit Top, Middle Road, which runs off Wollombi Road.

Since purchasing the mine in 2005, Austar has been implementing a program of continuous improvement for its operations. This program is being undertaken principally through the ongoing development and review of the Austar:

- Mining Operations Plan (MOP);
- Site Water Management Plan (SWMP);
- Voluntary Pollution Reduction Program (PRP) that is being implemented as part of Environment Protection Licence (EPL) 416; and
- Environmental Monitoring Program (EMP).

Details of these Plans and Programs are provided in **Appendix 2**.

2.3 DA 29/95

As discussed in **Section 2.1**, underground mining at Austar is currently occurring within the DA 29/95 approval area (refer to **Figure 2.3**). DA 29/95 was approved in 1996 to allow conventional retreat longwall mining in the approval area shown in **Figure 1.3** at a rate of 3 Mtpa with an approved extraction height of up to 4.5 metres. DA 29/95 was modified in 2006 and 2008 to allow an increase in the approved extraction height to 6.5 metres and the use of LTCC technology in the Stage 1 and 2 areas respectively. The key activities that were approved under the 1996 consent and subsequent modifications are set out in **Table 2.3**. The current consent for DA 29/95 (as amended) is provided in **Appendix 1**. A compliance review of operations under DA 29/95 (as amended) was undertaken in December 2008. The results of this review were provided to the Department of Planning (DoP) in 2009 and an update on the current status of compliance was recently provided to DoP.

Table 2.3 – Summary of Activities Approved Under DA 29/95 and Modifications

Consent/Modification	Key Activities Approved
1996 Consent (DA 29/95)	• mining of up to 3 Mt of coal per annum within the DA 29/95 approval area (refer to **Figures 1.2** and **1.3**); • mining using conventional longwall mining techniques; • maximum coal extraction height of up to 4.5 metres; • total extraction tonnage of 63 million tonnes over a 21 year period; • transfer of the coal by underground conveyor to the surface; • washing and preparation of coal at Pelton CHPP; • stockpiling of raw and washed coal at Pelton CHPP; • reject emplacement in accordance with the Austar MOP; • transport of 3 Mtpa of product coal by rail to the Port of Newcastle; and • transport of up to 60,000 tonnes per annum of specialty coal product by road.
2006 Stage 1 Modification (27 September 2006)	• mining using LTCC technology in the Stage 1 area (refer to **Figure 1.2**); • extraction height of up to 6.5 metres in the Stage 1 area; • construction and operation of the following new infrastructure: ▪ larger capacity ventilation fan (No. 3 Shaft), ▪ new downcast shaft (No. 4 Shaft), ▪ new ten MVA substation, ▪ 2000 cubic metres per hour nitrogen inertisation plant, ▪ emulsion fluids and diesel storage and dispatch system, ▪ tube bundle shed, ▪ upgraded water treatment plant, and ▪ water reticulation and pumping upgrade; and • no change to the production rate or total tonnage of coal extracted from the DA 29/95 approval area.
2008 Stage 2 Modification	• mining using LTCC technology in the Stage 2 area (refer to **Figure 1.2**); • extraction height of up to 6.5 metres in the Stage 2 area; • no additional surface infrastructure; and • no change to the production rate or total tonnage of coal extracted from the DA 29/95 approval area.

Table 2.3 – Summary of Activities Approved Under DA 29/95 and Modifications (cont)

Consent/Modification	Key Activities Approved
2009 Stage 2 Modification (28 May 2009)	• increase length of Longwall A4 void by 15 m; • decrease the Longwall A5 void by 20 m; • increase the width of Longwalls A4 and A5 by 10 m; • increase the width of A4 to A5 chain pillar by 15 m to 65 m; and • decrease the A5 chain pillar by 5 m to 40 m.

3.0 Description of Proposed Modification

3.1 Proposed Changes to Underground Mining Methodology

The Stage 2 Extension Project will involve the extraction of up to 6.5 metres of coal from LW A5a (**Figure 1.4**) using LTCC technology. The key features of the project are as follows:

- mining of one longwall within the footprint of the original conceptual mine plan for the DA 29/95 approval area (refer to **Figures 1.3** and **1.4**);
- longwall extraction using LTCC technology (refer to **Section 3.1.1** for further details);
- increased extraction height from 4.5 metres to 6.5 metres;
- subsidence impacts within the envelope of those set out in the 1995 Environmental Impact Statement (HLA-Envirosciences, 1995) and approved in DA 29/95;
- no change to the existing underground mining area approved under DA 29/95;
- no change to the life of DA 29/95;
- no increase in the rate of extraction or total extraction tonnage approved under DA 29/95; and
- no change to the surface infrastructure required for the mining, handling, processing and transport of coal from the DA 29/95 approval area.

3.1.1 LTCC Mining Methodology

In Australia coal seams of 5 metres in thickness or greater have not been able to be fully extracted by conventional longwall mining methods. LTCC is a method of mining that has been in practice in one form or another for over 130 years and is designed to extract thicker coal seams by recovering coal that would otherwise be lost in traditional forms of longwall mining.

LTCC was introduced to China approximately 15 years ago and to Austar (Stage 1) in October 2006. Recent modifications to the technique at a number of underground coal mines in China have resulted in impressive coal recovery rates and performances (Xu, 2001).

LTCC has provided enormous interest to both the regulators and operators within Australia as it allows for significant improvements in the safe and reliable extraction of thick coal seams, optimising resource recovery, reducing energy required per tonne of coal to extract coal and affording a lower operating cost per tonne of coal extracted.

LTCC combines a conventional retreat longwall face with a second armoured face conveyor (AFC) towed behind the shield to recover coal that falls into the goaf. The roof supports are of a modified design incorporating a system of hydraulically operated tail-canopies at the rear of the support which can be moved up and down to allow the broken coal in the goaf area to spill onto a second AFC. This process continues until all of the coal is recovered and waste rock appears. Once waste rock appears the tail canopies are lowered and the AFC pulled forward to stop the recovery of rock from the goaf (ERM, 2006).

LTCC consists of the following operational steps:

- shearing coal in front of the AFC;
- pushing the front conveyor;
- setting the support forward;
- opening the tail-canopy of support to allow broken coal to spill onto the rear conveyor; and
- pulling the rear conveyor.

A schematic outlining the LTCC process is shown in **Figure 3.1**.

3.2 Employment

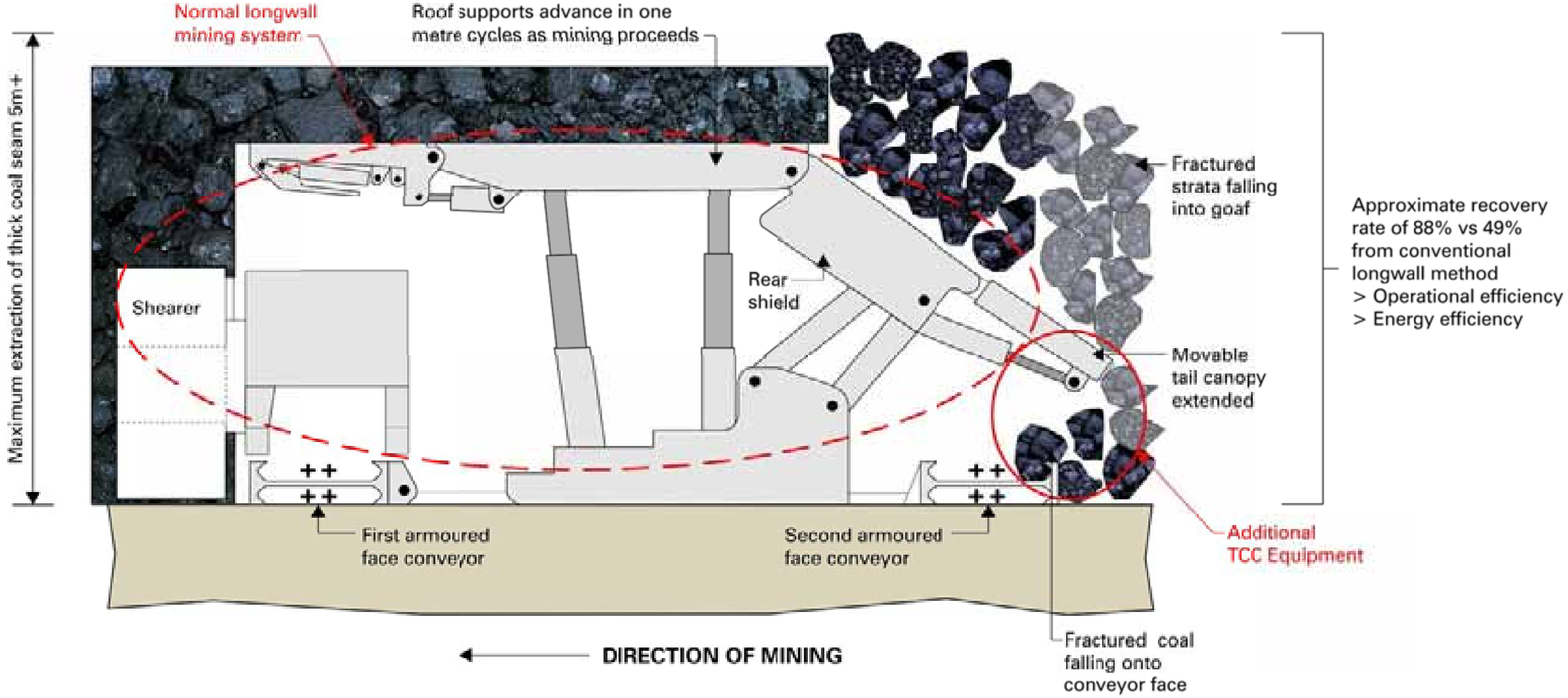
The Stage 2 Extension Project will result in the continuation of employment of 200 people at the Austar Mine Complex during the nine month extraction period. This will ensure continuity of employment for underground workers while the new ventilation shaft for the Stage 3 underground mining area is constructed.

3.3 Hours of Operation

Underground mining within the Stage 2 area will be a 24 hour, seven day per week operation.

3.4 Project Timing and Life of Operation

Austar proposes to commence longwall mining in the Stage 2 Extension Study Area in 2011 at the completion of longwall mining in longwall A5. At scheduled production levels, mining of longwall A5a will take approximately 9 months to complete.



Longwall Top Coal Caving LTCC Method

Combination of conventional retreat longwall face with second armoured face to recover coal that falls into goaf

Base Source: Austar Coal Mine (2007)

FIGURE 3.1

Longwall Top Coal Caving Method

4.0 Legislative Context

4.1 Commonwealth Legislation

4.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) has established a national assessment framework based on the principles of ecologically sustainable development. Proposed action, including projects, developments, activities and alterations that are considered likely to have a significant impact on matters protected by and listed under the EPBC Act need approval from the Minister for the Environment, Water, Heritage and the Arts.

Only those actions are that are deemed to have significant environment impact needed to be referred to Department of the Environment, Water, Heritage and the Arts (DEWHA) for assessment. The Project EA process has included assessment of significant impact under the EPBC Act of the following aspects:

- World Heritage properties (not applicable);
- National Heritage properties (not applicable);
- wetlands of international importance (not applicable);
- threatened species and ecological communities (see **Section 7.7**);
- migratory species (see **Section 7.7**);
- Commonwealth marine areas (not applicable); and
- nuclear actions (including uranium mines) (not applicable).

The proposed development will not have a significant impact on any of the matters of National Environmental Significance listed above. Details of the Ecological Assessment undertaken for the Stage 2 Extension Project are provided in **Section 7.7**.

4.1.2 Commonwealth Native Title Act 1993

The Commonwealth *Native Title Act 1993* (NT Act) is a set of rights and interests in relation to land or waters that have qualities identified and administered by the National Native Title Tribunal. The Tribunal is responsible for maintaining a National Native Title Register (NNTR) of native title claimants and bodies to whom native title rights have been granted. These native title holders and claimants must be consulted prior to the granting of a mining lease over land to which the native title claim or right applies.

The NT Act prescribes that native title can be extinguished under certain circumstances, including the granting of freehold land.

No native title claims are known to exist over the land or water system within the proposed Stage 2 Extension Study Area.

4.2 NSW State Legislation

4.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act is administered by the Department of Planning (DoP) and by local government at a local level. It is the primary legislation governing environmental planning and assessment for the State of NSW.

The objectives of the EP&A Act relevant to the Project encourage:

- the proper management, development and conservation of natural and artificial resources;
- the promotion and co-ordination of the orderly and economic use and development of land;
- the protection of the environment;
- ecologically sustainable development; and
- economically sustainable development.

Approval is sought for the proposed Stage 2 Extension Project as a modification to DA 29/95. As DA 29/95 was granted prior to 1 July 1998 under Section 100A of the EP&A Act, the modification to DA 29/95 must occur under Section 75W of the EP&A Act in accordance with Section 8J(8) of the Environmental Planning and Assessment Regulation 2000. The Minister for Planning will be the consent authority for the modification application.

As discussed in **Section 3.1**, the Stage 2 Extension project includes:

- an increase the maximum allowable extraction height of coal within the area to be mined by LW A5a from 4.5 metres to 6.5 metres without any substantial increase in subsidence or subsidence impacts; and
- use of LTCC technology for coal extraction in LW A5a.

The Stage 2 Extension Project is located wholly within the DA 29/95 approval area and will not require the construction of any new surface infrastructure. Subsidence impacts on the land surface will also be minor and impacts will be generally within the envelope of those set out in the 1995 Environmental Impact Statement (HLA-Envirosciences, 1995) and approved in DA 29/95.

4.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (PoEO Act) is administered by the Department of Environment, Climate Change and Water (DECCW). The Act establishes the procedures for issuing licences for environmental protection including waste, air, water and noise pollution control. The owner or occupier of a premise that is engaged in scheduled activities is required to hold an Environment Protection Licence (EPL) and comply at all times with the conditions of that licence.

Austar currently holds EPL 416 for its operations. The EPL was granted 7 May 2002, includes aspects of air, water, applications to land and noise pollution and is reviewed annually. Further details of EPL 416 are provided in **Appendix 2**

4.2.3 Mining Act 1992

The *Mining Act 1992* as administered by the Department of Industry and Investment (DII) on behalf of the Minister for Mineral Resources and, amongst other legislative instruments, places controls on methods of exploration and mining, the disposal of mining waste, land rehabilitation and environmental management activities. The principal means of regulation is the requirement for nearly all exploration and mining to be conducted under a title, such as an exploration licence or a mining lease. It also addresses the environmental responsibilities of explorers and miners, royalties and compensation.

A Mining Lease granted under the *Mining Act 1992* entitles the leaseholder to mine coal from a deposit. Austar currently holds a number of mining leases as indicated in **Figure 2.3** and listed in **Appendix 2**. As the DA 29/95 approval area is entirely within a mining lease, no new leases will be required for the Stage 2 Extension Project.

4.2.4 Mine Subsidence Compensation Act 1961

Under the *Mine Subsidence Compensation Act 1961*, the approval of the Mine Subsidence Board (MSB) is required for the erection or alteration of improvements within a mine subsidence district. The proposed Stage 2 Extension Study Area is currently not a Declared Mine Subsidence District and approval under Section 15 of the *Mine Subsidence Compensation Act 1961* does not currently apply to the proposed development. Clause 47 of the Cessnock Local Environment Plan 1989 (LEP) which specifies conditions of development within mine subsidence districts is also not applicable. The area, however, is scheduled for review and possible proclamation.

In NSW, if a home or other improvement is damaged as a result of subsidence following the extraction of coal, the owner's rights are protected by the Mine Subsidence Compensation Act. Buildings built outside of and prior to the proclamation of a Mine Subsidence District are automatically covered for compensation. However, homes and other structures built in contravention of, or without, the Board's approval in a Mine Subsidence District, are not eligible for compensation in the event of damage due to mine subsidence.

4.2.5 Water Management Act 2000

The *Water Management Act 2000* (WMA) provides for the sustainable and integrated management of the State's water and is administered by the NSW Department of Water and Energy (DWE). The WMA governs the issue of new water licences, the trade of water licences and allocations for those water sources (rivers, lakes and groundwater) in NSW where water sharing plans have commenced.

Under the WMA, water access licences entitle a licence holder to a share of the water in a listed water source that can be sustainably extracted. Licences must also be obtained for new groundwater monitoring bores where water sharing plans have commenced.

The Stage 2 Extension Study Area is located within the Upper Wollombi Brook Water Source to which the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* applies. The Water Sharing Plan applies to all water in rivers, lakes and wetlands in this water source, all water contained within all alluvial sediments below the surface of the ground and all water occurring naturally on or below the surface of the ground shown on the registered plan for this water source except any water contained in fractured rock aquifers and basement rocks in these water sources. Any new groundwater monitoring bores in the alluvial aquifer adjacent to Quorrobolong and Cony Creeks will require licences under the WMA.

No water sharing plan is currently in force for the fractured rock aquifers and basement rocks (e.g. Greta Coal Seam aquifer). Licensing for interception of groundwater by mine workings in the Stage 2 Extension Study Area therefore continues under the *Water Act 1912*.

An embargo on any further applications for sub-surface water licences within the *Wollombi Brook Alluvium Water Shortage Zone GWMA 041* (refer to **Figure 4.1**) was in place prior to the commencement of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*. This zone of shallow alluvium within the Stage 2 Extension Study Area is limited to Quorrobolong and Cony Creek channels. The Department of Natural Resources, NSW Provisional River Data Groundwater Vulnerability Mapping indicates that the Wollombi Brook Catchment is classified as having very high to high groundwater vulnerability along its creek banks and a moderately high rating elsewhere. As indicated in the City Wide Settlement Strategy, these creek line areas are vulnerable to groundwater contamination (Cessnock City Council, 2004).

4.2.6 Water Act 1912

The *Water Act 1912* is administered by the NSW Office of Water and governs the issue of new water licences and the trade of water licences and allocations in areas where Water Sharing Plans under the WMA have not commenced. The licence is tied to the land as the licence covers both the right to take a specific volume of water as well as the works to be constructed. Most *Water Act 1912* licences for commercial purposes also have to be renewed every five years. At the time of writing, no Water Sharing Plan had commenced for water contained in fractured rock aquifers or basement rock within the Stage 2 Extension Study Area.

A permit under Part 5 of the *Water Act 1912* is required where groundwater is intercepted by mine workings. Austar currently holds a Part 5 permit under the *Water Act 1912*. The permit applies to all of CML2. The Part 5 permit will need to be amended following approval for Stage 3 to include that area outside of CML2.

There are no registered groundwater extraction bores within the Stage 2 Extension Study Area (refer to **Figure 3.1**).

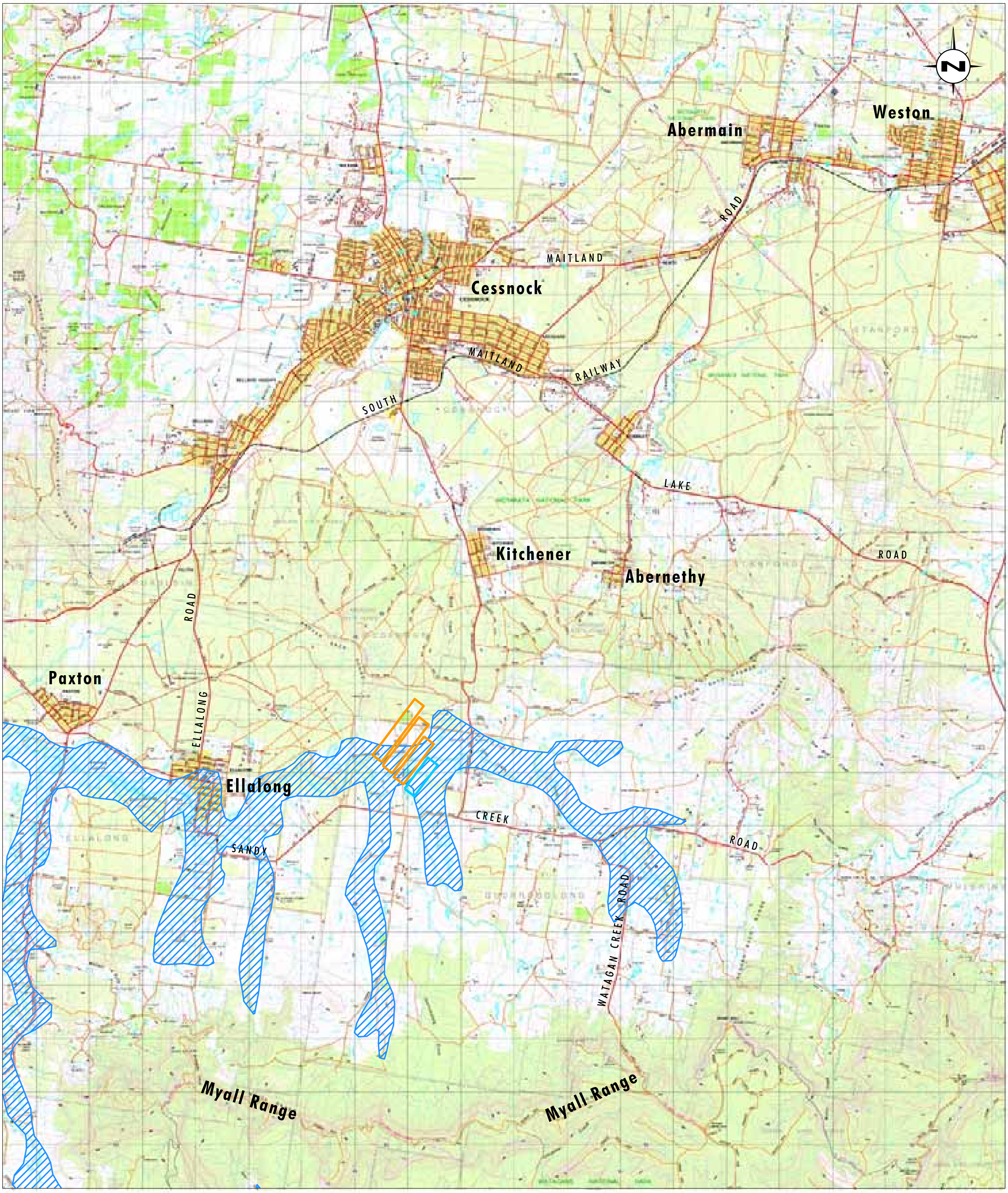
4.2.7 Heritage Act 1977

The *Heritage Act 1977* provides for the conservation and management of the State's built, marine, moveable and natural heritage. The Act provides for the constitution of the Heritage Council of NSW by which authority it is administered through the NSW Heritage Office. The Heritage Council maintains the State Heritage Register and the State Heritage Inventory, which list respectively heritage items of State significance and of local significance. The Heritage Council may also request local councils to prepare environmental planning instruments to protect items of local significance.

Under the Act, no item of historic heritage may be disturbed without an excavation permit from the Heritage Council unless subject to an exemption. An excavation permit is required under Section 60 of the Act for items listed on the State Heritage Register and under Section 140 of the Act for all other heritage items.

As no surface works are proposed as a part of the Stage 2 Extension Project, excavation permits under Section 60 of the Act will not be required.

Umwelt
Environmental Consultants



Source: Topo Maps: LPI NSW, Longwall Layout: Austar Coal Mine

0 1.0 2.0 4km
1:100 000

Legend

Layout for Stage 2 Longwall Panels
Layout for Stage 2 Extension Longwall Panel
Wollombi Brook Alluvium GWMA 041

FIGURE 4.1

Wollombi Brook Alluvium GWMA 041

File Name (A4): R56_V1/2274_729.dgn

4.2.8 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act* 1974 provides for the protection of native flora and fauna and the protection, preservation and management of all Aboriginal relics throughout NSW, irrespective of land tenure. The Act is administered by DECCW.

A Section 90 consent is required under the Act prior to the destruction of any known Aboriginal archaeological objects, with a Section 87 Preliminary Research Permit required to conduct excavations in areas of potential archaeological deposit (PAD) or in areas where further work to define the extent of a particular site is required. As no surface works are proposed as a part of the Stage 2 Extension Project, no consents or permits will be required under the *National Parks and Wildlife Act 1974.*

There are no specific requirements for the proposed development imposed by the sections of the Act which address native flora and fauna protection, with requirements under this section of the Act addressed by gaining development consent under the EP&A Act.

4.2.9 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act* 1995 (TSC Act) is administered by DECCW and provides protection for threatened plants and animals native to NSW (excluding fish and marine vegetation, which are protected under the *Fisheries Management Act* 1994) and integrates the conservation of threatened species into development approval processes under the EP&A Act. Under the EP&A Act, impacts on threatened species listed under the TSC Act are assessed by a seven-part test. Where a development is likely to have a significant impact on a threatened species, population or ecological community, the preparation of a Species Impact Statement (SIS) is required.

No threatened species listed under the TSC Act have been recorded within the Stage 2 Extension Study Area. Two threatened fauna species were previously recorded in close proximity to the Stage 2 Extension Study Area and potential habitat for two flora species was also identified. None of these species are predicted to be significantly impacted by the Stage 2 Extension Project and as such an SIS is not required (refer to **Section 7.7**).

4.2.10 Fisheries Management Act 1994

The *Fisheries Management Act* 1994 provides for the conservation of the State's aquatic resources and is administered by DII (Fisheries Division). The Act applies to all aquatic animals, whether alive or dead, excluding marine mammals, reptiles, birds and amphibians, which are covered by the provisions of legislation administered by DECCW. The Act requires that potential impacts of development on fish passage, water quality, fish habitat, riparian vegetation and threatened species be addressed during the environmental planning and assessment process. Where there is likely to be a significant impact on threatened species, the preparation of a SIS is required (under the EP&A Act). An assessment of the impact of the project on aquatic ecology is included in **Section 7.7**. The assessment concludes that the project will not significantly impact any threatened aquatic species and that a SIS is not required.

Under the *Fisheries Management Act 1994*, a permit must be obtained for any development/works which involves dredging or reclamation, any structure that may inhibit or obstruct the movement of fish within a waterway, cause damage or destruction of marine vegetation or involve the use of explosives. As no surface works are proposed as a part of the Stage 2 Extension Project, a permit under the *Fisheries Management Act* is not required.

4.2.11 Roads Act 1993

The *Roads Act 1993* in the proposed development area is administered by the RTA, Cessnock City Council or the Department of Lands. The RTA has jurisdiction over major roads, Cessnock City Council over minor roads and the Department of Lands over road reserves or Crown roads. Under Section 138, Part 9, Division 3 of the Act, a person must not (otherwise than with the consent of the appropriate roads authority):

- erect a structure or carry out a work in, or over a public road, or
- dig up or disturb the surface of a public road, or
- remove or interfere with a structure, work or tree on a public road, or
- pump water into a public road from any land adjoining the road, or
- connect a road (whether public or private) to a classified road,

No surface works are proposed as a part of the Stage 2 Extension Project and the Stage 2 Extension Project is unlikely to result in subsidence of roads, road reserves or Crown road reserves. Consequently, no approvals will be required under the *Roads Act 1993*.

4.3 State Environmental Planning Policies

State Environmental Planning Policies (SEPPs) deal with issues significant to the state of NSW. They are made by the Minister for Planning and may be exhibited in draft for public comment before gazetted as a legal document.

4.3.1 State Environmental Planning Policy (SEPP) 2007 (Mining, Petroleum Production and Extractive Industries)

The State Environmental Planning Policy (SEPP) (Mining, Petroleum Production and Extractive Industries) 2007 was gazetted in February 2007. The SEPP outlines where various extractive industries activities are permissible both with and without development consent. The SEPP also defines mining, petroleum production and extractive industries developments that are prohibited, exempt or complying developments. The SEPP identifies that extractive industries are permissible with development consent on land for which development for the purposes of agriculture or industry may be carried out (with or without development consent).

The SEPP aims to provide for:

- the proper management and development of mining, petroleum production and extractive material resources;
- to facilitate the orderly use and development of areas where the resources are located; and
- to establish appropriate planning controls to encourage sustainable management of these resources.

As discussed in **Section 4.5.2**, the land above LW A5a is zoned 1(a) – Rural and underground mining is permissible with development consent.

4.3.2 State Environmental Planning Policy No. 33 (SEPP) (Hazardous and Offensive Development)

The State Environmental Planning Policy (SEPP) No. 33 (Hazardous and Offensive Development) provides definitions for 'hazardous industry', 'hazardous storage establishment', 'offensive industry' and 'offensive storage establishment'. The definitions apply to all planning instruments, existing and future. Revised definitions enable decisions to approve or refuse a development to be based on the merit of the proposal.

The Stage 2 Extension Project is not considered hazardous or offensive. A detailed hazard assessment is therefore not required.

4.3.3 State Environmental Planning Policy No. 44 (SEPP) (Koala Habitat Protection)

The State Environmental Planning Policy (SEPP) No. 44 (Koala Habitat Protection) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline by:

(a) requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and

(b) encouraging the identification of areas of core koala habitat, and

(c) encouraging the inclusion of areas of core koala habitat in environment protection zones.

While Cessnock Local Government Area (LGA) is listed in Schedule 1 of the SEPP, no core or peripheral koala habitat has been identified within the Stage 2 Extension Study Area (refer to **Section 5.7**). The provisions of SEPP 44 do not apply and a koala plan of management is not required for the Project.

4.3.4 State Environmental Planning Policy No 55 (SEPP) (Remediation of Land)

State Environmental Planning Policy (SEPP) No. 55 (Remediation of Land) aims to provide a State-wide planning approach to the remediation of contaminated land.

Under the SEPP, a consent authority must not approve development on land unless the potential contamination issues have been considered. No potential issues of contamination from the Stage 2 Extension Project have been identified.

4.4 Regional Environmental and Development Plans

4.4.1 Lower Hunter Regional Strategy 2006

The Lower Hunter Regional Strategy 2006 (LHRS) (DoP, 2006) is a land use planning document that outlines the provision of sufficient, appropriately placed housing and employment land to cater for the Region's predicted growth over the next 25 years. The strategy is based on population growth projections which forecast that there will be an additional 160,000 people in the Region by 2031. These strategic planning documents state that mining will remain a significant element of the economies of both the Lower Hunter and the State.

The proposal is consistent with the LHRS objectives in relation to mining.

4.4.2 Lower Hunter Regional Conservation Plan 2006

The Lower Hunter Regional Conservation Plan 2006 (LHRCP) (DEC, 2006) sets out a 25-year program to direct and drive conservation efforts in the Lower Hunter Valley. It is a partner document to the DoP LHRS that sets out the full range of Government planning priorities, and identifies the proposed areas for growth. The primary objectives of the Regional Conservation Plan (RCP) are to complement the Government's Planning Strategy by:

- describing the conservation values of the Lower Hunter region analysing the current status of biodiversity within the region, and assessing the likely impacts of development identified in the Lower Hunter Regional Strategy (LHRS);
- assessing the biodiversity values of the region, at a landscape scale, and identifying strategic areas for biodiversity protection, enhancement or restoration;
- contributing to a practical framework that can secure, maintain and improve biodiversity values as the Hunter grows over the next 25 years; and
- guiding local level planning with respect to biodiversity, including the development of local biodiversity conservation strategies and the development of new Local Environmental Plans (LEP) that can merit biodiversity certification.

Mining is not listed as one of the Future Threats to Biodiversity in the Lower Hunter however, two elements and reserve establishment of the LHRCP apply to the management and operational considerations of the Project. They include:

1. a large addition to Werakata National Park near Cessnock (2200 hectares) – the gazetted Werakata State Conservation Area (SCA) – which will significantly expand the existing area of reserve and will conserve significant areas of endangered ecological communities (EECs) including Lower Hunter Spotted Gum, Ironbark and Forest Red Gum; and
2. establishment of the Ellalong Lagoon Conservation Area (430 hectares) to the east of Paxton, which contains important freshwater wetland communities, will protect further EECs including habitat for the green and golden bell frog.

The formal conservation management status of Ellalong Lagoon has also been considered in discussions of potential mine impacts on downstream water quality (refer to **Section 7.2**).

4.5 Local Environmental and Development Plans

4.5.1 Draft Cessnock Local Environment Plan 2008

The Draft Cessnock Local Environment Plan 2008 (LEP) has been prepared and released for comment. This LEP aims to supersede the current Cessnock Local Environment Plan 1989.

The proposed development is consistent with the aims of the Draft LEP 2008, which are:

(a) to strengthen and protect a high quality, sustainable lifestyle for the Cessnock local government area's residents and visitors;

(b) to conserve and enhance, for current and future generations, the ecological integrity, environmental heritage and environmental significance of the Cessnock local government area;

(c) to encourage development for employment and housing purposes in appropriate locations having regard to proximity to appropriate infrastructure, to ensure efficient use of land and services, to provide walk-able urban environments and to reduce dependency on the use of private vehicles; and

(d) to provide opportunities for a range of new housing and housing choice in locations that have good access to public transport, community facilities and services, retail and commercial services and employment opportunities, including opportunities for the provision of adaptable and affordable housing.

4.5.2 Cessnock Local Environment Plan 1989

The Cessnock Local Environment Plan 1989 was last updated on 11 May 2007 in the form of a legislated update. This LEP is one of the current planning instruments applicable to proposed development in the Cessnock LGA. As specified on the LEP Zoning Map (refer to **Figure 4.2**), land within the Stage 2 Extension Study Area is zoned 1(a) – Rural 'A' Zone.

The Stage 2 Extension Project is consistent with the objectives of this zone outlined below:

The stated objectives of this zone are:

(a) to enable the continuation of existing forms of agricultural land use and occupation;

(b) to ensure that potentially productive land is not withdrawn from production;

(c) to encourage new forms of agricultural land use;

(d) to enable other forms of development which are associated with rural activity and which require an isolated location, or which support tourism and recreation, and

(e) to ensure that the type and intensity of development is appropriate in relation to:

(i) the rural capability and suitability of the land;
(ii) the preservation of the agricultural, mineral and extractive production potential of the land;
(iii) the rural environment (including scenic resources); and
(iv) the costs of providing public services and amenities.

4.5.3 Cessnock Development Control Plan 2006

The Cessnock Development Control Plan 2006 (DCP) complements the statutory provisions contained in the Cessnock LEP 1989 by providing detailed guidelines for development within the Cessnock LGA. The current DCP replaces a number of existing Development Control Plans as required to comply with Section 74C of the *Environmental Planning and Assessment Act 1979*, as amended. The aims of the DCP are:

- to provide a detailed planning document that outlines requirements for development which meets community expectations and addresses the key environmental planning issues of the Local Government Area;

- to identify exempt and complying development provisions in accordance with sections 76 & 76A of the EP&A Act and Clause 10A in the Cessnock LEP 1989;

- to identify certain development as advertised development and to detail public notification requirements in accordance with Section 74C of the EP&A Act;

- to promote a more simplistic framework for dealing with Development Applications (DAs) consistent with the amended requirements of the EP&A Act;

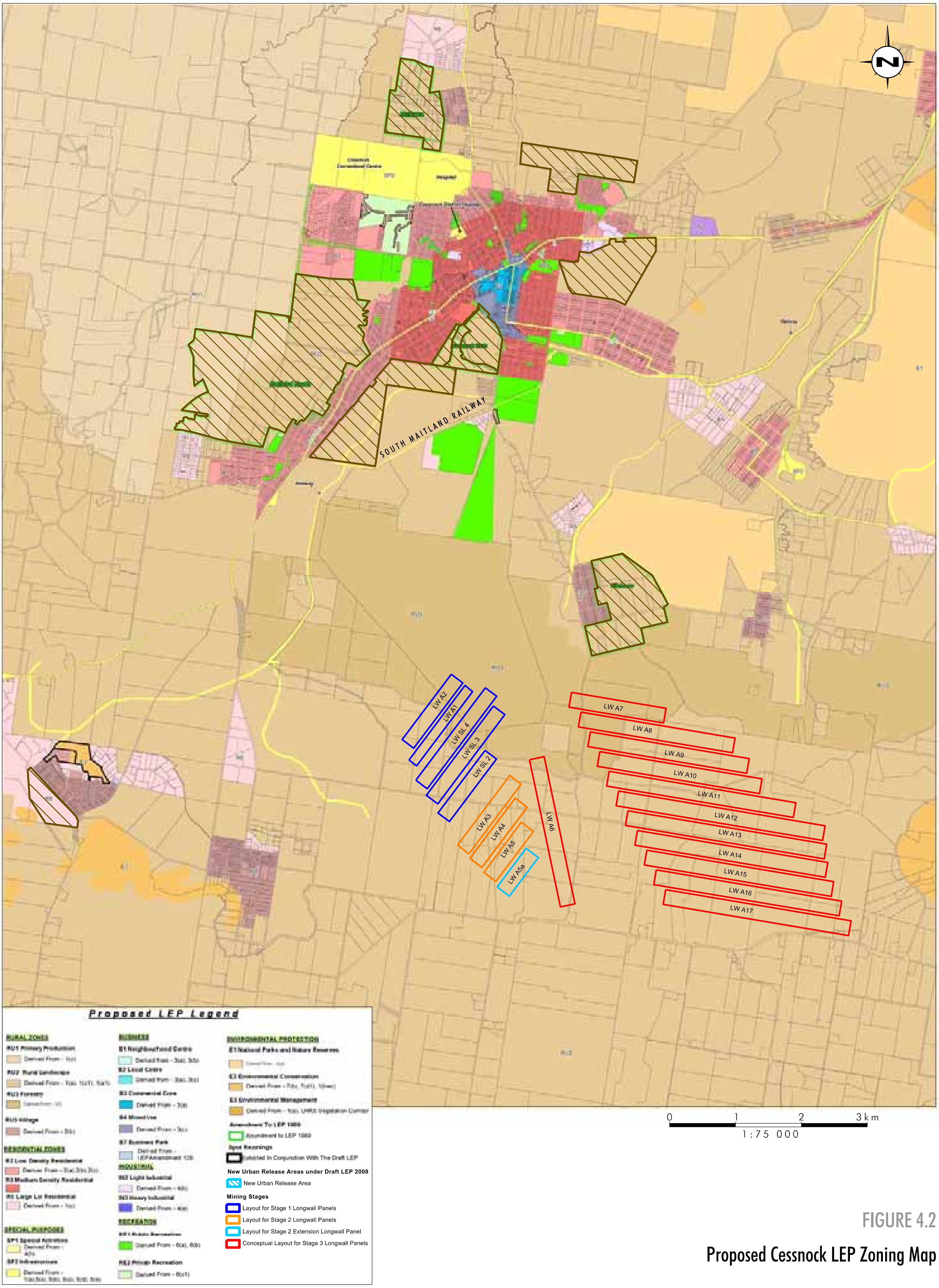


FIGURE 4.2

Proposed Cessnock LEP Zoning Map

Source: Cessnock City Council, 2007

File Name (A4): R56_V1/2274_730.dgn

- to encourage and assist effective community participation in the decision-making process;
- to provide a more accessible and understandable set of guidelines to the general public; and
- to apply common or consistent requirements and procedures in the assessment of all applications.

4.5.3.1 E1- Ellalong Lagoon Catchment Area

The DCP is applicable to the Stage 2 Extension Project due to its proximity to the Ellalong Lagoon Catchment Area (E1). The Area is identified as E1, as referenced in the DCP 2006, Part E – Specific Areas (refer to **Figure 4.3**). The Part E – Specific Areas was incorporated into the DCP in March 2007. The objectives of E1 include:

(a) to ensure that the water quality of Ellalong Lagoon, which is already under stress, does not deteriorate further;

(b) to guide subdivision of land to ensure that allotments created meet the objectives of this plan;

(c) to control the erection of dwellings and dual occupancy developments to ensure that they are appropriately sited to take account of on-site constraints;

(d) to reduce nutrient load entering Ellalong Lagoon by ensuring that effluent from residential and rural areas is adequately contained and treated where necessary;

(e) to reduce sediment transfer through adequate control over clearing of land and development works;

(f) to ensure that new developments are not adversely affected by flooding nor exacerbate existing flood levels; and

(g) to promote the use of land within Rural 1(a) zoning for agricultural purposes, whilst ensuring that a high standard of environmental management is incorporated into existing and future developments.

The proposed development addresses the objectives of the relevant components of the DCP.

4.5.4 Cessnock City Wide Settlement Strategy 2004

The Cessnock City Wide Settlement Strategy 2004 (CWSS) (Cessnock, 2004) seeks to address the competing interests that Council must consider when determining the appropriate land use or density for settlement opportunities and follows the principles of ecologically sustainable development. The CWSS indicates that the mining of coal has long been one of the driving forces behind the economies of many of the Lower Hunter LGAs, including Cessnock.

The Wollombi Brook Catchment details in the CWSS and mapping indicates that the Wollombi Brook Catchment is classified as having very high to high groundwater vulnerability along its creek banks and a moderately high rating elsewhere. These Wollombi creek line areas are vulnerable to groundwater contamination.

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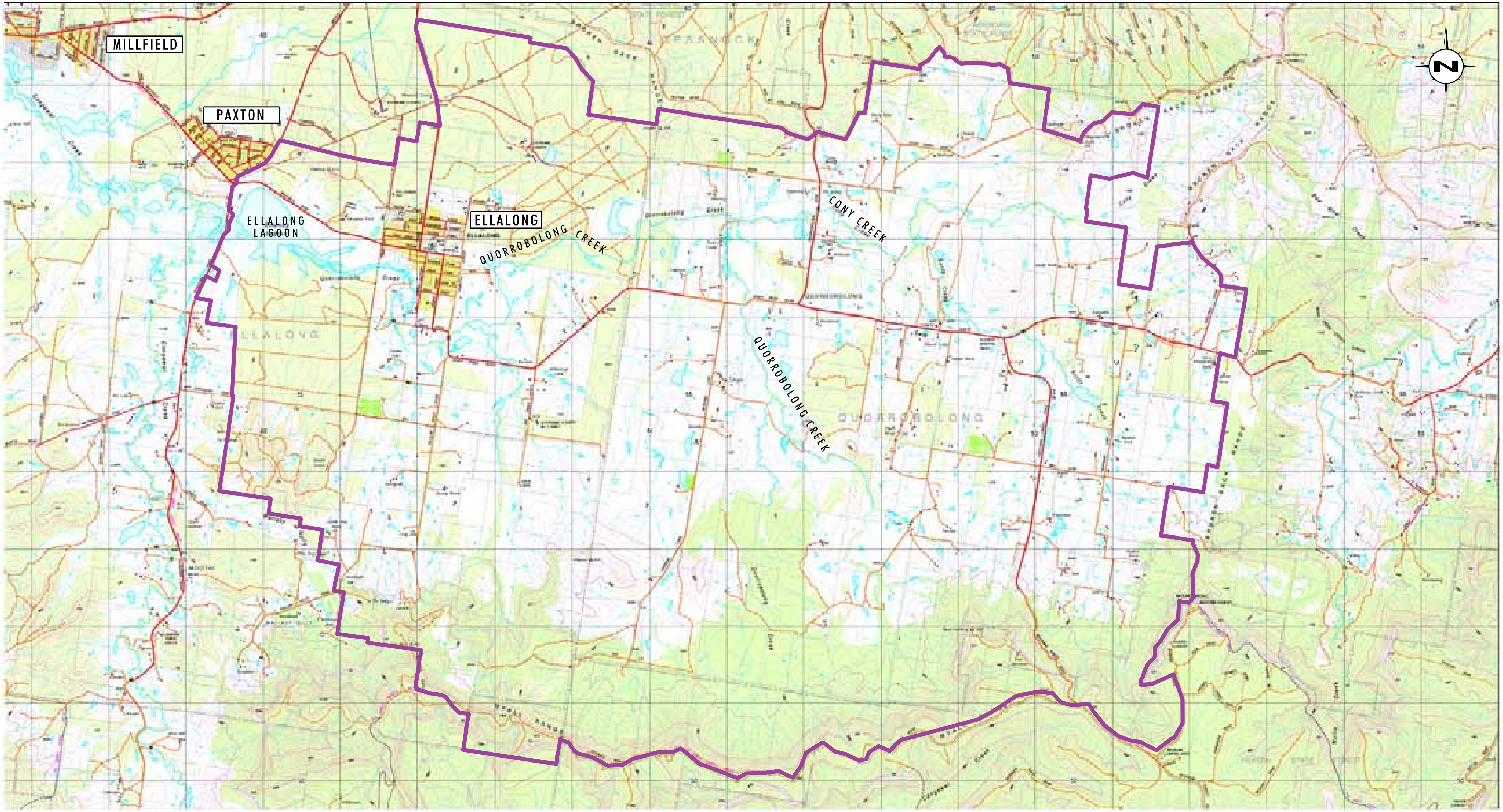


Source: Topo Maps: LPI NSW

0 1 2 3km
1:70 000

Legend

Ellalong Lagoon Catchment Management Area

FIGURE 4.3

Ellalong Lagoon Catchment Management Area

4.5.5 Cessnock Social and Community Plan

The Cessnock Social and Community Plan November 2004 to November 2009 (CSCP) (Cessnock, 2004) has been prepared by Cessnock City Council in partnership with a number of stakeholders within the community and community services centre. The CSCP identifies a range of needs within the Cessnock LGA community and proposes actions and strategies which aim to address the needs identified.

The CSCP states that despite the closure of most of the local mines, many residents travel to the Upper Hunter or Central Coast to retain employment in the coal mining industry.

As stated in **Section 3.2**, the Project will continue to employ 200 people and ensure continuity between underground mining in the Stage 2 and Stage 3 areas.

5.0 Environmental Context

This section provides the environmental context for the Stage 2 Extension Project. It describes the key climate, landform and land use characteristics of the land in proximity to the LW A5a underground mining area in **Sections 5.1** to **5.3**. An environmental risk assessment analysing the risk of significant environmental impact as a result of the Stage 2 Extension Project taking into account the environmental context is set out in **Section 6**. **Section 6** also sets out the key community issues raised during the consultation process for the Stage 2 Extension Project. A detailed impact assessment for key environmental aspects identified in the environmental risk assessment is set out in **Section 7.3**.

5.1 Climate

The climate of the Lower Hunter Valley is described as warm temperate. The region is characterised by seasonal variations from hot wet summers to mild dry winters. The average temperature range is between minus 4.2 to 44.9 degrees Celsius and the highest mean 9 am wind speed is 13.9 kilometres per hour (BoM, 2007).

Rainfall in the region is summer dominant, often presenting as high intensity storms. The entire region receives an average of 750 to 950 mm of rain per annum. Cessnock receives approximately 750 mm of rain per year, which falls on 66 days of the year (BoM, 2007).

Analysis of historical daily rainfall data (Umwelt, 2008b) indicates that major storm events have occurred in the region in 1927, 1930, 1949, 1990 and 2007. Each of these storm events have typically resulted in overland flow flooding and backwater flooding within the Austar Mine Complex. In the 1990 storm event, for example, 311 mm fell in 48 hours at Mulbring and 296 mm fell at Congewai, the two closest stations near Quorrobolong at the time.

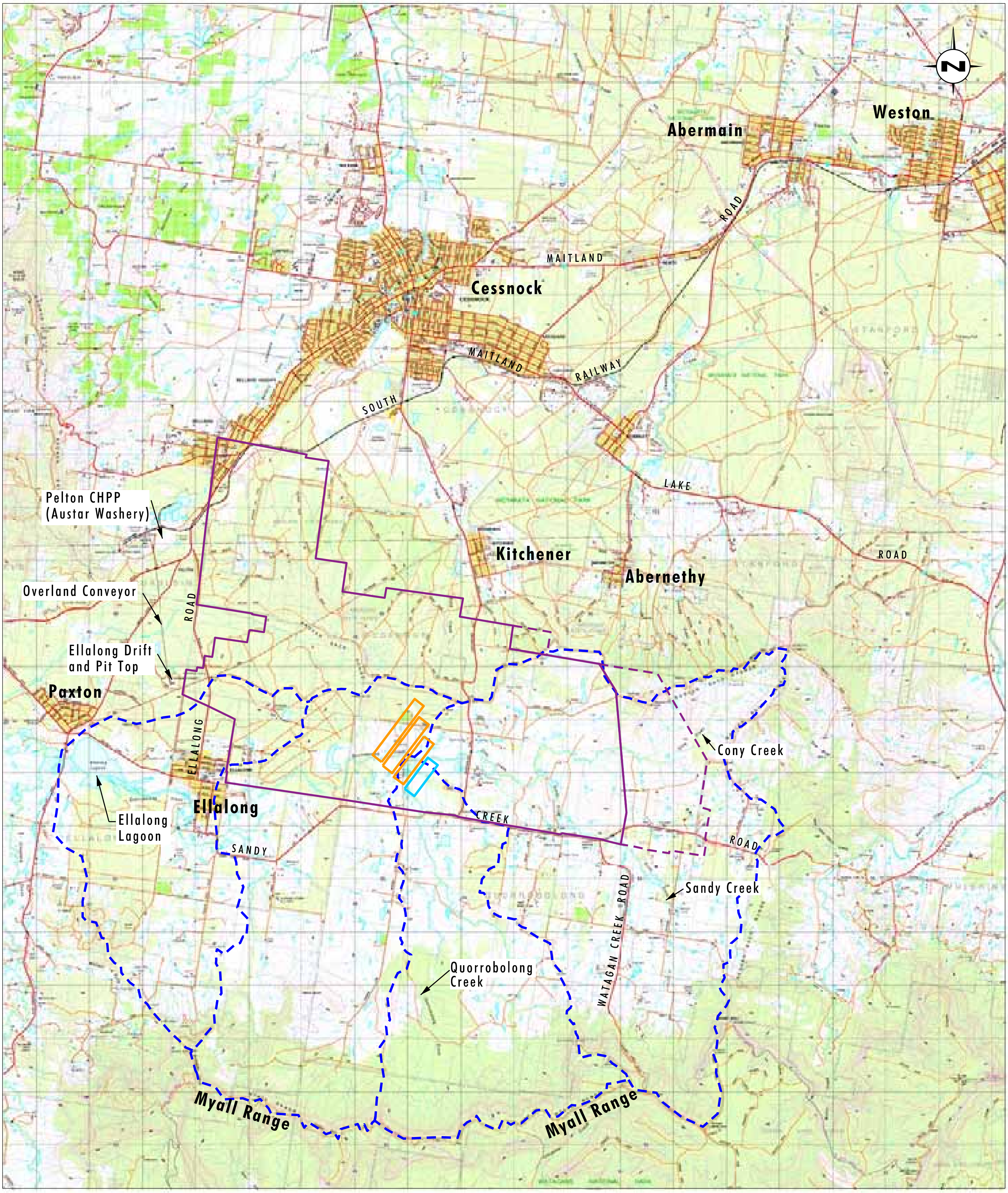
5.2 Existing Landform Characteristics

5.2.1 Topography and Drainage

The morphology of the area surrounding Austar Mine Complex includes Broken Back Range (see **Figure 1.1**); the alluvial flats landforms of Black Creek, Bellbird Creek, Cony, Sandy Creek and Quorrobolong Creek systems and the intervening, undulating lands. Catchment boundaries in the vicinity of the proposed Stage 2 Extension Study Area are shown on **Figure 5.1**.

The Stage 2 Extension Study Area is located to the south of Broken Back Range, a major landform extending from west of Pokolbin to Mulbring. The area encompasses the gentle south facing lower slopes of the Broken Back Range and the extensive creek flat of the Quorrobolong Creek system. The landform above the Stage 2 Extension Study Area is within the Quorrobolong Creek catchment area, with Quorrobolong Creek and one major tributary, Cony Creek, running through the area. Further details of the characteristics of Quorrobolong Creek and Cony Creek catchments are provided in **Section 5.2.2**.

The Stage 2 Extension Study Area drains to Congewai Creek catchment which is bounded by the Watagan Mountains in the south, Broken Back Range in the north and west and Black and Wallis/Swamp Creek catchments to the east. Water flows west out of the catchment via Quorrobolong Creek system which drains to Ellalong Lagoon from where it flows into Congewai Creek, Wollombi Brook and subsequently the Hunter River.



Source: Topo Maps: LPI NSW, Longwall Layout: Austar Coal Mine

0 1.0 2.0 4km
1:100 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Consolidated Mining Lease (CML) 2
- Proposed Stage 3 Extension Boundary
- Catchment Boundary

FIGURE 5.1

Stage 2 Extension: Catchment Boundaries

The Lagoon is situated immediately to the south of the townships of Ellalong and Paxton and will be conserved as the 530 hectare Ellalong Lagoon Conservation Area. A large area of endangered Hunter Lowland Red Gum Forest and small areas of River-flat Eucalypt Forest on coastal floodplain will be protected. The Lagoon itself supports a population of green and golden bell-frogs (CCC, 2004). Potential impacts on Ellalong Lagoon have been raised as an issue during consultation relating to underground mining at Austar and are taken into consideration as part of the flooding and drainage assessment set out in **Section 7.3**.

5.2.2 Quorrobolong Creek and Cony Creek Catchments

The Stage 2 Extension Study Area is located on the south facing lower gentle slopes of the Broken Back Range and the extensive creek flat of the Quorrobolong Creek system. The highest elevation in the immediate vicinity of the Stage 2 Extension Study Area is 161 metres above sea level and forms part of a northwest-southeast oriented spur that extends from the crest of Broken Back Range to a knoll that is located adjacent to the northern bank of Quorrobolong Creek. The creek flat that encircles this knoll typically has an elevation of approximately 125 mAHD. Slopes in the area of the floodplain range between 1% and 5% with the southern face of the knoll exhibiting near vertical sections.

The major drainage line through the area is Quorrobolong Creek which is a fourth order stream. Quorrobolong Creek enters the study area in the south-eastern corner of LW A5a. The drainage line travels in a northerly direction to its confluence with Cony Creek over Longwall A5.

Quorrobolong Creek between the south-eastern corner of LW A5a and its confluence with Cony Creek is characterised by an incised channel that is typically 2 to 5 metres wide at the base and 8 to 10 metres wide at top of bank. The creek banks have steep sides which are typically 2 to 3 metres high and stable. The creek is bounded on either side by a thin strip of riparian vegetation. A series of off-stream farm dams are located on the western side of the creek.

Upstream of its confluence with Quorrobolong Creek, Cony Creek exhibits a broad channel that has a base width of approximately 6 to 10 metres and a top of bank width of approximately 30 to 40 metres and bank heights of 2 to 3 metres. Upstream of the confluence Cony Creek is lined by riparian vegetation that varies in width from one row of trees to approximately 50 metres.

Immediately downstream of the confluence, the channel narrows to be approximately 20 metres wide at top of bank. The northern bank of the creek is confined by a steep rock outcrop that is located on the southern face of a knoll. The top of the knoll has an elevation of approximately 160 mAHD which is 40 metres above the bed of the creek. This section of the creek is a natural constriction that acts as a control to flows in the Quorrobolong and Cony Creek systems upstream of the knoll. Quorrobolong Creek from the confluence flows due west and exhibits a sandy substrate and scattered and discontinuous riparian vegetation. .

5.2.3 Regional Groundwater Resources

The regional groundwater resources in the area surrounding the Austar Mine Complex comprise:

1. Alluvial aquifers

   Quorrobolong Creek and Cony Creek each have alluvial sediment deposits. The groundwater in the alluvium is derived largely from infiltration of rainfall and runoff, although some is derived from lateral infiltration during high flows in the adjacent creeks. There is negligible utilisation of the alluvial groundwater in the area principally due to low yields and high salinity. There are no registered groundwater bores within the Stage 2 Extension Study Area, however there are several bores in the surrounding area as shown on **Figure 5.2**.

2. Fractured rock aquifers (including coal seam aquifers)

   The Permian strata overlying the coal measures in the Newcastle Coalfield generally have very low permeabilities ($<10^{-8}$ m/s). There are occasional layers that have a slightly higher permeability and represent relative aquifers. Discontinuities in this water bearing strata are termed fractured rock aquifers. Flows are often small in these zones, and water quality is generally poor and suitable only for stock use. Fractured rock strata in the vicinity of Austar Mine Complex include the Branxton Formation and the Greta Coal Measures.

3. Abandoned coal mines

   The local groundwater regime in the vicinity of the Austar Mine Complex is heavily influenced by historic mine workings. Abandoned collieries adjacent to the Austar mine such as Pelton, Bellbird, Kalingo, Aberdare Central and Aberdare East (see **Figure 2.1**) are partially filled with groundwater that typically has very low pH, high conductivity and high iron and sulphate levels. These abandoned workings are filled by normal groundwater percolation through fractured rock and through infiltration via interconnected cracking in areas where shallow workings exist. Fine tailings from Pelton CHPP and mine water from the former Southland colliery are also discharged into Pelton and Bellbird collieries in accordance with the Austar Site Water Management Plan (Austar 2008).

   As stated, the quality of water contained in the abandoned mine workings is extremely poor. This is evidenced by the groundwater quality data obtained for water entering the mine through the coal barriers between the abandoned mines and the Austar workings.

5.2.4 Geology and Soils

Geology

Austar is located in the South Maitland Coalfield of the Maitland Group which forms part of the Newcastle Coalfields. The mid Permian Age Greta Coal Measures outcrop around the Lochinvar Anticline, which is the dominant structural feature in the Cessnock area. Austar Mine Complex is located on the nose of the Anticline. Coal in the Stage 2 Extension Area will be sourced from the Greta Seam at depths of approximately 530 to 560 metres below the surface (refer to **Section 7.1** for further details). The Seam is the main economic coal seam in the Greta Coal Measures (Connell Wagner, 2007).

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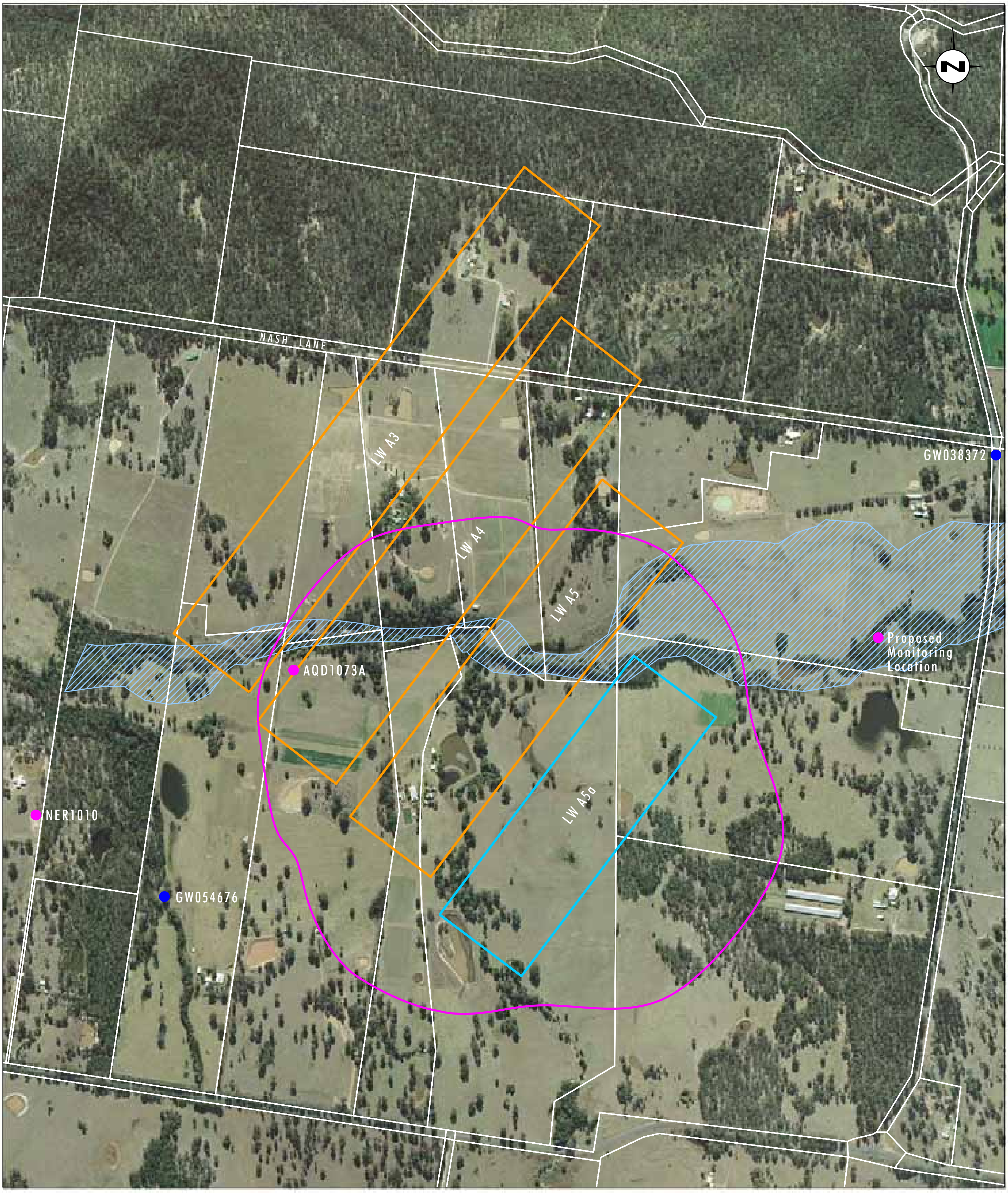


Source: AAM Hatch, 2006
Base Source: Austar Coal Mine

0 200 400 600m
1:12 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Stage 2 Extension Study Area
- Alluvial Area
- Groundwater Bore Locations
- Austar Groundwater Monitoring Sites
- Cadastral Boundary

FIGURE 5.2

Extent of Alluvium

File Name (A4): R56_V1/2274_737.dgn

The Greta Seam is overlain by the Branxton Formation, which comprises a series of interbedded sandstone and siltstone layers up to 20 metres thick. The Pelton Seam, which is less than 0.5 metres thick, lies at the top of the Branxton Formation and forms the upper limit of the Greta Coal Measures (Connell Wagner, 2007).

Four geological units are present in the area surrounding the proposed Stage 3 development (see **Figure 5.3**). The geological units include:

1. Undifferentiated alluvium

   The undifferentiated alluvium is confined to the alignment of Cony Creek and Quorrobolong Creek. It covers the majority of the area over LW A5a and a significant portion of the Stage 2 extension area. The alluvium contains sand, silt, clay, gravel, residual and colluvial deposits, channel, levee, lacustrine, floodplain and swamp deposits. Tertiary terraces may also be present.

2. Branxton Formation

   The Formation overlies the Greta Coal Measures and extends to the ground surface. The Formation occurs across areas of the proposed Stage 2 Extension Study Area located away from the alignment of Cony Creek and Quorrobolong Creek. Maximum thickness in this region is of the order of 1300 metres, and comprises sandstone and conglomerate towards the base, with silty sandstone becoming more common towards the top. The rock is generally strong and massive, with few bedding plane partings. The thickness and strength of this formation is such that it can span significant distances when undermined and as a result it effectively acts as a beam above the mining goaf supporting the overlying strata. Characteristics of the Branxton Formation and its response to predicted subsidence impacts are discussed further in **Section 6.1**.

Soils

One soil landscape, the Quarrabolong Soil Landscape, occurs within the Stage 2 Extension Study Area as shown on **Figure 5.4**. The Landscape defines the creek lines and associated landforms (flats, lower hillslopes) of the Quorrobolong Creek, and Cony Creek systems. These soils have very low permeability and very high strength when dry (Charman and Murphy, 1991). The sandy nature of the upper horizons potentially leads to accelerated erosion if disturbed (HLA, 1995).

5.3 Land Use

Land use in the area surrounding the Stage 2 Extension Study Area is primarily rural lands (with dispersed rural settings), residential and the forested areas of Werakata State Conservation Area. The dominant land uses within and adjacent to the Stage 2 Extension Study Area include grazing, poultry production, forestry and mining.

As specified on the Cessnock LEP Zoning Map (refer to **Figure 4.2**), the land surrounding the proposed development area is zoned 1(a) Rural 'A' Zone.

The Stage 2 Extension Study Area is located under private rural allotments as shown on **Figure 5.5**. Allotments have been predominantly cleared for grazing purposes, are elongated and aligned north to south, with east west property boundaries aligned with the channel of Quorrobolong Creek. The land is gently sloping and properties have access to natural water supplies from pools along Quorrobolong Creek and its tributaries. A number of farm dams exist across the area supplying water for cattle.

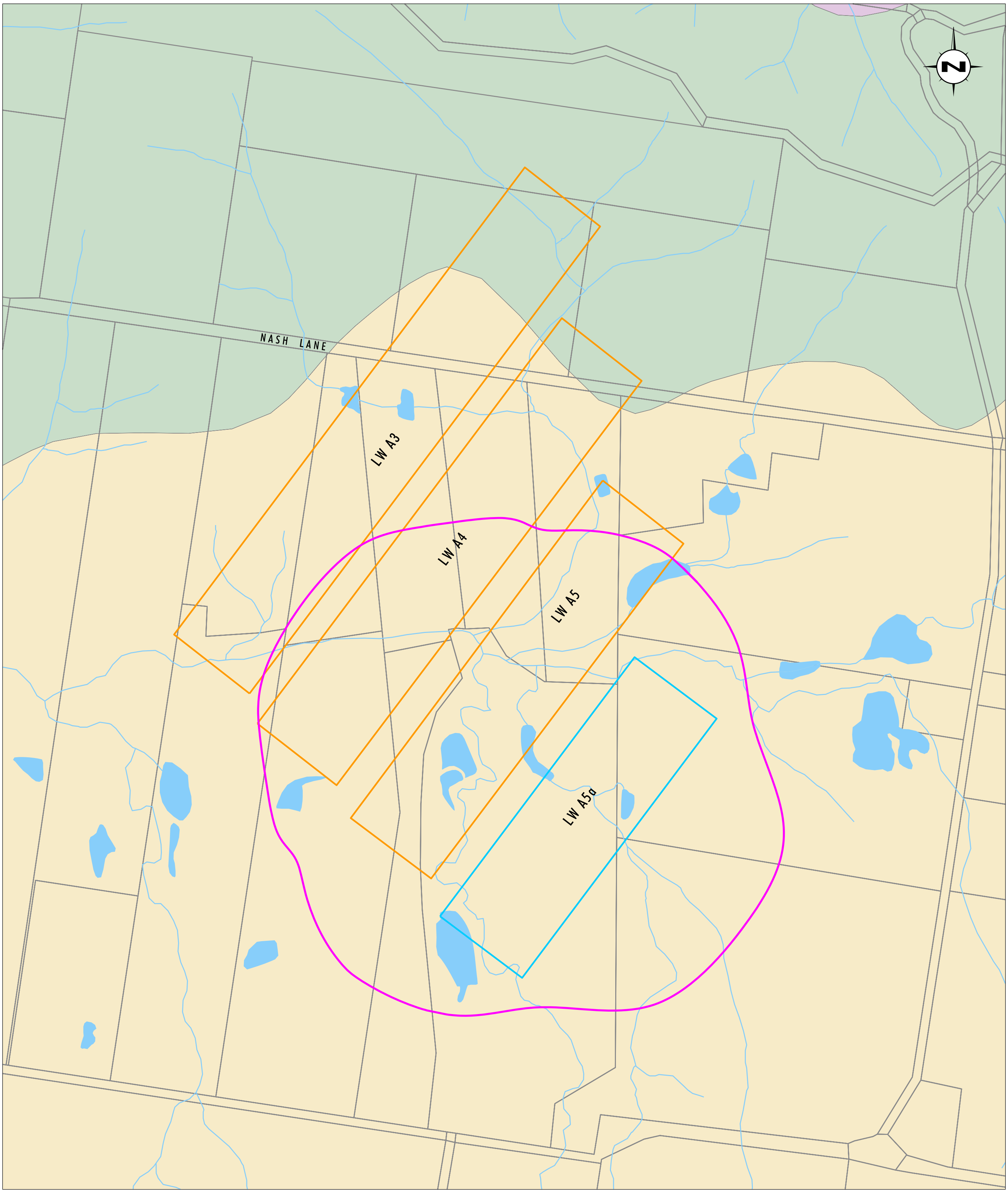
Source: Cadastre: LPI NSW, Geology: Mineral Resources 2003, Longwall Layout: Austar Coal Mine

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Stage 2 Extension Study Area
- Branxton Formation (Conglomerate, sandstone, siltstone)
- Fenestella Shale (Conglomerate, sandstone, siltstone)
- Undifferentiated alluvial deposits; sand, silt, clay and gravel; some residual and colluvial deposits. Includes some channel, levee, lacustrine, floodplain and swamp deposits. May include some higher level Tertiary terraces
- Cadastral Boundary

FIGURE 5.3

Geological Map



Source: Cadastre: LPI NSW, Soils: Department of Natural Resources 2005, Longwall Layout: Austar Coal Mine

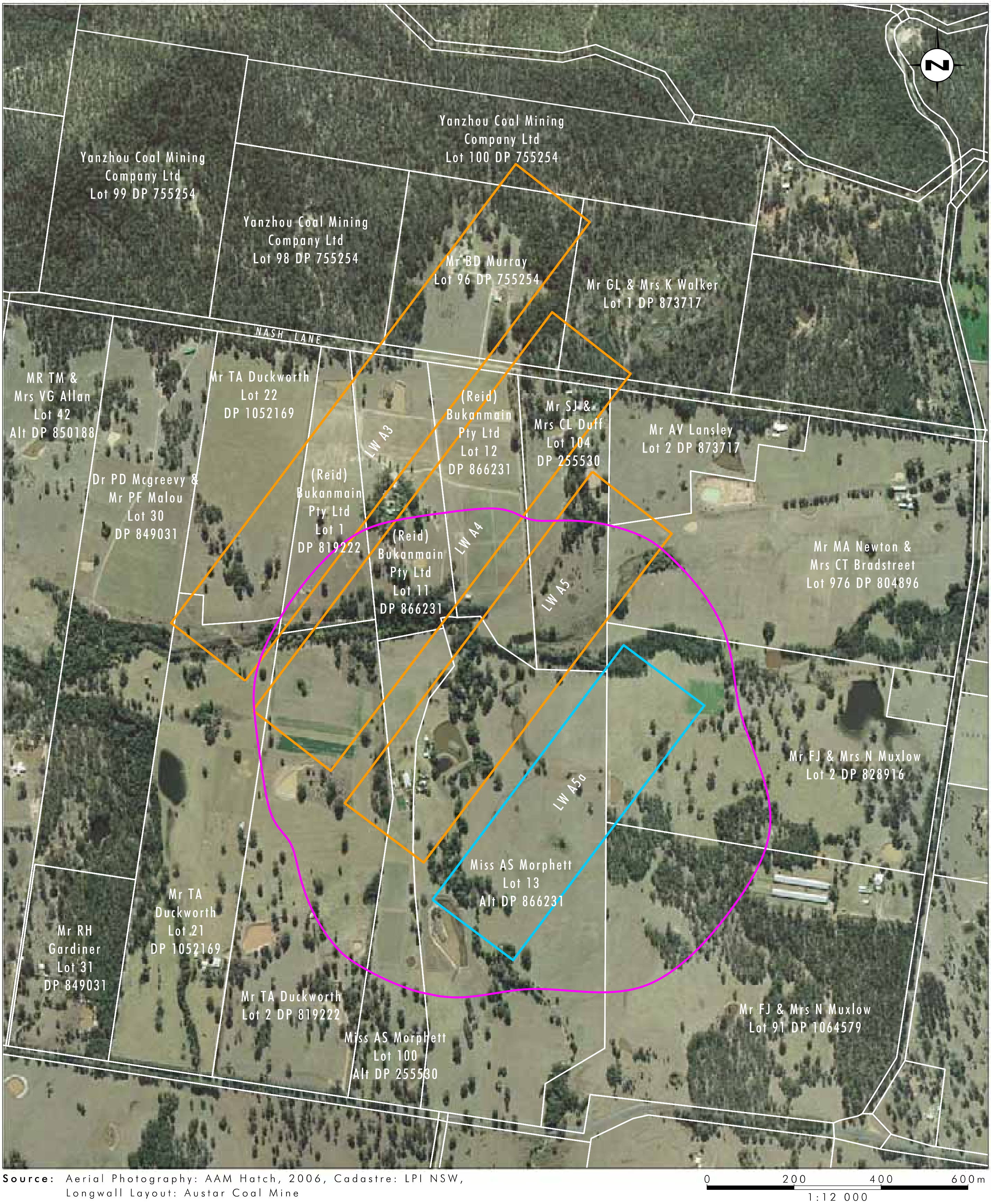
0 200 400 600m
1:12 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Stage 2 Extension Study Area
- Quorrobolong Soil Landscape
- Aberdare Soil Landscape
- Cadastral Boundary
- Drainage Line

FIGURE 5.4

Soil Landscapes



Source: Aerial Photography: AAM Hatch, 2006, Cadastre: LPI NSW, Longwall Layout: Austar Coal Mine

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Stage 2 Extension Study Area
- Cadastral Boundary

FIGURE 5.5

Stage 2 Extension Lot and DP

One rural residence and associated infrastructure (e.g. tennis court, swimming pool and so on) and a number of rural structures (e.g. farm buildings, tanks and sheds) are located within the Stage 2 Extension Study Area.

6.0 Environmental Risk Assessment

6.1 Scope and Methodology

An environmental risk assessment for the Stage 2 Extension Project was undertaken on 5 November 2009 at Austar Coal Mine. The purpose of the risk assessment was to:

- review the environmental hazards associated with the Stage 2 Extension Project; and
- determine what controls, if any, are required to reduce or eliminate any identified hazards to tolerable levels as far as practicable.

The area under consideration in the risk assessment was the Stage 2 Extension Study Area. The risk assessment used the list of surface and sub-surface features that may be affected by underground coal mining included in Appendix B of the *Guideline for Applications for Subsidence Management Approvals* (NSW Department of Mineral Resources, 2003) as the basis for identifying potential environmental impacts as a result of the Stage 2 Extension Project.

Risk rankings were assigned to each potential environmental impact using Austar's likelihood and consequence matrix (refer to **Appendix 3**). The risk assessment has been used as a screening process to determine which environmental aspects require further detailed impact assessment. All impacts identified as having negligible likelihood of occurrence have not been assessed further in this EA. Detailed assessments of impacts with a risk ranking of 'low' or greater are provided in **Section 7**.

The risk assessment was facilitated by AXYS Consulting and included participants from Austar Coal Mine and Umwelt (Australia) Pty Limited. The environmental context for the Stage 2 Extension Project provided in **Section 5** above was used as a basis for the risk assessment. The findings of the risk assessment are presented in full in **Appendix 3** and summarised in **Sections 6.2** below.

A community consultation program is also currently being undertaken by Austar regarding the Stage 2 Extension Project. A discussion of the consultation strategy and key issues raised by community members is set out in **Section 6.3**.

6.2 Results

6.2.1 Landform

Mining of LW A5a will result in the subsidence of the landform within the 20 mm subsidence contour shown on **Figure 1.4**. Landform changes due to subsidence were identified as having a low risk of significant environmental impacts as subsidence will be generally within the envelope of subsidence set out in the 1995 Environmental Impact Statement (HLA-Envirosciences, 1995) and approved in DA 29/95. In addition, results from underground mining in the Stage 1 and Stage 2 areas have indicated no significant landform impacts. Further assessment of potential landform impacts due to subsidence is provided in **Section 7.1**.

6.2.2 Visual Attributes

The visual context of the Stage 2 Extension Study Area is of predominantly rural land holdings with cleared pasture areas interspersed with native vegetation. The area surrounding the Stage 2 Extension Study Area is characterised by native vegetation, cleared pasture areas, roads, and small villages.

Visually prominent features of the area include Ellalong Lagoon, Broken Back Ranges and Watagan Mountains. Werakata State Conservation Area is located to the north of the Stage 2 Extension Study Area.

Subsidence as a result of the Stage 2 Extension Project is predicted to be within the range of subsidence approved under DA 29/95. In addition, no changes to the surface infrastructure required for the mining, handling, processing and transport of coal from the DA 29/95 approval area are proposed. Consequently the risk of significant visual impact as a result of the Stage 2 Extension Project is considered negligible and no further impact assessment is required.

6.2.3 Flooding and Drainage

Possible environmental impacts relating to flooding and drainage within the Stage 2 Extension Study Area identified in the environmental risk assessment include changes to water flow (including depth, duration and velocity of flood waters), water quality and channel stability in Quorrobolong Creek and Cony Creek due to mine subsidence. The risk of significant impacts on flooding and drainage as a result of mining of LW A5a was assessed as moderate. A further assessment of potential impacts on flooding and drainage is therefore required, and is provided in **Section 7.3**.

6.2.4 Groundwater

Possible environmental impacts relating to groundwater resources within the Stage 2 Extension Study Area identified in the environmental risk assessment include changes to groundwater level and quality due to mine subsidence. The risk of significant impacts was assessed as low due to the limited use of groundwater resource in the area, the lack of significant impacts on groundwater resources as a result of mining in the Stage 1 and Stage 2 areas and the fact that the subsidence impacts will be within the range of subsidence impacts assessed in the 1995 EIS. A further assessment of potential impacts on groundwater resources is required, and is provided in **Section 7.4**.

6.2.5 Air Quality

As discussed in **Section 3.1**, the Stage 2 Extension Project will not result in any increase in the rate of extraction or total extraction tonnage approved under DA 29/95, nor will it result in any changes to the surface infrastructure required for the mining, handling, processing and transport of coal from the DA 29/95 area. Consequently, the Stage 2 Extension Project will not result in emissions to air beyond those already approved under DA 29/95. The risk of additional air quality impacts from the Stage 2 Extension Project beyond those already approved under DA 29/95 was therefore assessed as negligible and no further impact assessment is required.

6.2.6 Greenhouse Gas and Energy

Potential environmental impacts as a result of the Stage 2 Extension Project identified in the environmental risk assessment included increased use of energy and emission of greenhouse gas to mine LW A5a. As discussed in **Sections 1.2** and **3.1.1**, the use of LTCC technology will result in approximately 60% greater recovery of the coal resource in LW A5a than conventional longwall methods, for approximately the same amount of energy expenditure. In addition, the Stage 2 Extension Project will not result in any increase in the rate of extraction or total extraction tonnage approved under DA 29/95. The Stage 2

Extension Project will therefore result in lower energy consumption and consequent greenhouse gas emission per tonne of coal mined than undertaking conventional longwall mining as approved under DA 29/95. The risk of increased use of energy and emission of greenhouse gas to mine LW A5a was therefore assessed as low. A further assessment is provided in **Section 7.5**.

6.2.7 Heritage Attributes

Previous surveys of the Stage 2 Extension Study Area, conducted as a part of the 1995 EIS (HLA-Envirosciences, 1995), did not identify any sites of historic heritage significance. However the Stage 2 Extension Study Area has potential to contain areas of Aboriginal archaeological or cultural heritage significance. Possible impacts on the heritage attributes of the Stage 2 Extension Study Area identified in the risk assessment include damage to sites of Aboriginal archaeological or cultural heritage significance if surface restoration works are required as a result of subsidence impacts. It was noted in the risk assessment that the ground surface within the Stage 2 Extension Study Area has been used for agriculture and much of the Study Area is already disturbed. As the Stage 2 Extension Project will not include surface disturbance works beyond those already approved under DA 29/95, and as the subsidence impacts will be within the range of subsidence impacts assessed in the 1995 EIS, the risk of impacts on heritage impacts was assessed as low. A further assessment is provided in **Section 7.6**.

6.2.8 Ecological Attributes

The Stage 2 Extension Study Area contains two Ecologically Endangered Communities (EECs). In addition, two threatened flora species and a number of threatened flora species have the potential to occur within the area. Consequently, the possible impacts on the ecological attributes of the area include damage or loss of natural vegetation, loss of protected species or EECs and/or their habitat. As the Stage 2 Extension Project will not include surface disturbance works beyond those already approved under DA 29/95, and as the subsidence impacts will be within the range of subsidence impacts assessed in the 1995 EIS, the risk of significant impacts was assessed as low. A further assessment provided in **Section 7.7** below

6.2.9 Noise

As discussed in **Section 3.1**, the Stage 2 Extension Project includes a modification to the method and height of longwall extraction within LW A5a only. It will not result in any increase in the rate of extraction or total extraction tonnage approved under DA 29/95, nor will it result in any changes to the surface infrastructure required for the mining, handling, processing and transport of coal from the DA 29/95 area. Consequently, the Stage 2 Extension Project will not result in noise emissions beyond those already approved under DA 29/95. The risk of additional noise impacts from the Stage 2 Extension Project beyond those already approved under DA 29/95 was therefore assessed as negligible and no further impact assessment is required.

6.2.10 Vibration

As discussed, the Stage 2 Extension Project will involve the extraction of coal using LTCC techniques from longwall A5a. The vibration monitoring program undertaken as a part of Stage 1 and Stage 2 mining operations has not indicated any significant vibration outside of that approved under DA 29/95 as a result of underground mining using LTCC techniques. Consequently an increase in vibration as a result of mining of LW A5a using LTCC techniques is considered unlikely. Monitoring of vibration for the Stage 2 Extension Project will be undertaken as a continuation of the existing Stage 2 monitoring program. The risk of additional vibration impacts from the Stage 2 Extension Project beyond those already approved under DA 29/95 was assessed as negligible. A further assessment of vibration from the Stage 2 Extension Project is provided in **Section 7.2**.

6.2.11 Built Features

6.2.11.1 Public Utilities

The environmental risk assessment included a review of public utilities occurring within the area (e.g. roads, railways, bridges, pipelines and so on). A full list of the utilities considered in the risk assessment is included in **Appendix 3**. The risk assessment found that the Stage 2 Extension Project could potentially impact on 11 kV and domestic electricity transmission lines and domestic telecommunication lines. The risk of damage was assessed as being moderate and further impact assessment is therefore necessary. A further assessment of subsidence impacts on public utilities is provided in **Section 7.1**.

6.2.11.2 Farm Land, Facilities and Residences

The environmental risk assessment included a review of farm land, facilities and residences occurring within the Stage 2 Extension Study Area. A full list of the items considered in the risk assessment is included in **Appendix 3**. The risk assessment found that the Stage 2 Extension Project could potentially impact on lands and facilities within six rural properties, and may impact upon two rural residences. The risk of damage was assessed as being moderate to high and further impact assessment is therefore necessary. A further assessment of subsidence impacts on farm land, facilities and residences is provided in **Section 7.1**.

6.3 Community Consultation

The community consultation program being undertaken by Austar has included letters and presentations to key stakeholders including landholders within the Stage 2 Extension Study Area and the Austar Coal Mine Community Consultative Committee (CCC). An example of the letters of information and the presentation given to the key stakeholders in regard to the Stage 2 Extension Project is provided in **Appendix 4**. The consultation program forms a part of the ongoing community consultation undertaken by Austar and will continue throughout the Stage 2 Extension Project modification application process. Ongoing consultation will be linked to the existing Property Subsidence Management Planning process and the CCC.

The key issues of community interest raised to date in the consultation process include:

- area of subsidence impact;
- impact on housing, other structures and agricultural areas within the Stage 2 Extension Study Area; and
- impact on creek lines, flooding and drainage

A further assessment of subsidence impacts on farm land, facilities and residences is provided in **Section 7.1**. An assessment of impacts on creek lines, flooding and drainage is provided in **Section 7.3**.

7.0 Environmental Impacts and Control Measures

7.1 Subsidence Impacts

Mine Subsidence Engineering Consultants Pty Limited (MSEC) was commissioned by Austar to prepare subsidence predictions based on the conceptual mine plan for the Stage 2 Extension Project and undertake impact assessments in regard to natural and built features in the area of potential impact. The detailed Subsidence Impact Assessment prepared by MSEC is provided in **Appendix 5** and should be consulted for a full explanation of the subsidence assessment. Proposed LW A5a is a single panel located adjacent to LW A5 of the approved Stage 2 (LW A3 to LW A5). The position of proposed LW A5a and the Subsidence Impact Assessment Study Area are indicated in **Figure 1.4**. This section of the report summarises and presents the major findings of the Subsidence Impact Assessment.

7.1.1 Subsidence Prediction Methodology

Underground longwall mining involves the removal of coal from a series of panels (extraction areas) within a coal seam. As the coal in each longwall panel is removed, the roof behind the mine workings is allowed to collapse causing the overlying rock to fracture and settle. The settlement potentially progresses up through the overlying strata that may result in a degree of subsidence of the ground surface.

It is proposed that LW A5a will be mined using Longwall Top Coal Caving (LTCC) techniques. A description of LTCC techniques is provided in **Section 3.1.1**.

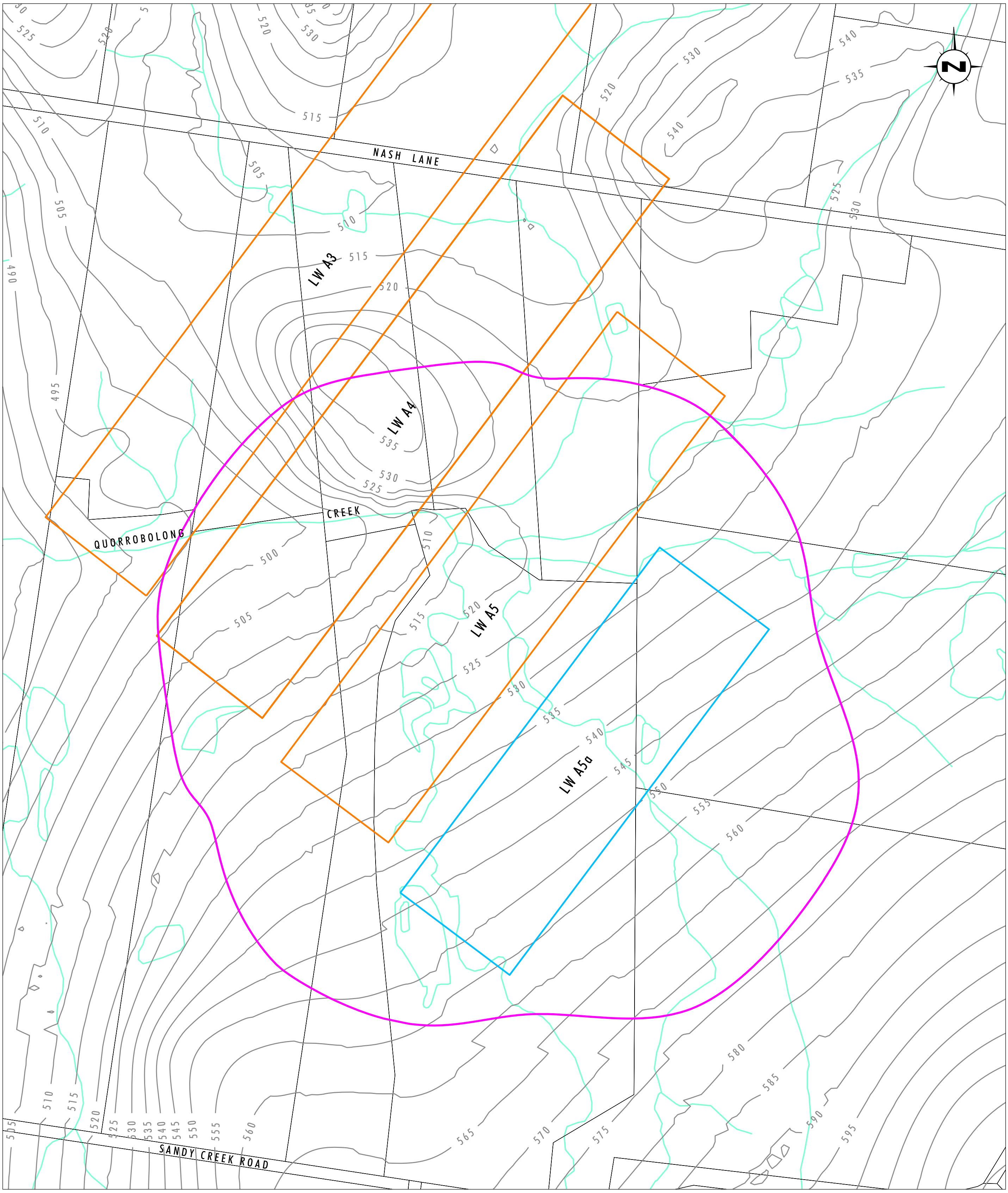
The depth of cover to the Greta Coal Seam above the proposed LW A5a varies between a minimum of 530 metres, at the northern corner of proposed LW A5a, to a maximum of 560 metres, at the southern corner of proposed LW A5a (refer to **Figure 7.1**). The seam floor at the proposed longwall generally dips from the north-west to the south-east.

Thickness of the coal seam within the mining area of proposed LW A5a varies between a minimum of 5.5 metres, at the finishing (south-western) end and a maximum of 6.0 metres, near the commencing (north-eastern) end of proposed LW A5a. A cross-section through the proposed longwall is illustrated in **Appendix 5**.

An empirical approach to predicting systematic and non-systematic subsidence has generally been adopted in the coalfields of New South Wales and has been applied to the Stage 2 Extension Project. This methodology has expanded in recent years by the development of the Incremental Profile Method (IPM). The calibrated IPM has been used by MSEC to assess the subsidence parameters for the Project.

Subsidence predictions have been presented at two levels, those being:

- **Maximum Predicted Subsidence** which is the maximum subsidence that is predicted to occur based on the calibrated IPM model MSEC developed for the site; and
- **Upper Bound Subsidence** which has been derived assuming that subsidence is equivalent to 65% of the extracted seam thickness, which is typically the maximum subsidence experienced in the Newcastle Coalfield. The Upper Bound subsidence prediction was generated for the Stage 2 Extension Project for formal risk assessment purposes and is substantially greater than the Maximum Predicted Subsidence indicated by the calibrated IPM model developed by MSEC.



Source: Austar Coal Mine
Note: Contour Interval 5m

0 100 200 400m
1:9 000

Legend

- Stage 2 Extension Study Area
- Layout for Stage 2 Longwall Panel
- Layout for Stage 2 Longwall Panel
- Drainage Line
- Contours

FIGURE 7.1

Stage 2 Extension Project Depth of Cover

Subsidence generally refers to the range of ground movements which result from mining operations. A typical subsidence profile is illustrated in **Figure 7.2**. Ground movements are described by the following parameters:

- subsidence refers to the vertical and horizontal displacement of the ground;
- tilt is the change in the slope of the ground as a result of differential subsidence;
- curvature refers to the rate of change of tilt; and
- strain is the change in horizontal distance between two points on the ground. Tensile strains occur when the distance between two points increases and compressive strains occur when the distance between two points decreases.

Normal ground movements resulting from the extraction of pillars or longwalls are referred to as systematic subsidence movements. The movements may be incremental or cumulative.

Non-systematic subsidence movements include far-field horizontal movements, irregular subsidence movements and valley related movements.

7.1.2 Subsidence Predictions and Assessment

A subsidence profile may be projected once the following parameters have been determined:

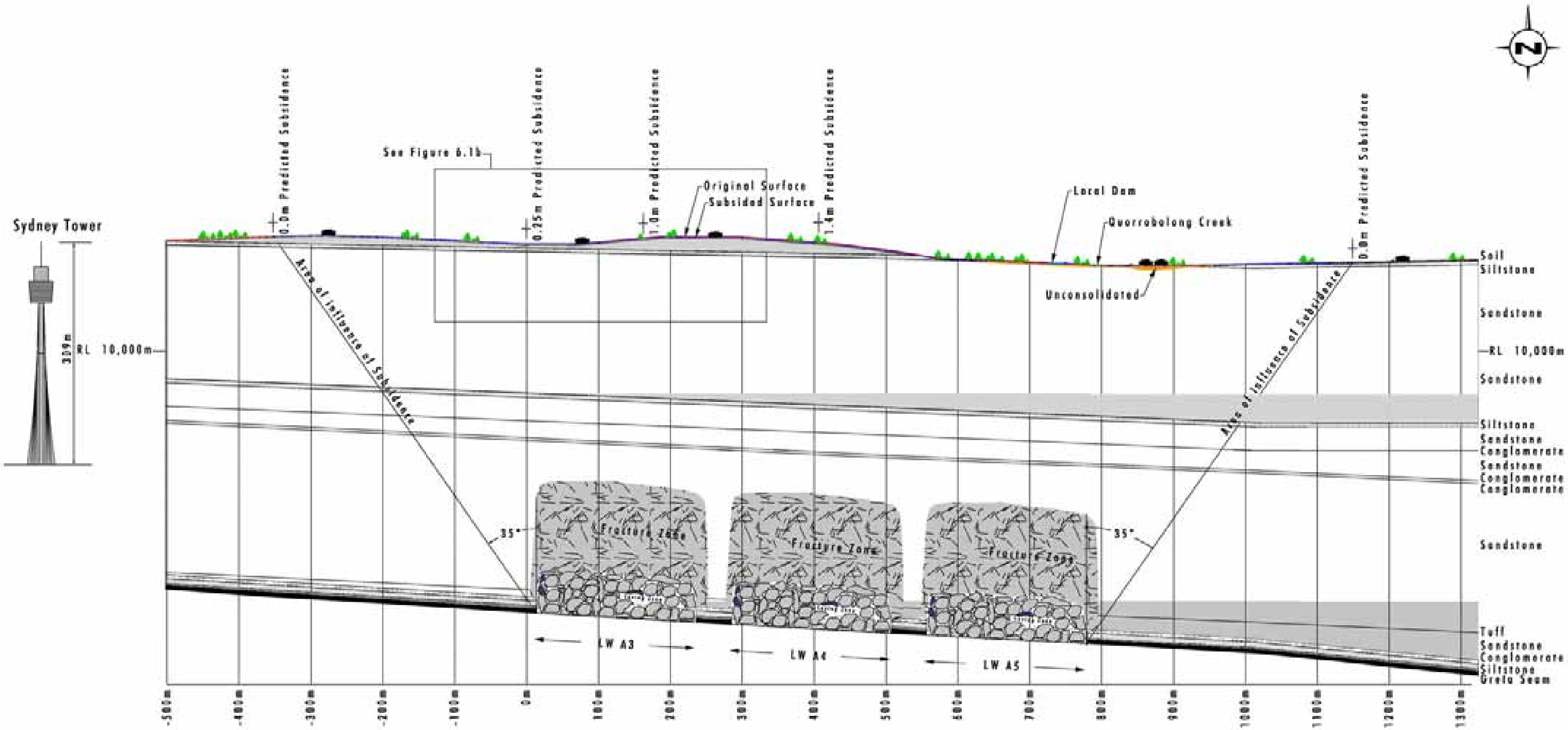
- maximum subsidence value;
- location of the inflection point;
- average goaf edge subsidence; and
- limit of subsidence.

The limit of subsidence is determined from the depth of cover and the angle of draw.

The predicted maximum tensile strain, compressive strain and tilt can be determined from the maximum subsidence and depth of cover. Profiles can be predicted in both the transverse and longitudinal directions, thus allowing the subsidence, tilts, systematic curvatures and systematic strains to be predicted at any point on the surface above a series of longwalls.

The predicted systematic subsidence parameters for the proposed underground mining of LW A5a were made using a calibrated IPM. The model was calibrated using measured local subsidence data from the colliery, including the previously extracted Longwalls SL1 to SL4 and Longwalls 1 to 13A. The monitoring results from LW A1 and A2 from Stage 1 of the Austar mine, where coal has been extracted using LTCC techniques, have been compared to the predictions made by the calibrated IPM model. The maximum observed subsidence, tilts and strains were typically less than or similar to those predicted by the calibrated IPM model.

The overall IPM empirical methodology is based on a large database of observed monitoring data from previously extracted longwalls within the Southern, Newcastle, Hunter and Western Coalfields of New South Wales. This database includes observed subsidence profiles based on extraction heights varying from less than 2 metres up to 5 metres. The IPM is slightly conservative and based upon predicting the incremental subsidence profile for each longwall in a series of longwalls. The respective incremental profiles are then added to show the cumulative subsidence profile at any stage in the development of a series of



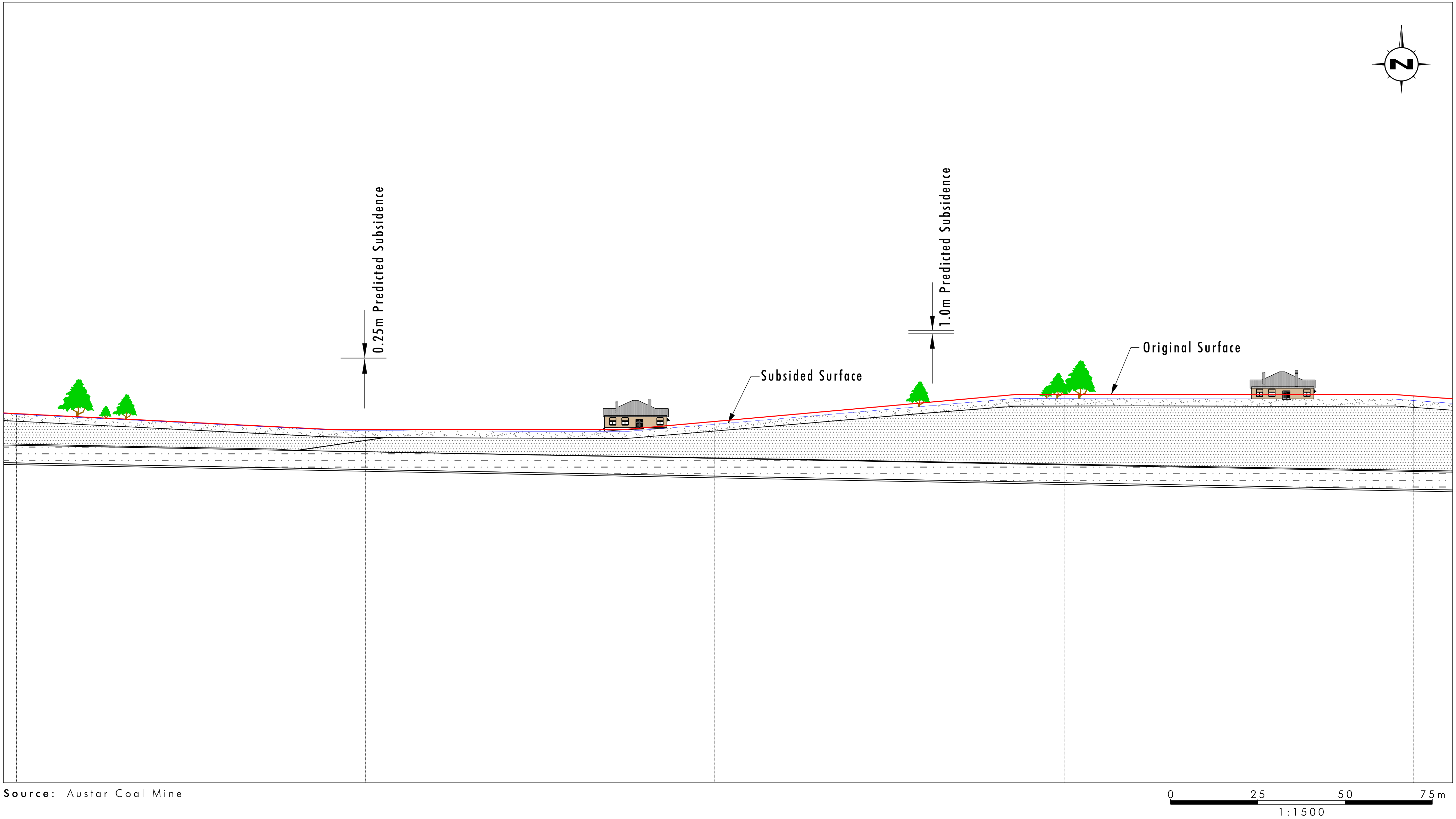
Anticipated Subsided Landform Stage 2 Area

FIGURE 7.2a

Typical Cross Section - Stage 2

Source: Austar Coal Mine

File Name (A4): R56_V1/2274_732.dgn



Source: Austar Coal Mine

FIGURE 7.2b

Typical Cross Section - Stage 2
Inset

longwalls. This method also allows for variations in tilt, curvature and strain to be determined across a series of longwalls.

The seam thickness for proposed LW A5a ranges from 5.5 to 6.0 metres. LTCC equipment will mine the bottom 3 metres of the seam and recover approximately 85% of the top coal. The equivalent extracted seam thickness as a result is approximately 5.1 to 5.6 metres which is up to 10 % thicker than the upper limit of seam thickness in the database used to develop the IPM. However, the IPM model has been calibrated for LTCC methods and comparisons between the observed subsidence during the extraction of Stage 1 LW A1 and A2 with the predictions made by the calibrated IPM model indicate that the model provides reasonable, if not slightly conservative, predictions.

Subsidence impact assessment involves using the subsidence predictions to forecast the level of impact on natural and man-made surface features within the project area and beyond. A detailed review of natural features and items of surface infrastructure potentially impacted by the project has been completed and detailed subsidence predictions and impact assessment provided for these items (refer to the full MSEC report in **Appendix 5**).

Sections 7.1.8 to **7.1.15** provide a description of the potential physical impacts of subsidence on the land and surface features. Further details of the impact of subsidence on particular environmental aspects are provided in the following sections:

- surface drainage systems – **Section 7.3**;
- groundwater resources – **Section 7.4**;
- Aboriginal heritage sites – **Section 7.6.1**;
- historic heritage sites – **Section 7.6.2**, and
- flora and fauna – **Section 7.7**.

7.1.3 Physical Context for Subsidence Impact Assessment

The Study Area (shown in **Figure 1.4**) was defined as the sum of the surface areas bounded by the following limits:

- the 26.5 degree angle of draw line from the proposed extents of LW A5a;
- the predicted limit of vertical subsidence resulting from the extraction of proposed LW A5a, taken as the 20 mm subsidence contour; and
- features sensitive to far-field movements.

A number of structures and natural features were identified in the Study Area during the Subsidence Impact Assessment and include:

- watercourses, including Cony and Quorrobolong Creeks;
- steep slopes;
- electrical infrastructure comprising 11 kV powerlines and consumer lines;
- telecommunication services;
- farm dams; and

- houses and rural building structures.

Features outside of the Study Area that are expected to experience and be sensitive to far-field movements include:

- sections of Cony and Quorrobolong Creeks outside the Study Area but within the predicted limits of the valley related movements; and

- Survey Control Marks.

The locations of these structures and features are shown in **Appendix 5**.

The substantial Branxton Formation which forms the geological strata above the Greta Coal Seam is very thick and strong and acts as a beam over the mined areas. As a result the majority of subsidence results from the compression of the chain pillars that are left between successive longwalls with the Branxton Formation effectively supporting the landform above the longwalls and transferring the resultant load to the chain pillars. The beam action of the Branxton Formation has considerable bearing on subsidence potential and surface subsidence impacts. The landform above mined areas following subsidence tends to subside reasonably uniformly creating a broad shallow subsidence bowl.

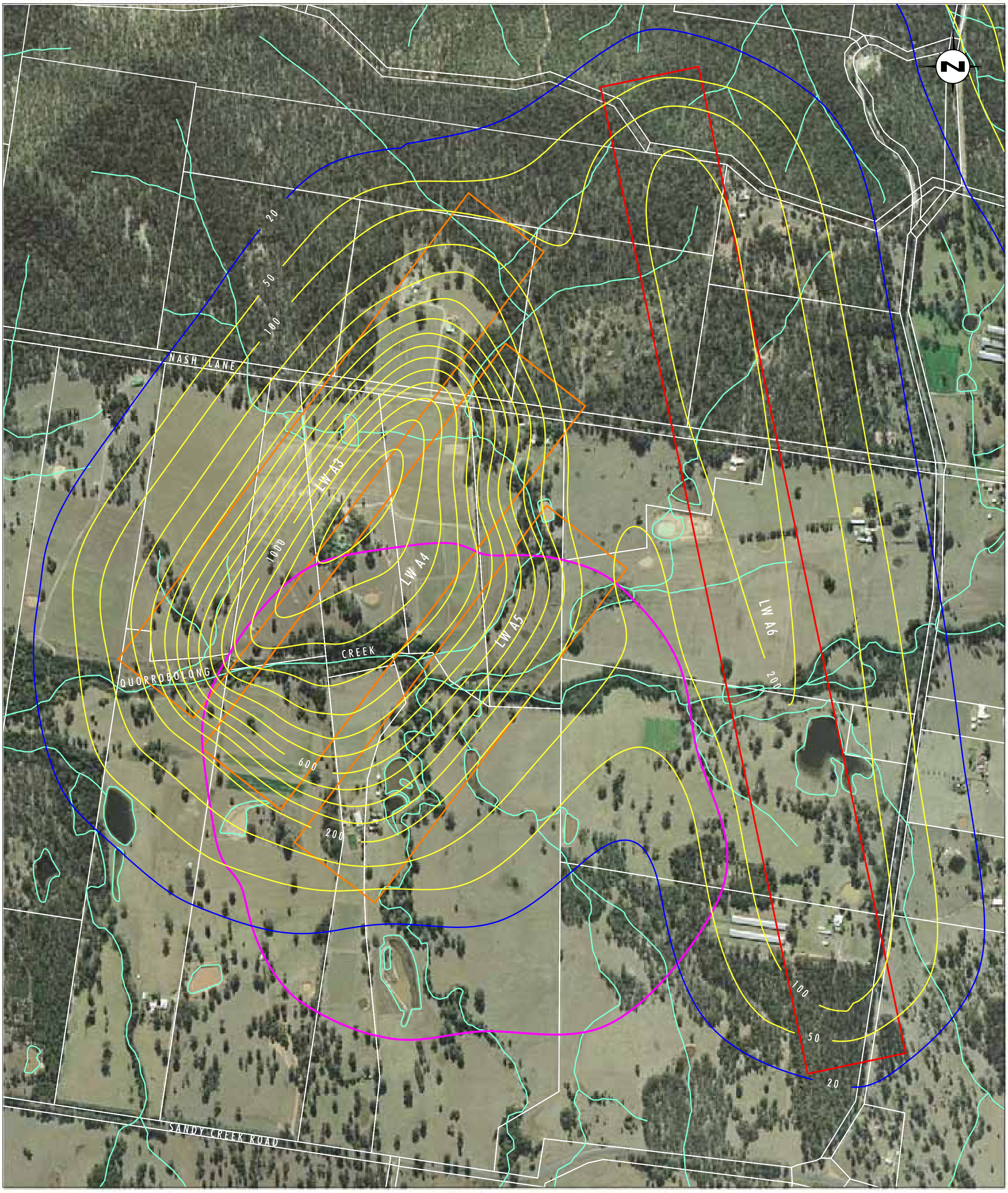
7.1.4 Maximum Predicted Systematic Subsidence Parameters

Maximum predicted subsidence within the study area for the existing approved Stage 2 and Stage 3 mining areas is shown in **Figure 7.3**. The maximum predicted subsidence within the study area including the Stage 2 Extension Project is shown in **Figure 7.4**. The predicted landform as a result of maximum predicted subsidence following the extraction of the proposed longwall is shown on **Figure 7.5**. A summary of the maximum predicted incremental and cumulative systematic subsidence parameters is provided in **Tables 7.1** and **7.2** respectively. As discussed in **Appendix 5**, the extraction of the future LW A6 from the Stage 3 area is predicted to result in an additional subsidence of 200 mm at the eastern extent of the Study Area, and an additional subsidence of 40 mm above the commencing (north-eastern) end of the proposed LW A5a (refer to **Figures 7.3** and **7.4)**. The extraction of LW A6 will not alter the maximum predicted systematic subsidence parameters for the study area and hence has not been included in **Tables 7.1** and **7.2**. Further discussion of the interaction between the Stage 2 Extension Project and Stage 3 is provided in **Section 7.1.17** and **Appendix 5**.

Table 7.1 – Maximum Predicted Incremental Systematic Subsidence Parameters Resulting from the Extraction of LW A5a

Longwall	Maximum Predicted Cumulative Subsidence (mm)	Maximum Predicted Cumulative Tilt (mm/m)	Maximum Predicted Total Systematic Hogging Curvature (mm/m)	Maximum Predicted Total Systematic Sagging Curvature (mm/m)
LWA5a	650	3.0	0.03	0.06

Umwelt
Environmental Consultants



Source: Austar Coal Mine
Note: Contour Interval 100mm

0 200 400 600m
1:12 000

Legend

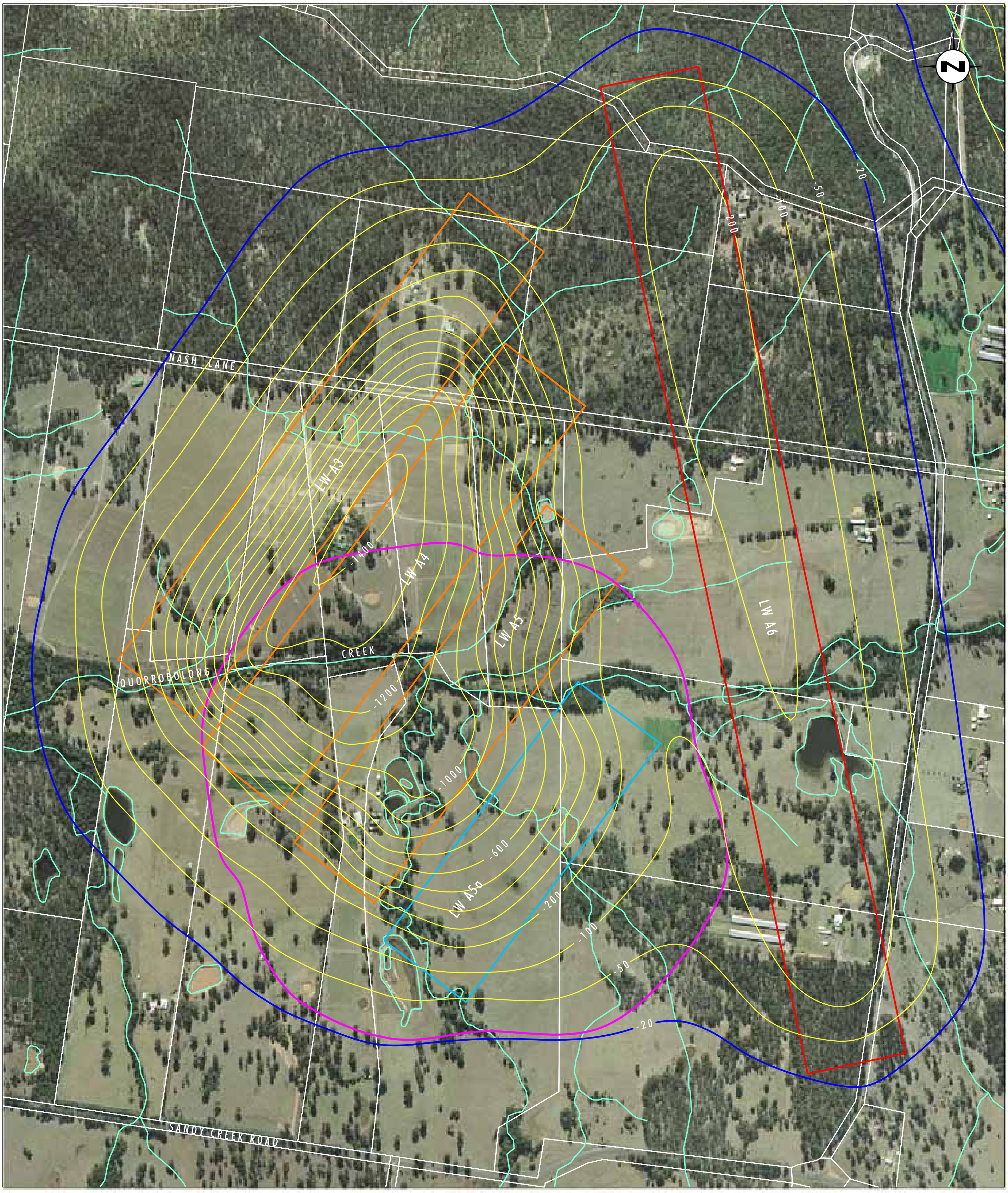
- Stage 2 Extension Study Area
- Layout for Stage 2 Longwall Panel
- Layout for Stage 2 Extension Longwall Panel
- Drainage Line
- Approved Predicted Subsidence -20mm Contour
- Approved Predicted Subsidence Contour

FIGURE 7.3

Predicted Subsidence Stages 2 and 3 As Approved

File Name (A4): R56_V1/2274_794.dgn

Umwelt
Environmental Consultants



Source: Austar Coal Mine
Note: Contour Interval 50mm

0 200 400 600m
1:12 000

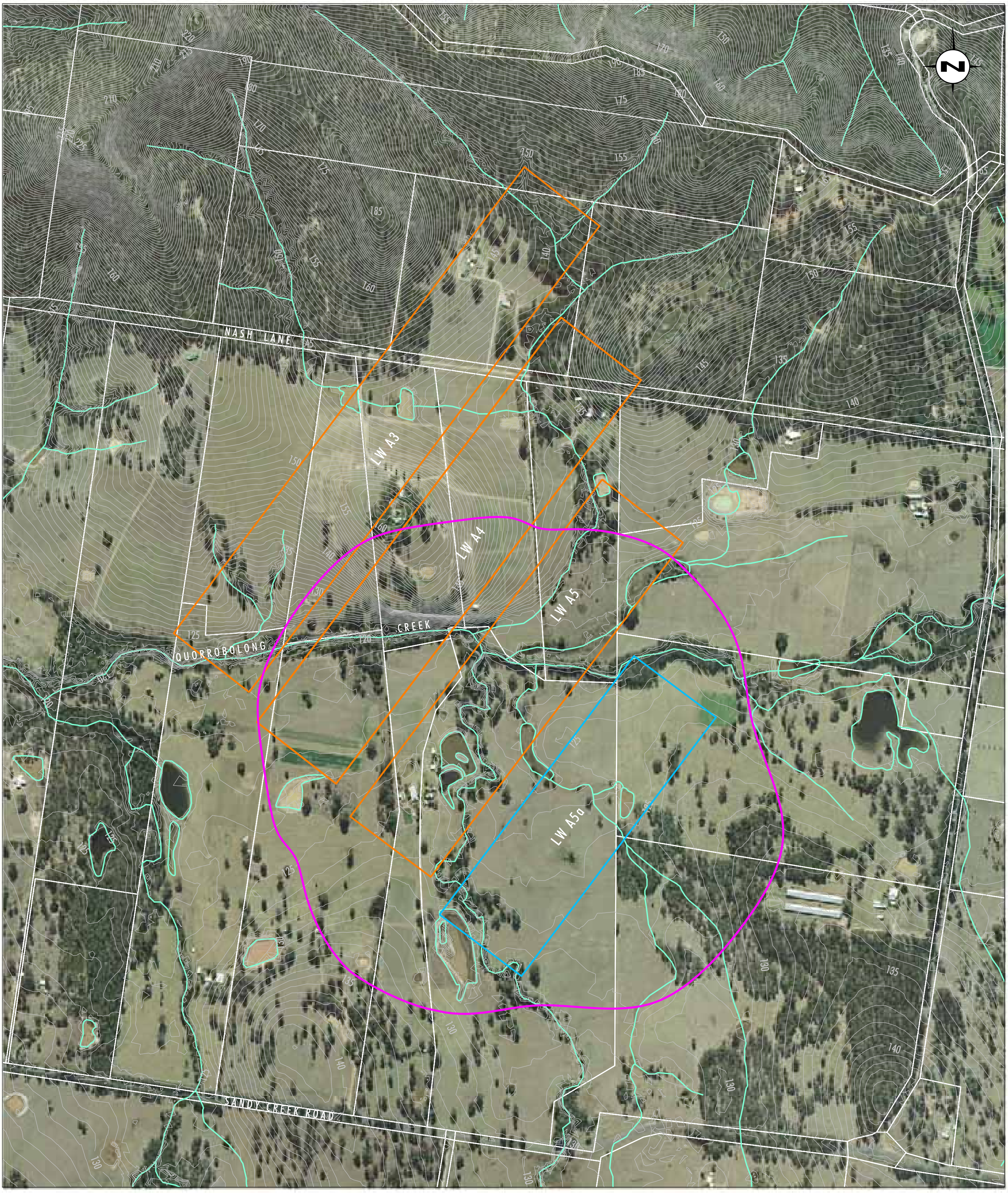
Legend

- Stage 2 Extension Study Area
- Layout for Stage 2 Longwall Panel
- Layout for Stage 2 Longwall Panel
- Layout for Stage 2 Extension Longwall Panel
- Drainage Line
- Approved Predicted Subsidence -20mm Contour
- Approved Predicted Subsidence Contour

FIGURE 7.4

Predicted Subsidence Stages 2 and 3 As Approved Plus Stage 2 Extension

File Name (A4): R56_V1/2274_795.dgn



Source: Austar Coal Mine
Note: Contour Interval 1m

0 200 400 600m
1:12 000

Legend

- Stage 2 Extension Study Area
- Layout for Stage 2 Longwall Panel
- Layout for Stage 2 Longwall Panel
- Drainage Line
- Contours

FIGURE 7.5

Predicted Landform After Completion of LW A5a

Table 7.2 – Maximum Predicted Cumulative Systematic Subsidence Parameters Resulting from the Extraction of LW A3 to A5a

Longwall	Maximum Predicted Cumulative Subsidence (mm)	Maximum Predicted Cumulative Tilt (mm/m)	Maximum Predicted Total Systematic Hogging Curvature (mm/m)	Maximum Predicted Total Systematic Sagging Curvature (mm/m)
After LWA3-LWA5	1400	5.7	0.05	0.12
After LWA5a	1450	5.7	0.05	0.12

As can be seen from **Table 7.2**, the predicted cumulative effects of extracting LW A5a are only slightly greater than those predicted for LW A3 to A5 that form the already approved Stage 2.

7.1.5 Maximum Upper Bound Systematic Subsidence Parameters

The upper bound systematic subsidence parameters are described in **Section 7.1.1** and the predicted landform as a result of upper bound subsidence is shown in **Appendix 5**. The predicted maximum upper bound incremental and cumulative systematic subsidence parameters are summarised in **Tables 7.3** and **7.4**.

Table 7.3 – Maximum Predicted Upper Bound Incremental Systematic Subsidence Parameters Resulting from the Extraction of LW A5a

Longwall	Maximum Upper Bound Cumulative Subsidence (mm)	Maximum Upper Bound Cumulative Tilt (mm/m)	Maximum Predicted Total Systematic Hogging Curvature (mm/m)	Maximum Predicted Total Systematic Sagging Curvature (mm/m)
LWA5a	1300	6.0	0.06	0.12

Table 7.4 – Maximum Predicted Upper Bound Cumulative Systematic Subsidence Parameters Resulting from the Extraction of LW A3 to A5a

Longwall	Maximum Upper Bound Cumulative Subsidence (mm)	Maximum Upper Bound Cumulative Tilt (mm/m)	Maximum Predicted Total Systematic Hogging Curvature (mm/m)	Maximum Predicted Total Systematic Sagging Curvature (mm/m)
After LWA3-LWA5	2950	11	0.08	0.25
After LWA5a	3000	12	0.08	0.25

As can be seen from **Table 7.4**, the predicted maximum upper bound cumulative effects of extracting LW A5a are only slightly greater than those predicted for LW A3 to LW A5 that form the already approved Stage 2.

7.1.6 Predicted Strain

A statistical approach was used to express the predicted strain with the Study Area in order to convey the variation in strain that is likely to occur from the predicted average values. The range of potential strains above the proposed longwall were determined from monitoring data from the previously mined longwalls at the colliery, some of which were mined using LTCC techniques and some of which were mined using conventional techniques.

The frequency distributions of the maximum observed tensile and compressive strains above the longwalls follow a gamma distribution. **Table 7.5** shows the statistical properties of the data for survey bays above goaf (the previously extracted longwalls) and above solid coal (above the chain pillars or above solid coal within 250 metres of the nearest goaf edge).

Table 7.5 –Observed Strains from Previously Mined Longwalls at the Colliery

	Survey Bays Above Goaf		Survey Bays Above Solid Coal	
	Tensile Strain	Compressive Strain	Tensile Strain	Compressive Strain
Number of survey bays	256		333	
Maximum strain (mm/m)	2.8	4.1	1.7	1.3
Mean strain (mm/m)	0.18	0.35	0.15	0.11
Standard Deviation (mm/m)	0.32	0.56	0.19	0.21

The probability that a level of strain will be exceeded is provided for survey bays above goaf and solid coal is provided in **Table 7.6**, based on the gamma distributions of the observed values.

Table 7.6 – Probability of Exceedance for Strain at Survey Bays

Strain		Probability of Exceedance	
		Survey Bays Above Goaf	Survey Bays Above Solid Coal
Compression	-5.0	1 in 1500	No data
	-4.0	1 in 500	No data
	-3.0	1 in 150	No data
	-2.5	1 in 80	No data
	-2.0	1 in 40	No data
	-1.5	1 in 20	1 in 400
	-1.0	1 in 10	1 in 100
	-0.75	1 in 7	1 in 40
	-0.5	1 in 5	1 in 20
	-0.25	1 in 3	1 in 7
Tension	0.25	1 in 4	1 in 5
	0.5	1 in 9	1 in 15
	0.75	1 in 15	1 in 50
	1.0	1 in 30	1 in 150
	1.5	1 in 90	1 in 1300
	2.0	1 in 250	No data
	2.5	1 in 700	No data
	3.0	1 in 2000	No data

7.1.7 Likely Height of the Fractured Zone above the Proposed Longwalls

The height of the collapsed zone, which forms immediately above extracted longwalls, is generally between 21 to 33 times the extracted seam thickness. Based on a variable effective seam height of 5.1 to 5.6 metres, the height of the collapsed zone for the proposed longwalls varies between approximately 105 and 185 metres.

The upper limit of the fractured zone will be reached when the strata above the collapsed zone are sufficiently strong to span the goaf area without significant bending or shear strains being developed. The upper limit of the fracture zone is estimated to be between 235 metres and 275 metres. The depth of cover above the proposed longwall ranges from approximately 530 metres to 560 metres. It is unlikely, therefore, that the fractured zone would extend up to the surface.

7.1.8 Projected Impacts on Watercourses

The impact assessments for Quorrobolong and Cony Creeks should be read in conjunction with the findings from the flood modelling work discussed in **Section 7.3**. As discussed in **Section 7.3** a detailed flood model of the creeks has been prepared by Umwelt using the maximum predicted and the Upper Bound subsidence movements resulting from the extraction of the proposed longwalls, which were provided by MSEC (2009).

Maximum predicted cumulative subsidence, upsidence and closure along Quorrobolong Creek and Cony Creek are summarised in **Table 7.7**.

Table 7.7 – Maximum Predicted Cumulative Subsidence, Upsidence and Closure along Quorrobolong and Cony Creeks Resulting from the Extraction of LW A3 to A5a

Creek	Longwall	Maximum Predicted Cumulative Subsidence (mm)	Maximum Predicted Cumulative Upsidence (mm)	Maximum Predicted Cumulative Closure (mm)
Quorrobolong Creek	After LWA3-LWA5	1065	185	120
	After LWA5a	1250	205	135
Cony Creek	After LWA3-LWA5	825	105	90
	After LWA5a	1050	155	100

The extraction of LW A6 in Stage 3 is predicted to result in additional subsidence movements along Cony Creek within the Study Area. The predicted additional movements are 180 mm subsidence, 20 mm upsidence and 10 mm closure.

Table 7.8 shows the lengths of the sections of the creeks that will be affected by subsidence as a result of the extraction of the longwalls in the Stage 2 and Stage 2 Extension phases.

Table 7.8 – Length of Quorrobolong and Cony Creeks Affected by Subsidence and Valley Related Movements Resulting from the Extraction of LW A3 to A5a

Creek	Longwall	Length of Creek within Predicted Limits of Vertical Subsidence (km)	Length of Creek within Predicted Limits of Valley Related Movements (km)
Quorrobolong Creek	After LWA3-LWA5	1.9	1.0
	After LWA5a	2.3	1.3
Cony Creek	After LWA3-LWA5	0.7	0.4
	After LWA5a	0.8	0.6

It is unlikely that the maximum Upper Bound subsidence predictions listed in **Table 7.4** would be exceeded because they are based on an assumed subsidence of 65% of the effective seam thickness, which is the maximum typically observed in the Newcastle area. The increased likelihoods of ponding and flooding along Quorrobolong and Cony Creeks as a result of this predicted subsidence is discussed further in **Section 7.3**.

As previously discussed, the Branxton Formation forms the upper section of the constrained zone. This formation is massive, relatively homogeneous and contains relatively thick beds. As a result upsidence and valley closure impacts are expected to be less than those listed in **Table 7.7**.

Following the extraction of LW A5a the Quorrobolong and Cony Creeks are expected to experience a maximum change in grade of 0.5% and 0.4% respectively, which is similar to the change in grade predicted to occur after the extraction of LW A3 to A5. The locations of the maximum changes in grade are expected to occur further upstream as a result of the extraction of LW A5a.

The maximum predicted hogging and sagging curvatures for Quorrobolong Creek as a result of the extraction of LW A3 to A5a are 0.03 km^{-1} and 0.05 km^{-1} respectively, which correspond to minimum radii of curvatures of 30 km and 20 km. The maximum predicted hogging and sagging curvatures for Cony Creek as a result of the extraction of LW A3 to A5a are 0.03 km^{-1} and 0.01 km^{-1} respectively, which correspond to minimum radii of curvatures of 30 km and 100 km. The extraction of Longwall A6 as part of Stage 3 is not expected to result in any significant curvature changes along Cony Creek within the Study Area.

The strains above the Stage 2 longwalls are expected to be similar to the range of strains measured during the previously extracted longwalls at the colliery. The maximum tensile strain measured was 2.8 mm/m and the maximum compressive strain measured was 4.1 mm/m. It is possible that the Quorrobolong and Cony Creeks could also experience elevated compressive strains as a result of valley closure movements. Compressive strains of greater than 2 mm/m have been observed in the past for locations with similar magnitudes of upsidence and closure as predicted for the Quorrobolong and Cony Creeks.

It is expected that management strategies for the creeks already in place for the extraction of LW A3 to LW A5 could be expanded to include LW A5a and that with these management strategies in place there would be no long term impacts on the creeks resulting from the extraction of the proposed longwall.

7.1.9 Projected Impacts on Steep Slopes

Steep slopes are defined as areas of land having a natural gradient greater than 1 in 3 (a grade of 33%, or an angle to the horizontal greater than 18°). There are steep slopes within the Study Area approximately 325 metres north-west of LW A5a. The predicted effects of the extraction of LW A5a on the steep slopes within the Study Area include:

- maximum incremental systematic subsidence of 50 mm, which is considered small compared to the predicted subsidence of 1200 mm resulting from the extraction of LW A3 to LW A5;
- additional tilt of 0.3 mm/m (< 0.1 %); and
- additional curvatures and strains in the order of survey tolerance.

If the maximum upper bound systematic tilt anywhere above the proposed longwalls of 12 mm/m were to occur at the steep slopes, it would still be unlikely to result in any significant impact, as the change in surface gradient of only 1 % is still very small when compared to the natural gradients of the steep slopes. Further, any surface cracking resulting from increased hogging or sagging curvature would be expected to be minor and could be remediated by infilling with soil or other suitable materials, or by locally regrading and recompacting the surface if required.

It is considered unlikely that there would be any significant impacts on the steep slopes as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.10 Projected Impacts on Electrical Infrastructure

The electrical services within the Study Area comprise two branches of an 11 kV powerline and consumer lines which connect rural properties. The location of these services is provided in **Appendix 5**. The cables along the 11 kV powerline branches will not be affected by ground strains, as they are supported by the poles above ground level.

The maximum predicted incremental tilt due to the extraction of LW A5a is 3.0 mm/m (0.3 %) and the maximum predicted cumulative tilt due to the extraction of LW A3 to A5a is 5.7 mm/m (0.6%). Low voltage powerlines have been successfully undermined in the past at the colliery and elsewhere in NSW where the magnitude of the predicted strains were similar to those predicted for LW A5a.

It is considered unlikely that there would be any significant impacts on the powerlines as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.11 Projected Impacts on Telecommunications Infrastructure

The telecommunications infrastructure within the Study Area comprises overhead copper communications cables and underground copper communications cables. The location of these services is provided in **Appendix 5**. The overhead cables will not be affected by ground strains, as they are supported by the poles above ground level. The underground cables are unlikely to be affected by tilt, though they could be affected by curvatures and ground strains resulting from the extraction of LW A5a. The maximum predicted incremental effects in the vicinity of the telecommunications infrastructure from the extraction of LW A5a are:

- Systematic subsidence of 125 mm;
- Systematic hogging curvature of 0.01 km^{-1} (minimum radius of curvature of 100 km); and
- Systematic sagging curvature of less than 0.01 km^{-1} (minimum radius of curvature of 100 km).

Copper cables are very flexible and are expected to tolerate the predicted curvatures. Copper telecommunications cables have been successfully undermined in the past at the colliery and elsewhere in NSW where the magnitude of the predicted strains were greater than those predicted for LW A5a.

It is considered unlikely that there would be any significant impacts on the telecommunications cables as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.12 Projected Impacts on Rural Building Structures

The locations of the rural building structures are shown in **Appendix 5**. There are nine structures that have been identified, including sheds, garages and other non-residential buildings. **Table 7.9** shows the maximum cumulative predicted subsidence, tilt and curvature at each structure due to the extraction of LW A3 to A5 and LW A3 to A5a. The predicted additional effects from the extraction of Longwall A6 in Stage 3 are negligible.

Table 7.9 – Maximum Predicted Systematic Subsidence, Tilt and Curvature for the Rural Building Structures Resulting from the Extraction of LW A3 to A5a

Structure ID	Maximum Predicted Total Systematic Subsidence (mm)		Maximum Predicted Total Systematic Tilt (mm/m)		Maximum Predicted Systematic Hogging Curvature (km^{-1})		Maximum Predicted Systematic Sagging Curvature (km^{-1})	
	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a
A01b	425	650	3.4	4.0	0.01	0.02	0.02	0.02
A01c	450	775	2.8	3.3	0.01	0.01	0.02	0.02
A01d	400	725	2.9	3.6	0.01	0.01	0.02	0.02
A01e	600	875	2.6	2.2	0.01	0.03	0.02	0.02
A01f	325	600	2.9	3.8	0.02	0.02	0.01	0.02
A01g	675	925	2.5	2.0	0.01	0.03	0.01	0.02
A01j	< 20	< 20	< 0.2	< 0.2	< 0.01	0.00	< 0.01	< 0.01
A01k	< 20	< 20	< 0.2	< 0.2	< 0.01	0.00	< 0.01	< 0.01
A04d	1100	1200	2.7	2.3	0.03	0.03	0.04	0.04

It is expected that all rural building structures within the Study Area will remain safe, serviceable and repairable throughout the mining period. Any impacts are expected to be easily repaired using normal building maintenance techniques.

As discussed in **Appendix 5**, the rural building structures located outside the Study Area, including those above the future longwall A6, are predicted to experience less than 20 mm of subsidence as the result of the extraction of LW A5a. It is unlikely, therefore, that the structures located outside the Study Area would experience any significant impacts resulting from the extraction of LW A5a. A specific assessment of impacts on rural structures in property A15 (Muxlow), located to the east of the Study Area directly over approved longwall A6 has been requested by DoP. This assessment is provided in **Appendix 6**.

It is considered unlikely that there would be any significant impacts on the rural building structures as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.13 Projected Impacts on Farm Dams

The locations of the 14 farm dams that have been identified within the Study Area are shown in **Appendix 5**. **Table 7.10** shows the maximum cumulative predicted subsidence, tilt and curvature at each dam due to the extraction of LW A3 to A5 and LW A3 to A5a. The predicted additional effects from the extraction of Longwall A6 in Stage 3 are negligible.

Table 7.10 – Maximum Predicted Systematic Subsidence, Tilt and Curvature for the Farm Dams Resulting from the Extraction of LW A3 to A5a

Structure ID	Maximum Predicted Total Systematic Subsidence (mm)		Maximum Predicted Total Systematic Tilt (mm/m)		Maximum Predicted Systematic Hogging Curvature (km^{-1})		Maximum Predicted Systematic Sagging Curvature (km^{-1})	
	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a
A01d01	525	875	2.7	2.4	0.01	0.01	0.01	0.02
A01d02	700	950	2.8	1.7	0.02	0.03	0.01	0.02
A01d03	425	925	3.0	1.8	0.02	0.02	0.01	0.04
A01d04	125	750	0.9	2.0	0.01	0.01	< 0.01	0.01
A01d05	25	175	0.3	2.0	< 0.01	0.02	< 0.01	< 0.01
A01d07	150	750	1.2	2.1	0.01	0.01	< 0.01	0.03
A01d08	< 20	50	0.1	0.4	< 0.01	< 0.01	< 0.01	< 0.01
A01d09	625	850	3.4	3.7	0.01	0.03	0.02	0.02
A04d04	1300	1325	1.1	0.9	0.02	0.02	0.02	0.02
A04d05	725	925	3.1	2.9	0.02	0.02	0.01	0.01
A04d06	275	350	3.1	3.7	0.04	0.04	< 0.01	0.01
A06d02	< 20	50	0.1	0.3	< 0.01	< 0.01	< 0.01	< 0.01
A10d01	75	475	0.4	2.8	< 0.01	0.02	< 0.01	0.01
A10d04	< 20	25	0.2	0.3	0.01	0.01	< 0.01	< 0.01

The predicted changes in freeboard at the farm dams are less than 200 mm and are unlikely to have a significant effect on the capacity or the stability of the dams. If cracking or leakage of water were to occur in the farm dam walls, it is expected that they would be easily identified and repaired.

It is considered unlikely that there would be any significant impacts on the farm dams as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.14 Projected Impacts on Houses

There are two houses located within the Study Area. The locations of the houses are shown in **Appendix 5**. House A01a is located above Longwall A5, approximately 170 metres north-west of the proposed LW A5a. House A06a is located west of the Stage 2 longwalls, approximately 270 metres west of the proposed LW A5a. **Table 7.11** shows the maximum predicted cumulative subsidence, tilt and curvature resulting from the extraction of LW A3 to A5 and A3 to A5a. The predicted additional effects from the extraction of Longwall A6 in Stage 3 are negligible.

Table 7.11 – Maximum Predicted Systematic Subsidence, Tilt and Curvature for the Houses Resulting from the Extraction of LW A3 to A5a

Structure ID	Maximum Predicted Total Systematic Subsidence (mm)		Maximum Predicted Total Systematic Tilt (mm/m)		Maximum Predicted Systematic Hogging Curvature (km^{-1})		Maximum Predicted Systematic Sagging Curvature (km^{-1})	
	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a	LWA3 to LWA5	LWA3 to LWA5a
A01a	500	750	3.2	3.8	0.01	0.03	0.02	0.02
A06a	< 20	50	0.2	0.3	< 0.01	< 0.01	< 0.01	< 0.01

Using the classification scheme in Table C1 of the Australian Standard 2870-1996, the impacts on the houses as a result of the extraction of LW A3 to A5a are classified as Category 1 for house A01a and Category 0 for house A06a. These categories represent minor impacts. There is a less than 1 % chance that house A01a could experience moderate or severe impacts as the result of anomalous non-systematic movements, and a negligible chance that house A06a could experience significant impacts from such movements.

As discussed in **Appendix 5**, the houses located outside the Study Area, including those above the future longwall A6, are predicted to experience less than 20 mm of subsidence as the result of the extraction of LW A5a. It is unlikely, therefore, that the houses located outside the Study Area would experience any significant impacts resulting from the extraction of LW A5a. A specific assessment of impacts on the house on property A15 (Muxlow), located to the east of the Study Area directly over approved longwall A6 has been requested by DoP. This assessment is provided in **Appendix 6**.

It is considered unlikely that there would be any significant impacts on the houses as a result of the extraction of LW A5a and that the management strategies developed for the extraction of LW A3 to A5 can be extended to include LW A5a.

7.1.15 Projected Impacts on Survey Control Marks

There are no survey control marks identified within the Study Area. There are some survey control marks to the south of the Study Area as shown in **Appendix 5**. It is possible that survey control marks up to three kilometres outside of the Study Area may be affected by far-field horizontal movements, so it will be necessary to re-establish these marks once the ground has stabilised after the extraction of LW A5a is complete.

7.1.16 Other Potential Subsidence Movements and Impacts

Other potential subsidence movements and impacts that could occur as a result of the extraction of the proposed LW A5a include:

- a maximum predicted systematic horizontal movement of approximately 90 mm;
- far-field horizontal movements are likely to occur though the impact of these movements on natural features and items of surface infrastructure within the vicinity of the Study Area is not expected to be significant;
- some vibrations may be felt at the surface as the longwall is mined and the strata subsides though they are expected to be of sufficiently low amplitude so as to not result in any significant structural impact;
- the impact of noise at the surface as a result of the subsidence of strata after the extraction of the longwall is predicted to be insignificant;
- it is expected that a seismic event is unlikely to result in additional subsidence above the proposed longwall; and
- the typical crack widths resulting from normal systematic subsidence as a result of the extraction of the proposed longwall are expected to be up to 25 mm in width, though are expected to be minor in nature and easily remediated.

7.1.17 Stage 2 Extension and Stage 3 Interaction

The potential cumulative impacts of the proposed Stage 2 Extension project combined with the extraction of LW A6 to LW A17 as a part of underground mining in the Stage 3 area are outlined in Section 4.5 of **Appendix 5**. As discussed in **Appendix 5**, the extraction of the future LW A6 is predicted to result in an additional subsidence of 200 mm at the eastern extent of the Study Area, and an additional subsidence of 40 mm above the commencing (north-eastern) end of the proposed LW A5a (refer to **Figures 7.3** and **7.4)**. The predictions and impact assessments provided in **Sections 7.1.1** to **7.1.16**, for the features located in the eastern part of the Study Area, include discussions on the additional subsidence movements resulting from the extraction of the future LW A6.

The predicted conventional subsidence movements, resulting from the remaining Stage 3 Longwalls A7 to A17, are negligible within the Study Area. The extraction of these future longwalls is unlikely therefore, to result in any significant impacts on the natural features and items of surface infrastructure located within the Study Area (refer to **Appendix 5**).

7.1.18 Subsidence Monitoring, Management and Contingency Measures

The monitoring, management and mitigation of subsidence is an integral component of the current Austar Mining Operations Plan 2008-2015 (MOP) and the Austar Subsidence Management Plan (SMP).

Austar has communicated with surrounding communities and stakeholders regarding the subsidence impact assessment, potential subsidence impacts, monitoring and management considerations for Stage 2. An SMP and Property Subsidence Management Plans (PSMPs) have been developed for land holdings within the Stage 2 area. These plans will be amended for properties within the Stage 2 Extension Study Area prior to mining taking place.

The following subsidence monitoring procedures will be implemented as part of the Stage 2 Extension Project, and will be further refined in consultation as mining progresses:

- subsidence monitoring lines to be located as determined as part of the SMP process;
- visual assessment of all natural features and items of surface infrastructure before, during and following mining to detect subsidence impacts such as surface cracking, irregularities in the subsidence profile, erosion, damage to structures, changes in drainage patterns or loss of water from drainage structures;
- assessment of all building structures by a structural engineer (where landholder approval obtained) before and after mining; and
- verification and revision of subsidence predictions as mining progresses.

There will be ongoing refinement and calibration of the subsidence predictive model throughout the project life as a result of subsidence monitoring and comparison with predictions. As the coal resource is extracted, refinement and verification of the model will be incorporated into the SMP, providing a more accurate basis for the assessment and management of subsidence impacts as the project progresses. Contingency measures such as revisions to the mine plan and extraction height will be explored if subsidence monitoring indicates that subsidence impacts are greater than predicted.

Significant subsidence impacts on the land surface from the proposed Stage 2 Extension Project are not predicted. However, in the event that subsidence impacts are greater than those predicted, a variety of contingency measures and rehabilitation techniques are available to repair, or avoid further, impacts of subsidence. Remediation techniques will vary depending on the extent of surface cracking or landform changes. These techniques will aim to minimise the impact on the surface whilst achieving an acceptable level of rehabilitation from land user safety, mine safety and environmental perspectives.

In areas where smaller scale cracking is predicted to occur, remediation activities may include one, or a combination of the following methods:

- infilling of cracks with soil to seal cracks visible at the surface;
- tilling the ground surface using small agricultural equipment to blend fill material and restore the soil profile; and/or
- where necessary, using small machinery, such as a small excavator, bobcat or grader, to restore the surface profile.

Where subsidence remediation is required within sensitive areas such as adjacent to Aboriginal sites or significant ecological areas, hand methods can be used to repair any cracking and restore the soil profile.

Austar is committed to effective and timely rehabilitation of surface cracking should it occur, whilst minimising impact on the natural environment, cultural values and land use. The ground surface across the project area will be visually inspected during and following longwall extraction so that significant cracking or irregularities in the subsidence profile can be identified and remediated where required.

A summary of Subsidence Management and Remediation Measures is provided in **Table 7.12**.

Table 7.12 – Summary of Subsidence Management and Remediation Measures

Feature/Location	Typical Management and Remediation Options
Cony and Quorrobolong Creeks and other drainage lines	• Visual monitoring during the extraction period. • Any significant tensile cracking will be remediated by infilling with alluvials or other suitable material or by locally regrading and recompacting the surface.
Steep slopes	• Visual monitoring during the extraction period. • Any significant cracking will be identified and remediated as required.
Telecommunications Infrastructure	• Visual monitoring during the extraction period. • Any significant impact will be identified and remediated as required.
Building Structures	• Rural building structure above the proposed longwalls will be inspected prior to being mined beneath, to assess the existing condition and whether any preventive measures may be required. • Rural building structures are visually monitored during mining. • Repair impacted fences if required.
Farm dams	• All water retaining structures visually monitored during mining.
Houses	• Houses above the proposed longwalls will be inspected prior to being mined beneath, to assess the existing condition and whether any preventive measures may be required. • Houses are visually monitored during mining.

As part of ongoing subsidence management a Property Subsidence Management Plan (PSMP) has been developed for each landholder within the Stage 2 area whose property was potentially subject to subsidence of greater than 20 mm. The existing PSMPs will be updated to include additional provisions relating to the Stage 2 Extension Project for all properties potentially subject to subsidence of greater than 20 mm as a result of the extraction of LW A5a. A comprehensive consultation program with landholders will be undertaken and current property-specific baseline data will be compiled prior to mining and provided to landholders in the PSMPs. PSMPs will be prepared and discussed with relevant landholders as requested.

7.2 Vibration

7.2.1 Overview of Ground Vibration

As discussed in MSEC (2010), the settlement of the ground during and following longwall mining generally occurs as a series of gradual movements over time. These movements generally cannot be detected by people on the ground surface. However, occasionally movements in the rock layers immediately above the longwall can result in vibration in the ground which can be felt as a minor effect on the surface.

According to Renzo Tonin and Associates (1995), ground vibration can be thought of as the rapid backwards and forwards motion of the ground. Ground vibration associated with underground mining can occur in two possible ways:

- sudden failure of rock lying above the mined out area; and
- slippage along a fault line or rock fracture zone.

The sudden release of energy that occurs with a sudden rock failure or slippage results in ground vibration not dissimilar to the kind experienced when a heavy weight falls on the ground (Renzo Tonin and Associates, 1995). Ground vibration events from underground mining are short in duration, usually not lasting more than a second. These vibration events are referred to as 'ground tremors'.

Ground vibration is usually measured in terms of the maximum speed of movement of a point on the ground in the horizontal and vertical directions. This is known as the Peak Particle Velocity (PPV) and is measured by use of a vibration monitor.

7.2.2 Ground Vibration Criteria

No guideline criteria specifically relating to ground vibration as a result of underground mining are available for use in assessment of ground vibration at Austar Coal Mine. The following two more general guidelines provide guidance for vibration criteria for human response and structural damage respectively:

- *Assessing Vibration: a technical guideline* (NSW DECC, 2006); and
- *British Standard BS 7385:1993 Part 2 – Evaluation and Measurement for Vibration in Buildings.*

7.2.2.1 Human Response Criteria

The NSW Department of Environment and Climate Change (DECC) document *Assessing Vibration: a technical guideline* (February 2006) provides preferred and maximum vibration values for different receiver types such as residences, offices, workshops, and critical work areas (hospital operating theatres, precision laboratories etc). The criteria are non-mandatory goals that operations should seek to achieve through the application of all feasible and reasonable mitigation measures (DECC, 2006). The criteria relate specifically to human response to vibration. Criteria for structural damage are provided separately in **Section 7.2.2.2**.

DECC (2006) presents vibration criteria for continuous vibration (i.e. vibration that continues uninterrupted for a defined period e.g. continuous construction activity), and impulsive vibration, defined as vibration that builds up rapidly to a peak followed by a damped decay. As ground vibration as a result of mining is felt as infrequent, short duration events, the impulsive vibration criteria are applicable to Austar Coal Mine. The impulsive vibration criteria are listed in **Table 7.13** below.

Table 7.13 – Criteria for Exposure to Impulsive Vibration

Place	Time[1]	Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day- or night-time	0.14	0.28
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Offices	Day- or night-time	18.0	36.0
Workshops	Day- or night-time	18.0	36.0

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

The criteria for residences listed in **Table 7.13** above are considered to be the most applicable human response criteria given the land use of the Stage 2 Extension Study Area.

7.2.2.2 Structural Damage

For building damage, Australian Standard AS 2187: Part 2-2006 *Explosives – Storage and Use – Part 2: Use of Explosives* recommends the frequency dependant guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and Measurement for Vibration in Buildings Part* as they are considered to be applicable to Australian conditions.

The British Standard sets guideline values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in **Table 7.14**

Table 7.14 – Transient Vibration Guideline Values – Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	-
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The criterion for residential or light commercial type buildings of 15 mm/s is considered most appropriate for buildings within the Stage 2 Extension Study Area.

7.2.3 Historic Vibration Levels at Ellalong Colliery

Longwall mining in the Greta Seam at Ellalong Colliery to the south of the current approval area (refer to **Figure 1.2**) began in 1983. Both Ellalong Colliery and the Mines Subsidence Board monitored ground vibrations at the ground surface over the longwalls and at nearby residences over a number of years. According to MSEC (2009), three vibration events with surface PPVs of between 22 mm/s to 28 mm/s were recorded in 1991 and 1992. The remaining events during 1991 and 1992 were generally less than 8 mm/s.

The 1995 EIS (HLA Envirosciences, 1995) included a vibration report by Renzo Tonin & Associates Pty Ltd (Renzo Tonin) which sets out vibration levels recorded at No. 2 Shaft (location shown on **Figure 1.2**) and at two locations within the Ellalong community between May 1993 and June 1994. The results of all significant vibration events are provided in **Figure 7.6**.

As shown in **Figure 7.6**, the majority of vibration events at Ellalong Colliery recorded during May 1993 to June 1994 were less than 8 mm/s at No. 2 Shaft. An additional five events over the 12 month period had velocities of over 8 mm/s, with two events having velocities of over 20 mm/s. An additional event was recorded on 21/09/1993 with a velocity of 150 mm/s at No. 2 Shaft. However, the validity of this record is questioned as on this occasion no corresponding data was recorded by the two vibration monitors located in the residential areas. This point has been discarded as an outlier as it is unlikely that an event of this magnitude would escape detection at the other vibration monitors within the study area.

The 1995 EIS states that the vibration magnitudes previously measured at Ellalong Colliery and reported in Renzo Tonin (1995) are assumed 'likely to occur again within the subject region of mining considered here' (HLA-Envirosciences, 1995).

7.2.4 Vibration Monitoring in the Stage 2 Area

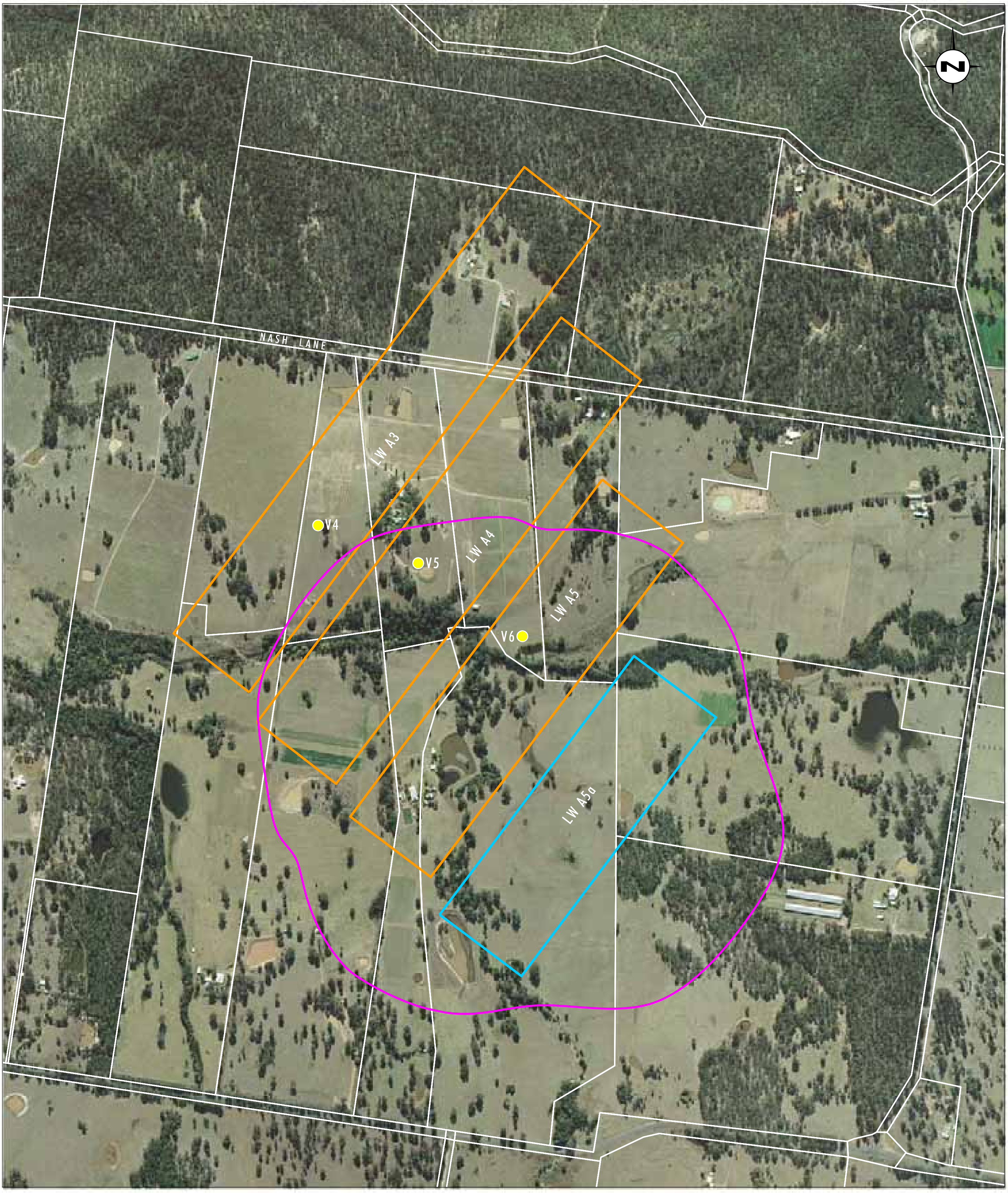
Austar is currently undertaking vibration monitoring in the Stage 2 area in accordance with *Austar Coal Mine Vibration Monitoring Plan – Longwall Panels A3, A4 & A5* (Austar, 2009). Vibration monitoring is currently occurring over LW A3 and LW A4 at vibration monitoring locations V4 and V5 respectively (refer to **Figure 7.7**).

Monitoring results from August 2009 to March 2010 are shown in **Figure 7.8** for daytime and night time periods. As shown in **Figure 7.8** vibration events during mining of LW A3 have typically been in the range of less than 8 mm/s PPV and have occurred up to four times per month. The highest magnitude event in the period from August 2009 to March 2010 was recorded on 29 January 2010 with a PPV of 15.9 mm/s recorded by vibration monitor V4 directly over LW A3. Vibration monitor V5, located approximately 250 metres to the south-east of vibration monitor V4 recorded a PPV of 9.8 mm/s. This event was not large enough to result in any significant structural impact to residences in the Stage 2 mining area.

A comparison of the results of monitoring within the Stage 2 mining area with information provided in the 1995 EIS (refer to **Section 7.2.3**) indicates that the vibration experienced within the Stage 2 mining area is within the range of that previously approved under DA 29/95.

7.2.5 Vibration from the Stage 2 Extension Project

Based on the data provided in **Sections 7.2.3** and **7.2.4** above, it is considered that the range of vibration experienced in the Stage 2 area to date has been within the envelope of that set out in the 1995 EIS and approved under DA 29/95. On this basis it is considered that mining in LW A5a using LTCC technology is unlikely to result in vibration impacts in excess of those already approved under DA 29/95. As discussed in the Subsidence Assessment (refer to **Appendix 5**), the levels of vibration would generally be expected to be low and would not be of sufficient amplitude to result in any significant structural impact. In addition, as discussed in Renzo Tonin (1995), the PPV of vibration events decreases with distance away from the source of the vibration. This coupled with the small number of



Source: AAM Hatch, 2006
Base Source: Austar Coal Mine

0 200 400 600m
1:12 000

Legend
Layout for Stage 2 Longwall Panels
Layout for Stage 2 Extension Longwall Panel
LWA5a 20mm Incremental Subsidence Contour
Vibration Monitoring Locations
Cadastral Boundary

FIGURE 7.6

Austar Stage 2 Vibration Monitoring Locations

File Name (A4): R56_V1/2274_778.dgn

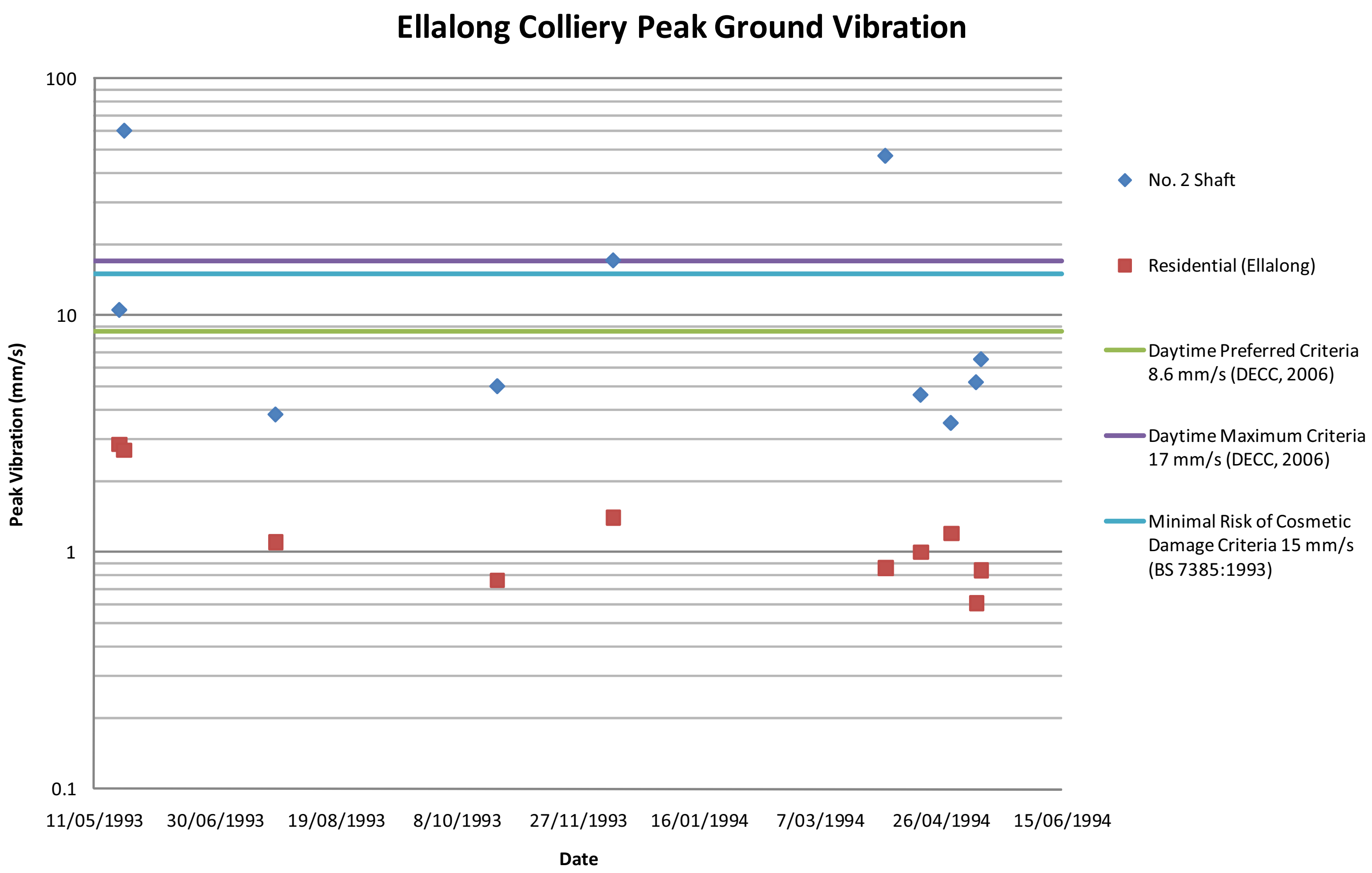
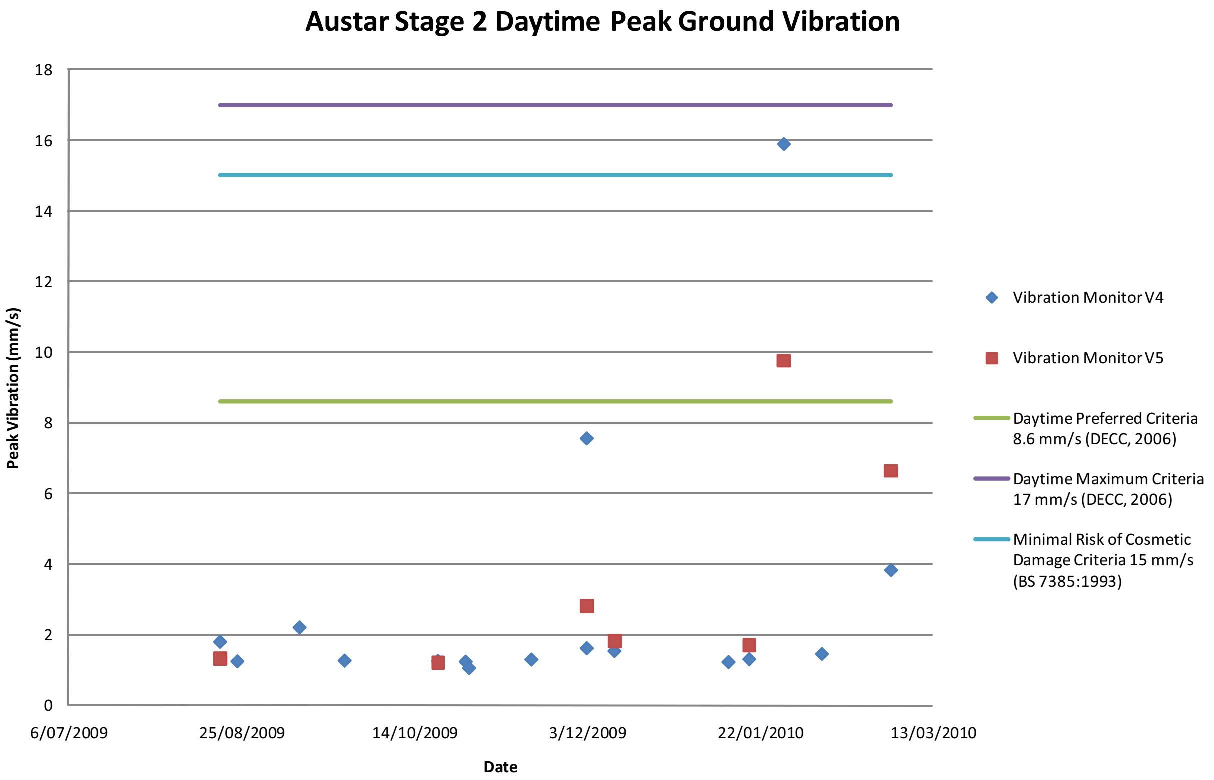


FIGURE 7.7

Ellalong Colliery Peak Ground Vibration



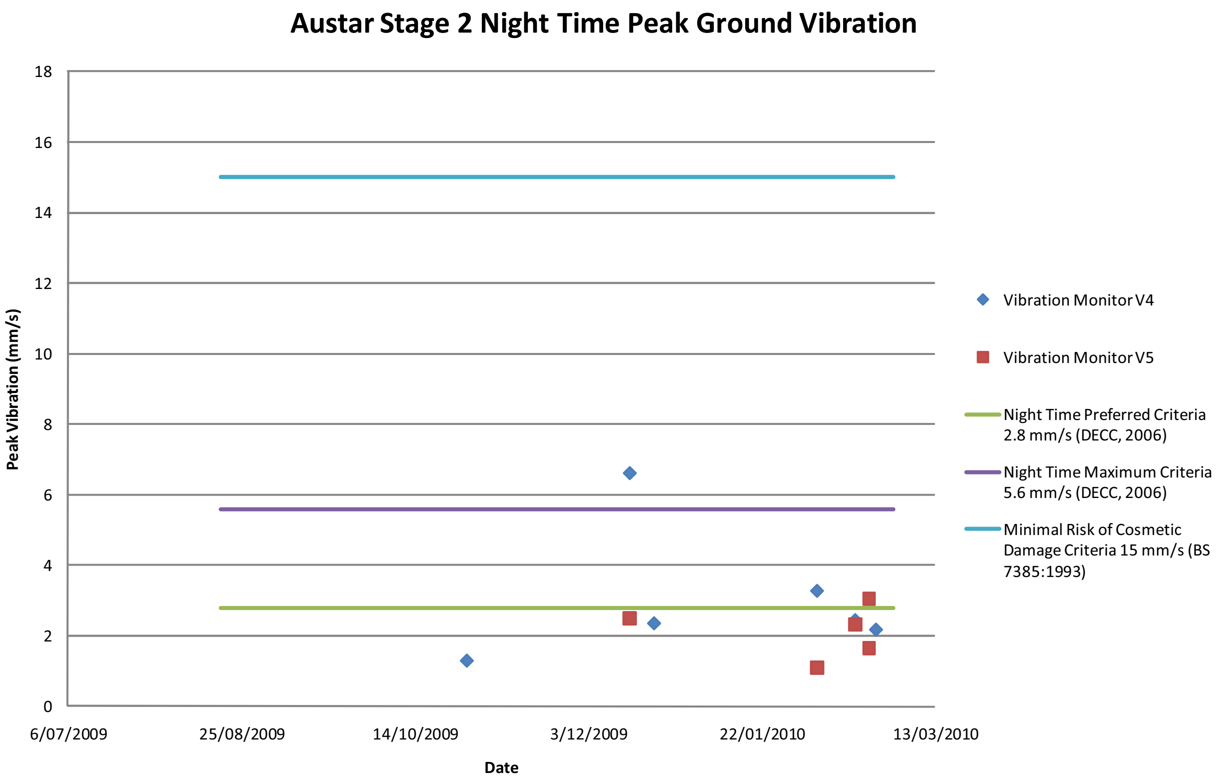


FIGURE 7.8

Austar Stage 2 Peak Ground Vibration

houses within the Stage 2 Extension Study Area means that the likelihood of damage to houses is low. Any structural impact which occurs due to vibration, resulting from the extraction of LW A5a using LTCC technology, is expected to be of a minor nature, and easily repaired using normal building maintenance techniques (MSEC, 2009).

Vibration from LW A5a will be monitored via an extension of the existing Austar Stage 2 Vibration Monitoring Program (Austar, 2009). Damage to structures as a result of vibration from the Stage 2 Extension Project will be managed in the same manner as damage to structures as a result of subsidence (refer to **Section 7.1** for further details).

7.3 Surface Water and Drainage

7.3.1 Surface Drainage and Flood Modelling

As discussed in **Section 5.2**, the Stage 2 Extension Study Area is located within the Quorrobolong Creek and Cony Creek catchments, which form part of the Congewai Creek and Wollombi Brook drainage systems. The proximity of the Stage 2 Extension Study Area to Quorrobolong Creek and Cony Creek catchments is shown on **Figure 5.1**.

To assess the potential impacts of the Stage 2 Extension Project on flooding and drainage, a detailed flooding and drainage assessment has been undertaken and is presented in **Appendix 7**. The assessment builds on the previous flooding and drainage assessments undertaken for the Stage 2 and Stage 3 areas (Umwelt, 2007a and Umwelt, 2008) which examine the potential impacts on the flooding and drainage regime of Quorrobolong Creek and its tributaries as a result of mining longwalls A3 to A5 (Stage 2) and longwalls A6 to A17 (Stage 3) respectively. The Stage 2 and Stage 3 flood assessments are detailed in *Flooding Assessment: Longwalls A3, A4 and A5* (Umwelt, 2007a) and *Flood and Drainage Assessment: Stage 3* (Umwelt, 2008).

The methodology used to undertake the flooding and drainage assessment is detailed in **Appendix 7** and included the following components:

- review and modification of the previously developed flood model for Stages 2 and 3 to take into account predicted changes to the landform due to mine subsidence from LW A5a;
- investigation of potential impacts of the Stage 2 Extension Project on flooding and drainage for 1 year and 100 year Average Recurrence Interval (ARI) flood events for a range of landform scenarios including:
    - pre-mining landform (modelling results described in detail in Umwelt, 2007a);
    - post-Stage 2 mining landform (modelling results described in detail in Umwelt, 2007a);
    - post-Stage 2 Extension mining landform (maximum predicted subsidence);
    - post-Stage 2 Extension mining landform (upper bound subsidence);
    - post-Stage 3 mining landform (including longwalls A3 to A5, A5a and A6 to A17); and
- analysis of predicted changes to flood depths, velocities, flood durations and hazards in the Quorrobolong Valley.

7.3.2 Surface Flows and Flooding Impacts

For each of the landform scenarios modelled as discussed above, the maximum water depths, maximum water velocities and maximum flood hazards were determined.

The predicted impacts on flooding as a result of the maximum predicted subsidence for the Stage 2 Extension Project are discussed in **Sections 7.3.2.1** to **7.3.2.3**. The predicted impacts on flooding as a result of the upper bound subsidence were assessed as a part of the risk assessment process and the results of this assessment are provided in **Appendix 7**.

Figures 7.9 and **7.10** shows the predicted maximum flood depths for the 100 year ARI flood events for the post-Stage 2 mining landform and the post-Stage 2 Extension mining landform. **Appendix 7** contains flood depth, flow velocity duration and flood hazard information for all scenarios modelled, including the post-Stage 3 mining landform.

7.3.2.1 Flood Depths

The modelling undertaken in Umwelt (2007) indicates that during the 100 year ARI event for the post-Stage 2 mining landform (i.e. after subsidence of LW A3 to A5) maximum flood depths within the Stage 2 mining area may reach depths of over 1.9 metres (refer to **Figure 7.9**). The modelled flood depths with predicted subsidence due to LW A5a (post-Stage 2 Extension mining landform) indicate a decrease downstream of the confluence of Cony Creek and Quorrobolong Creek of up to 160 mm (refer to **Figure 7.10**). This will return maximum flood depths in Quorrobolong Creek downstream of the confluence to depths similar to pre-Stage 2 mining conditions.

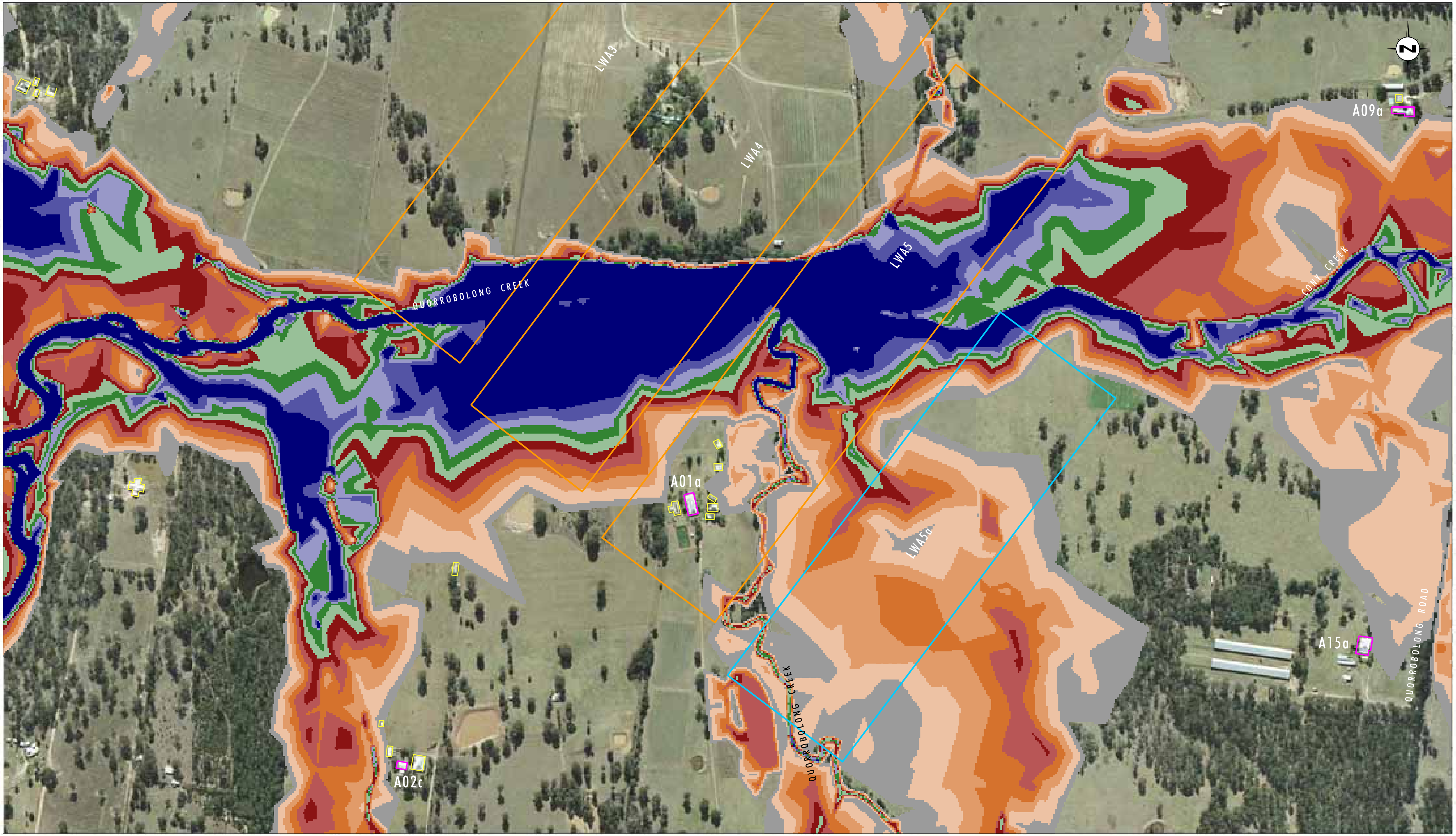
In the sections of Cony and Quorrobolong Creeks upstream of the natural flow constriction, modelling indicated an increase in the modelled 100 year ARI maximum flood levels with predicted subsidence due to LW A5a. These predicted increases in maximum flood depths typically occurred along Quorrobolong Creek upstream of the confluence with Cony Creek. The maximum modelled increase in flood depth was in the order of 500 mm, with an average increase for this area in the order of 100 mm. This increase in flood depth occurs over the section of Quorrobolong Creek overlying Longwall A5.

The modelling results indicated that the changes to the 100 year ARI flood event as a result of the predicted subsidence of LW A5a will only marginally increase the flood extent (refer to **Figures 7.7** and **7.8**) and will not increase flood depths at dwellings within the Quorrobolong Valley.

7.3.2.2 Velocities

Flood modelling (refer to **Appendix 7**) indicates that the maximum flow velocities within the channel sections of Quorrobolong Creek downstream of the natural flow constriction point were found to slightly decrease for the 100 year ARI flood event with predicted subsidence due to LW A5a compared to the post-Stage 2 mining landform.

Modelled peak flow velocities were found to increase on average by 0.1 m/s within the section of Quorrobolong Creek upstream of its confluence with Cony Creek. A maximum increase in in-channel velocities of approximately 0.5 m/s from 0.6 m/s to 1.1 m/s was predicted for a short section of the main channel of Quorrobolong Creek over Longwall A5. These increases were largely confined to the channel section and immediate overbank areas where small increases channel slopes occurred as a result of the additional subsidence. The localised increase in velocity is within the range of velocities naturally occurring within Quorrobolong Creek in large flood events and is not anticipated to significantly affect channel stability.



Base Source: AAM Hatch, 2006
Source: Longwall Layout: Austar Coal Mine
Note: Dwellings only shown for flood model extent

Legend
- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Building
- Dwelling
- A01a Dwelling Reference Number

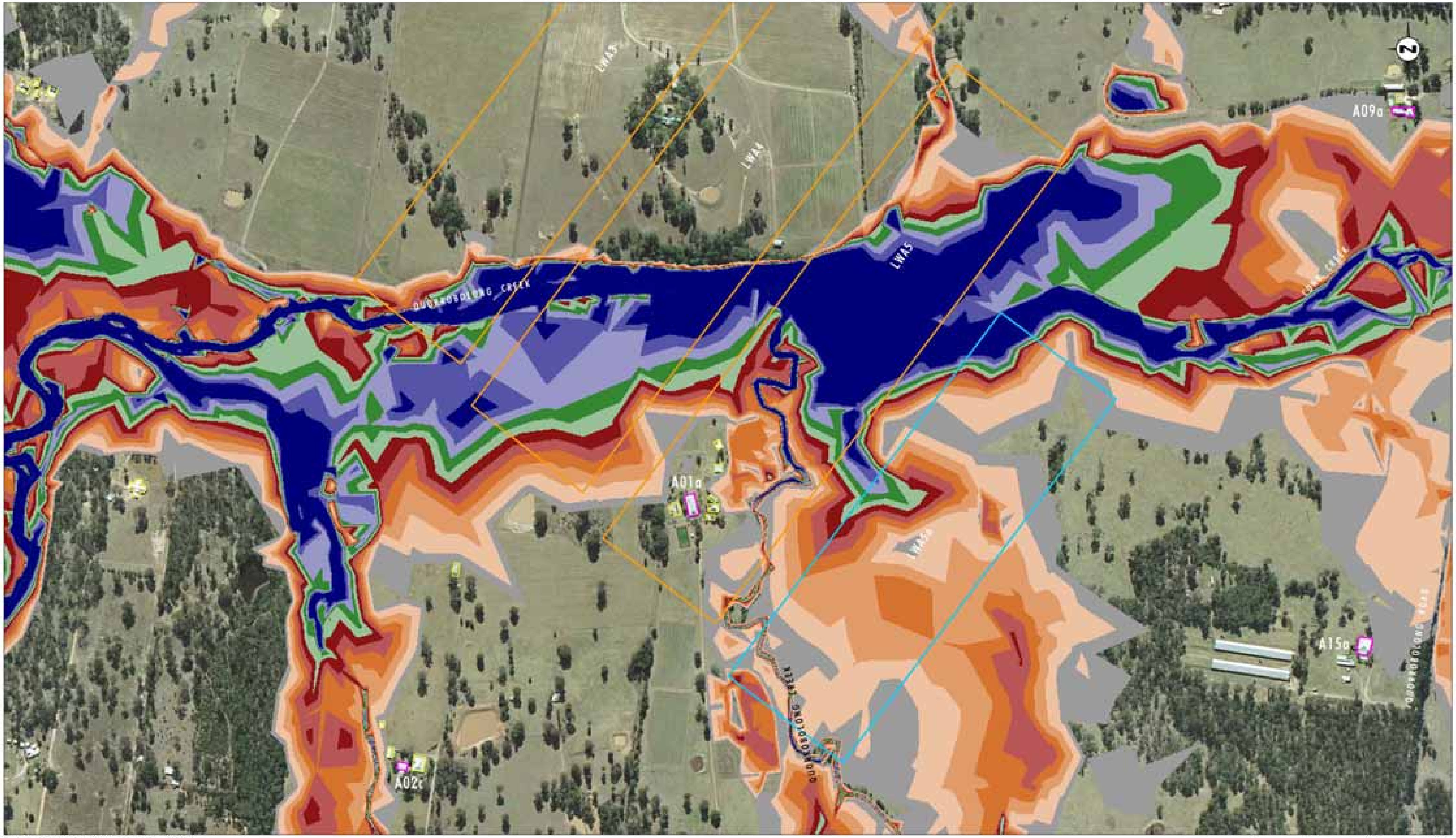
Water Depth (m)
- Range [0.001 : 0.100]
- Range [0.100 : 0.300]
- Range [0.300 : 0.500]
- Range [0.500 : 0.700]
- Range [0.700 : 0.900]
- Range [0.900 : 1.100]
- Range [1.100 : 1.300]
- Range [1.300 : 1.500]
- Range [1.500 : 1.700]
- Range [1.700 : 1.900]
- Range [>1.900]

FIGURE 7.9

100 year ARI Storm: Maximum Modelled Water Depths for Predicted Stage 2 Subsidence (Longwalls A3 to A5)

File Name (A3): R56_V1/2274_760.dgn

Umwelt



Base Source: AAM Hatch, 2006
Source: Longwall Layout: Austar Coal Mine
Note: Dwellings only shown for flood model extent

0 100 200 300m
1:6000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Building
- Dwelling
- A01a Dwelling Reference Number

Water Depth (m)

- Range [0.001 : 0.100]
- Range [0.100 : 0.300]
- Range [0.300 : 0.500]
- Range [0.500 : 0.700]
- Range [0.700 : 0.900]
- Range [0.900 : 1.100]
- Range [1.100 : 1.300]
- Range [1.300 : 1.500]
- Range [1.500 : 1.700]
- Range [1.700 : 1.900]
- Range [>1.900]

FIGURE 7.10

100 year ARI Storm: Maximum Modelled Water Depths for Predicted Subsidence Longwalls A3 to A5a

File Name (A3): R56_V1/2274_761.dgn

Analysis of the modelling results for Cony Creek and Quorrobolong Creek indicate that maximum velocities will remain within non-scouring levels for both the 100 year and 1 year ARI storm events following the Stage 2 Extension Project and as a result no significant changes due to velocity induced scouring or erosion are predicted.

7.3.2.3 Flood Hazards

In order to assess the potential flood hazards associated with underground mining in the Stage 2 Extension Study Area, the flood hazard categories outlined in Appendix G of the *Floodplain Development Manual* (2005) were utilised. The four flood hazard categories, in order of increasing hazard, are:

- unclassified;
- vehicles unstable;
- wading unsafe (and vehicles unstable); and
- damage to light structures.

Modelling indicated that negligible changes to the maximum flood hazard categories along access routes to dwellings would occur for the 100 year ARI flood event with the post-Stage 2 Extension mining landform compared to the post-Stage 2 mining landform. Flood hazard mapping for the Stage 2 Extension Study Area for all modelled scenarios is provided in **Appendix 7**.

7.3.2.4 Duration of Flooding and Overbank Ponding

The modelling indicates that there will be negligible effect on flow rates and hydrograph shape for the 100 year ARI storm event downstream of the Stage 2 mining area as a result of the Stage 2 Extension Project (refer to **Appendix 7**).

Analysis of remnant ponding indicates minor localised changes to some remnant ponding areas in existing flow paths, paddocks and dams with no predicted impact on access routes to, or within the properties south of Quorrobolong Creek (refer to **Appendix 7**).

7.3.3 Impacts on Stream Flow and Channel Stability

Analysis set out in **Appendix 7** indicates that the Stage 2 Extension Project will not have a significant impact on the flow regime of the Cony Creek and Quorrobolong Creek systems with only minor changes predicted in runoff regimes and peak discharges.

As discussed in **Section 7.1.8**, following the extraction of LW A5a, Quorrobolong and Cony Creeks are expected to experience a maximum change in grade of 0.5% and 0.4% respectively, which is similar to the change in grade predicted to occur after the extraction of LW A3 to A5. The locations of the maximum changes in grade are expected to occur further upstream as a result of the extraction of LW A5a.

As the predicted changes in in-channel grade are small and are considered to lie within the natural variations in grade of the creek lines of the Quorrobolong Valley, it is considered that the Stage 2 Extension Project will not significantly alter the flow capacity or stream velocities within the existing channels. It is also considered that there is minimal potential for channel realignment to occur as a result of the Stage 2 Extension Project.

The potential to increase erosion on the landform is also expected to be minimal due to the relatively small predicted changes in landform grades combined with the high level of groundcover limited amount of exposed soils that exist in the area.

7.3.4 Impacts on Surface Water Users

As discussed in **Section 7.3.3**, modelling indicates that the Stage 2 Extension Project is unlikely to have a significant impact on runoff or flow regimes within the Cony Creek and Quorrobolong Creek systems and as a result flows within the creeks should remain relatively unchanged.

The potential for mining to result in stream capture within these creek systems is also considered negligible predominantly due to the depth of cover and the strength and thickness of the underlying Branxton Formation. As set out in **Section 6.1**, the predicted upper limit of vertically interconnected cracking above the goaf is 270 metres or less with the depth of cover between the Greta Coal Seam and the bed of Quorrobolong Creek being in excess of 500 metres. Vertical fracturing within the constrained zone is generally discontinuous and is unlikely, therefore, to result in increased hydraulic conductivity. As a result the potential for flows within Quorrobolong Creek and Cony Creek to drain to the goaf resulting from the Stage 2 Extension Project is negligible.

This is supported by the fact that Quorrobolong Creek was previously undermined by LW1 to LW6, as well as LW SL1 within the DA 29/95 approval area at Southland Colliery. In these locations the depth of cover varies between 310 and 370 metres. Following mining there was no reported surface cracking in the creek bed.

7.3.5 Cumulative Impacts

As discussed in **Section 7.1**, the cumulative impact of the Stage 2 Extension Project and mining in the approved Stage 3 area is predicted to result in an additional subsidence of 200 mm at the eastern extent of the Study Area, and an additional subsidence of 40 mm above the commencing (north-eastern) end of the proposed LW A5a. The cumulative impact of the proposed Stage 2 Extension Project and Stage 3 on flooding and drainage has been assessed in Section 3.2 of the Flooding and Drainage Assessment set out in **Appendix 7**. As discussed in **Appendix 7**, the addition of Longwall A5a had negligible influence on the previously modelled flood depths, flows, velocities and flood hazard categories estimated for the Stage 3 operations with predicted subsidence.

The modelled flow hydrograph for immediately downstream of the Stage 2 mining area for mining of LW A5a and Stage 3 is similar to that derived for the post-Stage 2 Extension Project landform. It is therefore considered that the Stage 2 Extension Project will have negligible influence on the previously predicted cumulative flood and drainage impacts of underground mining within Stage 3.

7.4 Groundwater

7.4.1 Existing Groundwater Resources

As discussed in **Section 5.2.3**, there are three potential sources of groundwater that form an integral part of the local hydrogeological regime in the vicinity of the Stage 2 Extension Study Area including:

- alluvial aquifers;

- fractured rock aquifers (including coal seam aquifers); and
- abandoned coal mines.

The characteristics of these water sources and potential impacts as a result of the Stage 2 Extension Project are summarised in the following subsections.

7.4.1.1 Alluvial Aquifers

Quorrobolong Creek and its tributaries which flow in a general westerly direction across the Austar lease area comprise the alluvial aquifers in proximity to the Stage 2 Extension Study Area. The tributaries that cross the Austar lease, including Cony Creek, are second to fifth order streams, and comprise a series of intermittent creeks, which only flow after consistent or heavy rainfall. These creeks have shallow alluvium-filled valleys ranging in width up to 400 metres and support shallow, low yielding groundwater resources that exhibit no major water bearing zones. Due to the very low vertical permeability of the underlying rock strata, there is very little vertical leakage of groundwater from the alluvium, and it is essentially isolated hydraulically from the rest of the hydrogeological regime. The extent of alluvium associated with this creek system and which covers only a small proportion of the extended lease area is shown on **Figure 5.2**.

The NSW Office of Water database of water bores indicates that there are no registered bores within the local area that extract water from the alluvial deposits.

To provide greater understanding of the alluvial groundwater resource, Austar has established a monitoring bore in an existing borehole in the over Longwall A4 in the Stage 2 area (AQD 1073A). The locations of known bores are shown on **Figure 5.2**. This bore is 7.7 metres deep and is located in the alluvial deposits in Quorrobolong Creek over Longwall A4. The bore log indicates that the alluvium is less than 3 metres thick in this area, and the groundwater table was at a depth of 2.7 metres below the ground surface when the bore was drilled. Subsequent measurements have indicated that the groundwater table rose to a level of 1.6 metres below the surface following heavy rains in June 2007.

The variable composition and excessive fines content in the alluvium indicate that its overall permeability is not likely to be high, and yields from any water bores would generally be expected to be low. The limited data available also suggests that the groundwater quality is normally fair, and generally suitable for stock use but not domestic consumption. Consequently, as an aquifer, the alluvium is of limited use as a groundwater resource.

The only groundwater dependent ecosystem known in the area that relies to some extent on the groundwater in the alluvium in the vicinity of the Stage 2 Extension Study Area is the *Riparian Swamp Oak – Rough-barked Apple Open Forest*, which is restricted to a narrow band along the creek channels. For this reason, potential impacts on the alluvial aquifer must be determined, as there may be a consequential impact on the dependant ecosystems.

7.4.1.2 Fractured Rock Aquifers

Permian strata overlying the coal measures in the Newcastle Coalfield generally have very low permeabilities ($<10^{-8}$ m/s). Fractured rock aquifers generally comprise localised jointed or fractured zones, often adjacent to major faults.

Fractured rock aquifers have the potential for high flows, since they are confined aquifers and are at a relatively high pressure. Nevertheless, flows are often small in these zones, and water quality is generally poor and suitable only for stock use. Due to the very low vertical permeability of the Permian strata, there is very little leakage between any water-bearing zones or aquifers.

The occurrence of fractured rock aquifers overlying the Stage 2 Extension Study Area comprise those associated with the Branxton Formation and those associated with Greta Coal Seam.

The Branxton Formation contains few if any major fractured rock aquifers due to its massive nature. A search of the NSW Office of Water database of water bores indicates that there is one bore within the immediate vicinity of the Stage 2 Extension Study Area which intersected groundwater in the rock strata. This bore (GW 054676) is 39.6 metres deep, and is located to the west of Longwall A3 (refer to **Figure 5.2**). The limited data from the bore indicates that the water bearing zone was located in a shale layer below the alluvium. The bore is low-yielding, and produces a flow of about 1 L/sec of poor quality water (EC = 12,000-16,000 µS/cm). The poor groundwater quality in the Branxton Formation is due largely due to the fact that the rocks were formed in a marine environment. The standing water level in this bore is currently about 1.3 metres below the surface following heavy rainfall, although the groundwater table is normally more than 2 metres deep. The bore is not utilised for agricultural purposes, but is used as a background monitoring bore for the NSW Office of Water.

A seven metre deep bore, which intersects the soil profile, is located adjacent to the registered bore GW054676. The groundwater in this bore has an Electrical Conductivity (EC) of 10,000 to 11,000 µS/cm, and the depth to the water table is normally more than 2 metres. However, heavy rainfall in June and August 2007 reduced the near-surface groundwater EC to about 1600 µS/cm, and raised the water table to within 0.15 metres of the surface.

Drilling indicates a potential water-bearing zone in the Branxton Formation at a depth of 70 to 100 metres below the surface in the vicinity of the Stage 2 Extension Study Area.

Previous experience in the Newcastle Coalfield has shown that the permeability of the strata in the Branxton Formation is normally very low. The sandstone is generally strong and massive with a silica and/or clay matrix. As a result, the interstitial permeability is negligible, and any measured permeability derives from fractures and joints.

7.4.1.3 Coal Measures

Like the Permian strata, the rocks in the Greta Coal Measures also have very low permeabilities ($<10^{-8}$ m/s). The coal seams are normally the water-bearing zones in the coal measures due to the presence of cleats and fractures in the rock mass. Hitchcock (1995) concludes that the coal measures in the Newcastle Coalfield 'have a poor resource potential with low yielding aquifers of high salinity'.

Permeability of the Greta Seam decreases with depth. The importance of the seam as an aquifer is minimal, as it contains poor quality groundwater.

There are no known groundwater dependent ecosystems of any significance that rely on the groundwater from the Greta Seam.

7.4.1.4 Abandoned Mine Workings

As shown on **Figure 2.1** there are several abandoned collieries adjacent to the Austar mine which are partially filled with groundwater. In addition to normal groundwater percolation into these workings, they also receive water from several other sources. These main sources include the following:

- return of the brine component of the output from the Reverse Osmosis Plant into the underground workings;

- diversion of water from surface dams to underground workings during major storm events (governed by automatic control systems);
- tailings discharge from the CHPP into the underground workings;
- transfer of water from 2 east underground storage to the Bellbird Colliery workings; and
- inflow of rainfall/runoff from high intensity or prolonged rainfall events.

The quality of the water contained in the abandoned mine workings is extremely poor.

Typically rainfall does not infiltrate into the abandoned mine workings except during high intensity or prolonged rainfall events. Rainfall also enters the abandoned mines through significant one-off events such as the major rainfall event in June 2007 when a large volume of water was diverted via a sinkhole in Black Creek into the Aberdare Central workings. This resulted in approximately a 50 metre rise in water level in Aberdare Central and also increased water levels in the adjoining abandoned mines.

7.4.2 Potential Impacts

Minor additional depressurisation of the regional groundwater table associated with the coal seam as a result of mining within LW A5a is expected. Due to the depth of the coal seam (i.e. approximately 500 metres) and the long history of mining in the area, mining within LW A5a is not expected to cause significant changes in the availability of groundwater resource in the area. In terms of depressurisation of groundwater in the coal measures, it is considered that the Stage 2 Extension Project will have similar impacts to those envisaged in the 1995 EIS which formed the basis of development consent for the mining operation.

In regard to the shallow alluvial aquifer, subsidence modelling under taken by MSEC (2009) indicates that hydraulically interconnected fracture networks above the longwall goaf is likely to extend to a height of approximately 235 to 275 metres. The depth of cover above the coal seam ranges from approximately 530 metres to 560 metres over LW A5a. As a result there is negligible potential for hydraulically interconnected cracking to extend from the shallow alluvial aquifer associated with Cony Creek and Quorrobolong Creek to the goaf. On this basis there is negligible potential for groundwater loss from the shallow aquifer as a result of cracking of the strata over the goaf.

Subsidence modelling (MSEC 2009) indicates that valley closure and surface tension cracking may occur as a result of subsidence. This could cause minor cracking and fractures in the upper 15 metres of the underlying stratum. This cracking is unlikely to result in drainage or loss of groundwater but may increase the capacity of the upper section of the underlying stratum to store groundwater through increased void space. This increased void space will be negligible and is unlikely to result in a significant decrease in groundwater levels. Any reduction in groundwater levels will be offset by minor flows in the creek system which will readily fill the additional void space. Sediment moving through the creek system will over a short period of time fill any cracks that may result from tension cracking. As a result, it is considered that subsidence has negligible potential to adversely impact on groundwater levels in the area. As previously discussed, available groundwater quality information indicates that groundwater in the shallow alluvial aquifer is low yielding and of poor quality and as a consequence is not suitable for agricultural or domestic purposes. In addition, minor temporary changes in groundwater levels that may result from subsidence are unlikely to significantly reduce groundwater availability to the riparian ecosystems that align Cony and Quorrobolong Creeks and draw water from the associated alluvial aquifer.

7.4.3 Groundwater Monitoring and Contingency Measures

Austar has implemented a groundwater monitoring program as a part of its Site Water Management Plan for the Austar Mine Complex. The monitoring program includes monitoring of groundwater levels in both the alluvial aquifer and the shallow (70 metres to 100 metres below ground surface) water-bearing zone for any changes at the monitoring locations shown in **Figure 5.2**. Monitoring includes:

- ongoing continuous monitoring of groundwater levels in bore AQD 1073A adjacent to Quorrobolong Creek with EC readings taken every three months;
- daily rainfall in the vicinity of the site to provide context for fluctuations in groundwater level;
- ongoing review of groundwater levels in DWE bore GW054676 and the adjacent shallow bore;
- monitoring of groundwater levels in bore NER 1010 adjacent to the Stage 2 area in the water bearing zone located between 70-100 metres beneath the surface; and
- review of the monitoring results at three months intervals and reporting of the results at the completion of each longwall panel.

Ongoing analysis of the data will be carried out to determine if the changes are due to longwall extraction. If the changes are determined to be mining-related, the verification review process will examine the cause and suggest possible contingency measures.

It is considered that the existing groundwater monitoring provisions of the Austar Site Water Management Plan are appropriate to monitor any changes in the alluvial and shallow water-bearing zone as a result of the Stage 2 Extension Project.

7.5 Energy and Greenhouse Gas

As discussed in **Section 3.1**, the Stage 2 Extension Project will involve the extraction of up to 6.5 metres of coal from LW A5a (**Figure 1.4**) using LTCC technology. The extraction of coal will take place within the DA 29/95 approval area, and will not result in an increase in the rate of coal extraction or total extraction tonnage approved under DA 29/95. However, significant energy savings will be made per tonne of coal extracted from LW A5a if the use of LTCC technology is approved, compared to the use of conventional longwall mining techniques currently approved under DA 29/95.

Considerable economies-of-scale in terms of reduction in net energy required per tonne of coal extracted will result from the use of LTCC. This occurs because the longwall shearer is only required to cut a 3 metre thickness of coal, with the remainder of the up to 6.5 metre thick coal seam falling onto the rear conveyor of the LTCC under the force of gravity. As a result, extraction of a 6.5 metre thick coal seam using LTCC requires approximately 50% of the coal to be extracted using the longwall shearer and the other 50% being extracted using gravity to deliver the coal onto the rear conveyor.

Analysis of longwall mining using LTCC technology in the Stage 1 area indicates that operation of the rear conveyor uses approximately 5% of the total electrical power required to operate the LTCC equipment. As a result, in a 6.5 metre thick coal seam, mining of coal using the LTCC equipment can extract approximately 60% more coal per unit of energy used, than could be extracted using conventional longwall mining equipment. This makes the LTCC method considerably more energy efficient than conventional longwall mining techniques.

With less energy required per tonne of coal extracted compared to conventional longwall mining techniques, the LTCC method of coal extraction results in less greenhouse gas being produced in the generation of the energy required to extract coal. As a result, extraction the coal resource in LW A5a using LTCC techniques will result in significant energy and greenhouse gas savings compared to if the resource was extracted using conventional longwall mining techniques.

7.6 Heritage

7.6.1 Aboriginal Archaeology and Cultural Heritage

An archaeological survey was undertaken as part of the EIS for Ellalong Colliery – Extension into Bellbird South (HLA 1995a and HLA 1995b). The results of Brayshaw's (1987) investigations undertaken for the Bellbird South Coal Project were incorporated into this report (HLA 1995:6.10).

A small artefact scatter (Quorrobolong 1, NPWS No. 37-6-0422) was recorded by Brayshaw on the knoll adjacent to the northern side bank of Quorrobolong Creek. This site is on the boundary of the Stage 2 Extension Study Area and is located over Longwall A4 (see **Figure 7.11**). The site is located approximately 300 metres to the north of Quorrobolong Creek and 45 metres above it. Brayshaw described the site as follows:

> Small boulders of conglomerate sandstone were exposed on the hilltop, and artefacts were found in bare areas close to trees or in exposed scours.
>
> A total of 7 artefacts were found in an 80 x 25 metre area at a maximum density of 4/m².

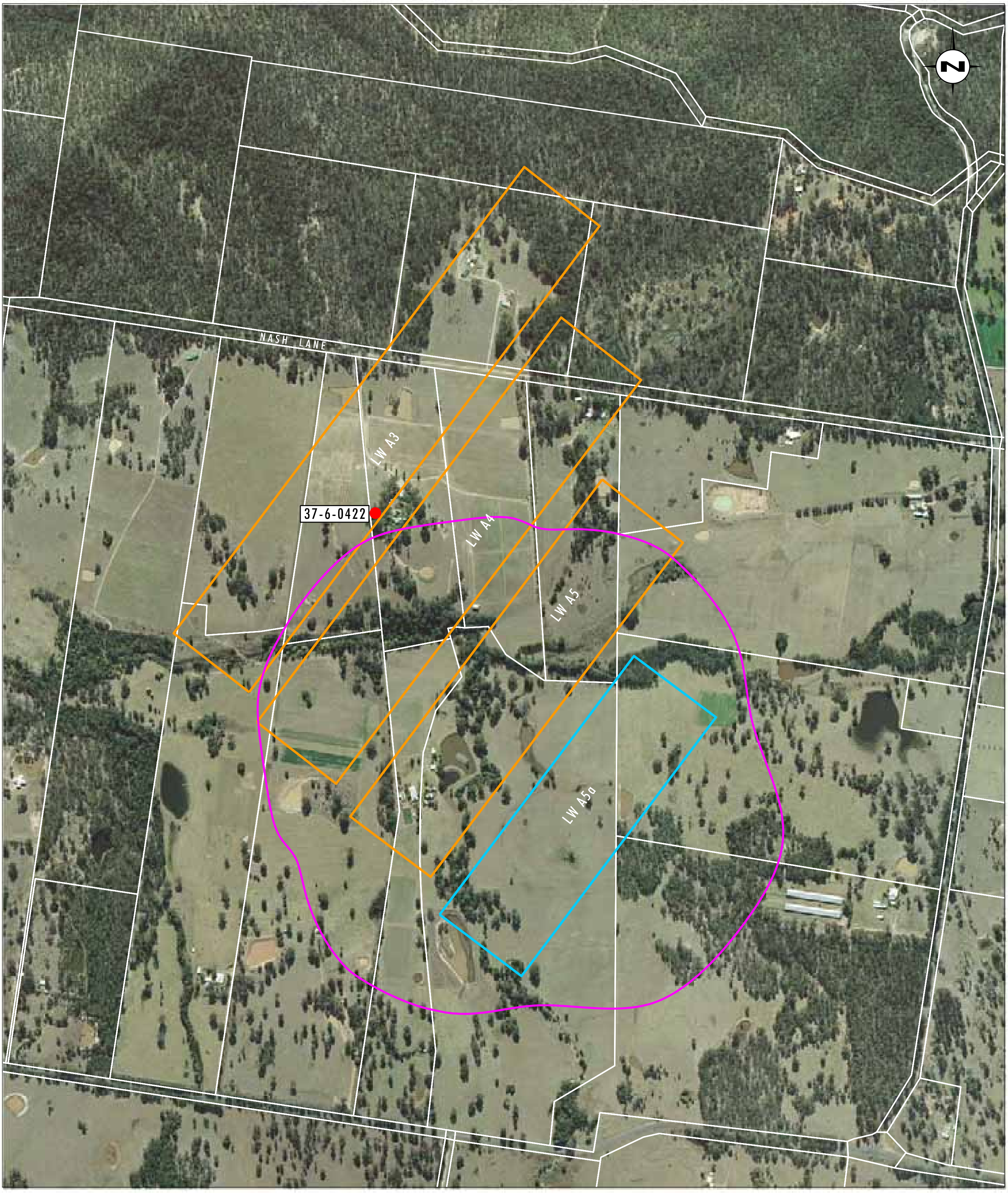
The artefacts included 3 indurated mudstone flakes, 1 silcrete flake, 1 silcrete core, 1 quartzite flake, and 1 quartzite flaked piece.

An isolated find (IF-1) was also located by Brayshaw on Broken Back Ridge to the north-west of the current study area (within Stage 1 of Austar Coal Mine). This site has not been assigned a NPWS number within the AHIMS database, probably because the description of this site was included on the site card for Quorrobolong 1. The site was located on a ridge saddle on Pelton Road, 1.6 kilometres north-west of Quorrobolong 1. The site consisted of a single multi-platformed silcrete core.

The Stage 2 Extension Study Area was not surveyed by HLA (1995b) because areas of proposed surface impact were focused upon. The potential impacts to this area caused by subsidence were addressed though the recommendation of a subsidence monitoring program. HLA (1995b:15-16) considered that potential increases in erosion, especially adjacent to creek lines and wetlands, were the major potential threats to any Aboriginal heritage sites if they existed in this area.

It was suggested that a monitoring grid line be established so that watercourses and archaeological sites could be monitored for any changes that could lead to erosion. If such changes occurred, they would be detected early and the surfaces graded to preserve drainage and prevent ponding (HLA 1995a:7.23). These measures would also enable erosion to be minimised.

Aboriginal heritage was also addressed in the Statement of Environmental Effects (SEE) undertaken for the Modification of Consent (Section 96(2) of the EP&A Act 1979) for Stage 1



Source: AAM Hatch, 2006
Base Source: Austar Coal Mine

0 200 400 600m
1:12 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- LWA5a 20mm Incremental Subsidence Contour
- Artefact Scatter
- Cadastral Boundary

FIGURE 7.11

Previously Recorded Aboriginal Heritage Sites within Proximity to the Stage 2 Extension Study Area

of the Austar Mine. The SEE reviewed HLA (1995a and 1995b) and Brayshaw (1987). IF-1, the isolated find recorded by Brayshaw (1987) was found to be located above one of the Stage 1 longwalls, however, it was concluded that the associated subsidence would not have a significant impact on the site. Consequently, no mitigation measures were recommended.

There is potential that both surface and subsurface Aboriginal heritage sites are located within the Stage 2 Extension Study Area. Areas adjacent to creek lines (reliable fresh water), and slightly elevated areas such as gently sloping lower slopes, benches, and spur crests have high archaeological sensitivity in this region. Additionally, the local Aboriginal community may consider the area to be of particular cultural significance.

Subsidence impact assessment and flood modelling indicates that surface drainage remediation works are not likely to be required in the Stage 2 Extension Study Area even if upper bound subsidence occurs.

Consistent with HLA (1995) recommendations which formed part of the existing development consent for underground mining, if surface works are required, an Aboriginal heritage assessment of the areas where works are likely to be required should be undertaken in consultation with the Aboriginal community prior to any surface disturbance.

7.6.2 European Heritage

HLA (1995a and 1995b) summarised the European history of the Ellalong/Cessnock area. The following information was extracted from HLA (1995b:5).

The small settlers who occupied the Cessnock region from the 1820s were involved in grazing sheep and cattle, growing wheat and maize and timber getting. Vineyards developed after the 1840s and formed an important part of the farming economy.

With the development of mines at East Greta in 1891, exploitation of the South Maitland Coalfields began and mines began to open as the Greta coal measures were followed south. Mines were established in the Cessnock area by 1906 and were linked to what later became the South Maitland Railway. Collieries to the south of Cessnock (in the vicinity of the current study area) were established in the 1920s.

The effect of coal mining was to increase the regional population and improve the transport links to Maitland and Newcastle. Maze (1933) notes two opposing effects of coal mining on the agriculture of the area. Firstly, people gave up farming and became miners. Secondly, the growing demand for fresh food increased the production of vegetable, fruit and dairy products. Maze (1933) paints a picture of changing land use patterns from small farms growing grain or grazing sheep and cattle to a mining landscape. This landscape consisted of mines, transport networks to take the coal out to Newcastle, and a network of residential towns (such as Ellalong and Paxton) for miners. The agricultural landscape changed to dairying and vegetable production on the richer soils with the marginal farms being abandoned (Maze 1933:37-38).

HLA (1995b:5) postulated that two types of European heritage sites would be found in the proposed Ellalong Colliery area (including the Stage 2 Extension Study Area) – agricultural related sites and mining related sites. The following sites were identified during the archaeological survey:

- a large ring-barked tree (EL-2) was located on the boundary of a proposed washery emplacement area which does not form part of the Stage 2 area. This site was associated with the early pattern of European land use and settlement but was found to be of low significance;

- a section of the Kalingo Junction to Millfield and Paxton branch line which is not part of the Stage 2 study area. This section of line was found to be significant for its association with the mining industry and as part of the well known South Maitland Railway System, one of the largest private railways in Australia). However, its significance was found to be compromised by the removal of all track signalling and other railway facilities, leaving only the track formation. The integrity of this section was also found to have been affected by the its cutting by the Ellalong to Pelton coal conveyor;

- a section of the Kalingo Junction to Cessnock No.1 Colliery line. This section was also assessed as being significant for the above reasons. However, this significance was found to be diminished by the low integrity of the line; and

- the Cessnock No.1 Colliery. This site has important historical associations with the development of the Cessnock coal fields. The site was assessed as being a rare example and retaining integrity. A Conservation Management Plan and Heritage Impact Statement were recommended for this site prior to its proposed re-opening.

No European heritage sites were identified in the Stage 2 Extension Study Area as a result of HLA's (1995a and 1995b) investigations.

7.7 Ecology

To assess the potential impacts of the Stage 2 Extension Project on the ecological attributes of the area an ecological assessment was undertaken by Umwelt. The ecological assessment is presented in **Appendix 8** and summarised in **Sections 7.7.1** to **7.7.5** below. The Stage 2 Extension Project Ecological Assessment draws on the previous ecological assessment for the Stage 2 area conducted in 2007, and the results of the ongoing Stage 2 ecological monitoring program, which commenced in autumn 2008. The Stage 2 ecological assessment is detailed in *Austar Stage 2 Subsidence Management Plan – Ecological Assessment* (Umwelt, 2007b).

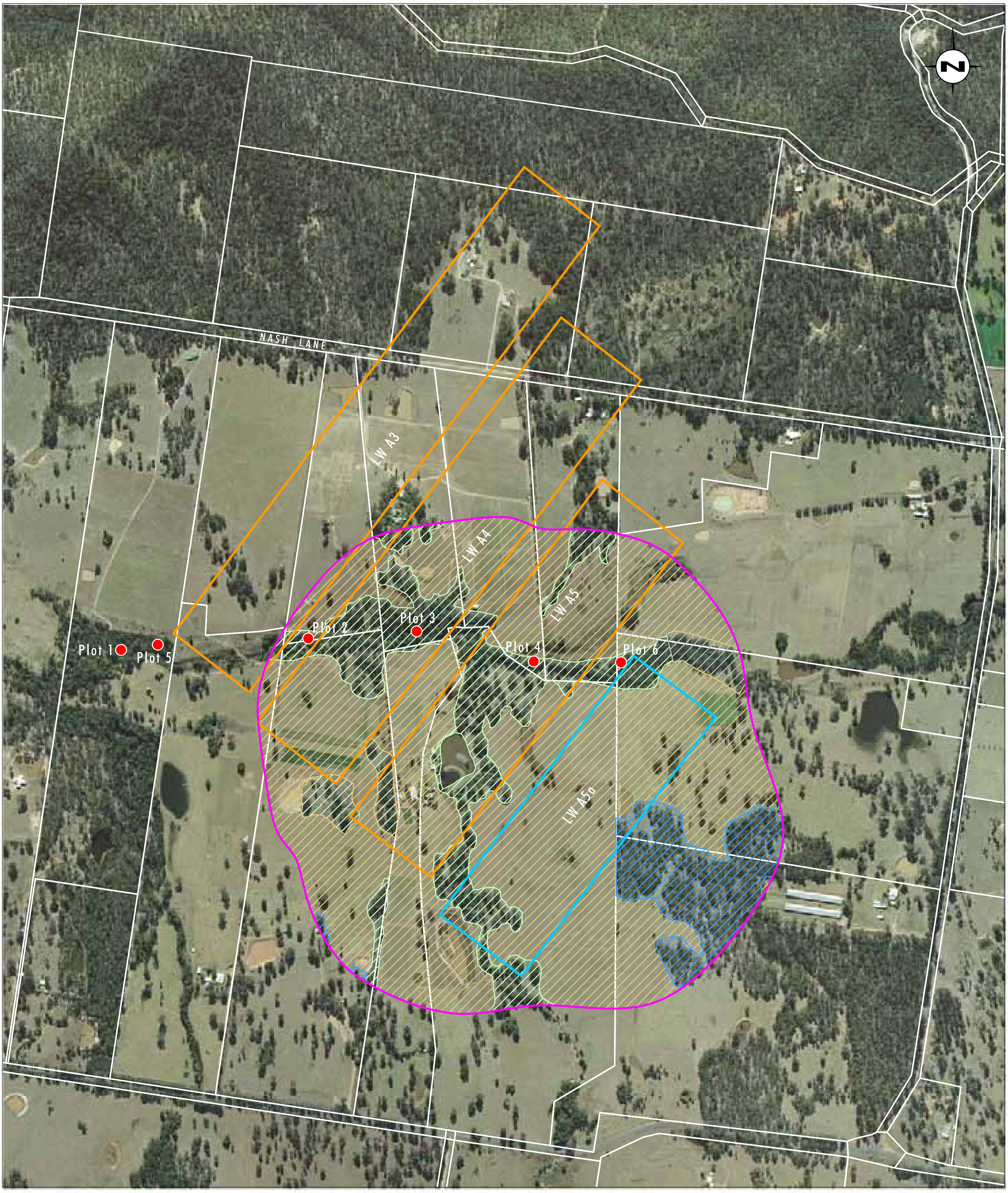
7.7.1 Existing Flora

The vegetation within the study area mainly comprises cleared land supporting Derived Grassland vegetation with some areas supporting small amounts of *Riparian Swamp Oak – Rough-barked Apple Open Forest* and *Spotted Gum – Ironbark Forest* (**Figure 7.12**).

Regional vegetation mapping identifies the vegetation of Quorrobolong Creek as *Central Hunter Riparian Forest*. The *Riparian Swamp Oak – Rough Barked Apple Open Forest* recorded within Stage 2 conforms to this community. Similarly, the *Spotted Gum – Ironbark Forest* recorded within the study area is considered most similar to this community. The *Spotted Gum – Ironbark Forest* corresponds to the Lower Hunter Spotted Gum – Ironbark Forest as described in **Appendix 8**.

On consideration of the structural and floristic composition of the *Riparian Swamp Oak – Rough-barked Apple Open Forest* and the geomorphology of the study area, this community has the potential to conform to the Ecologically Endangered Community (EEC) *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (NSW Scientific Committee 2005a). The *Spotted Gum – Ironbark Forest* was found to be consistent with the *Lower Hunter Spotted Gum – Ironbark Forest* EEC.

Umwelt
Environmental Consultants



Source: AAM Hatch, 2006
Base Source: Austar Coal Mine

0 200 400 600m
1:12 000

Legend

- Layout for Stage 2 Longwall Panels
- Layout for Stage 2 Extension Longwall Panel
- Stage 2 Extension Study Area
- Ecological Monitoring Sites
- Cadastral Boundary
- Spotted Gum - Ironbark Forest
- Swamp Oak Riparian Forest
- Derived Grassland with Scattered Canopy Trees
- Derived Grassland
- Riparian Swamp Oak - Rough-barked Apple Open Forest (Possible River-flat Eucalypt Forest EEC)

FIGURE 7.12

Vegetation Communities in the Stage 2 Extension Study Area

File Name (A4): R56_V1/2274_762.dgn

7.7.2 Existing Fauna

A list of the 66 fauna species recorded opportunistically during the survey of the study area is contained in **Appendix 8**. The list consists of 56 bird species, 1 reptile species, 2 amphibians, and 7 mammals. The area provides a range of foraging, roosting and nesting habitat for a variety of native fauna. The two broad habitat types were found to be Riparian habitats and Open Forest habitats. These are described in detail in **Appendix 8**.

7.7.3 Threatened Species

7.7.3.1 Flora

No threatened flora species were recorded in the study area, however two species are considered to have potential habitat within the study area. These are heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). Each of these species is discussed in detail in **Appendix 8**.

No endangered flora populations were identified within the study area and there is no potential for such populations to occur.

Seven regionally significant flora species were recorded within they study area (*Parsonsia straminea, Maytenus silvestris, Acacia parvipinnula Corymbia maculate, Eucalyptus amplifolia* subsp. *amplifolia, Melaleuca styphelioides,* and *Imperata cylindrica* var. *major)*, however, each of these species are relatively widespread throughout the region, and therefore do not pose a significant constraint to the Stage 2 Extension Project.

7.7.3.2 Fauna

No threatened fauna species were recorded within the study area, however, the speckled warbler (*Pyrrholaemus sagittata*) and the grey-crowned babbler (*Pomatostomus temporalis temporalis*), were recorded previously as part of the Stage 2 surveys (Umwelt, 2007b) and baseline ecological monitoring (Umwelt, 2009).

As these species have previously been recorded within close proximity to the current study area and share similar habitat, these species will be considered as part of this impact assessment as species potentially occurring within the current study area.

Additionally, there is potential habitat for a further 30 species. It is considered that subsidence associated with the Stage 2 Extension Project will cause minimal surface disturbance, and therefore it is unlikely to result in an impact on any of the threatened fauna species recorded or with potential to occur within the study area. As such, it was not considered necessary to undertake a seven part test of significance for any threatened fauna species. Further discussion of the impacts of the proposed development is provided in **Appendix 8**.

There were 13 EPBC–listed migratory species identified by the database searches undertaken for the study area which have either been recorded within the study area or are considered to have moderate to high potential to occur within the area (refer to **Appendix 8**). An assessment of significance has been undertaken for each of these.

There are no endangered fauna populations within the study area, nor is there any critical habitat. The study area does not comprise potential koala habitat as defined under SEPP.

7.7.4 Impact Assessment

The potential impacts of the proposed Stage 2 Extension Project will be limited to subsidence-related impacts only, and these impacts are predicted to be within the envelope of those set out in the 1995 EIS and approved under DA 29/95. There will be no disturbance to the surface environment as a result of the installation of infrastructure (such as roads, pipelines shafts), to support the underground workings.

It is expected that there will be no loss of vegetation as a result of tree fall from subsidence-related impacts. Further detail on the assessment of subsidence impacts associated with the Stage 2 Extension Project is provided in **Appendix 8**.

7.7.4.1 Flora

Given that there is expected to be no impact on surface vegetation as a result of the Stage 2 Extension Project, it is unlikely that the Stage 2 Extension Project will impact on the two TSC Act listed threatened flora species with potential to occur within the study area (wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*)).

Due to the negligible impacts of the Stage 2 Extension Project on fauna species, no seven part tests of significance under the EP&A Act are considered necessary for fauna species. However, a seven part test of significance under the TSC Act was prepared for the potential *River-flat Eucalypt Forest* Endangered Ecological Community (EEC) and the recorded *Lower Hunter Spotted Gum – Ironbark Forest* EEC to determine the significance of the likely impacts of the proposed extension on these communities (based on the assumption that the *River-flat Eucalypt Forest* EEC is present).

The assessment, which is provided in **Appendix 8**, concluded that the proposed extension will not result in a significant impact on the *River-flat Eucalypt Forest* EEC or the *Lower Hunter Spotted Gum – Ironbark Forest* EEC, based on the:

- predicted levels of subsidence (refer to **Section 7.1**);
- estimated changes to surface and groundwater flow patterns (refer to **Sections 7.3** and **7.4**); and
- lack of potential for tree fall or loss of terrestrial vegetation.

Monitoring of each community will be included as part of the current ecological monitoring program and will continue as per the baseline ecological monitoring (Umwelt 2009) for a period of time to ensure that there are no long term impacts. If significant impacts are detected then these will be investigated and appropriate remediation actions determined and implemented. Further information on current and proposed future management measures for the EECs within the study area is provided in **Section 7.7.5**.

Analysis of the predicted levels of subsidence and associated changes to hydrology (refer to **Sections 7.1** and **7.2**) has identified that the impacts of the proposed development on the ecology of the study area are likely to be negligible. The proposed development is not expected to have a significant impact on any threatened species, populations or EECs recorded or with potential to occur within the study area.

7.7.4.2 Fauna

It is not expected that the proposed extension will have an impact on any of the threatened species with the potential to occur within the study area, nor will it lead to significant alteration of fauna habitats.

The assessment of significance of the proposed extension under the EPBC Act was undertaken and concluded that there will be no significant impact on EPBC – listed threatened fauna species, migratory species or marine species as a result of the project

Due to the negligible impacts of the proposed extension on fauna species, no seven part test of significance under the TSC Act was considered necessary for threatened fauna species.

7.7.4.3 Key Threatening Processes

A number of Key Threatening Processes (KTPs) listed under the Schedules of the TSC Act, the EPBC Act and the FM Act, were identified as potentially of relevance to the project. Details regarding these KTPs, including an assessment of the applicability of the threatening process to the proposal is provided in **Appendix 8**.

In summary the KTPs of most relevance to the project are as follows:

TSC Act

- **Alterations due to subsidence associated with longwall mining:** this is likely to be the most relevant KTP associated with the Stage 2 Extension Project. All potential ecological impacts associated with the underground mining operations must be identified, and their significance assessed. Appropriate management measures will need to be implemented to mitigate any impacts of the underground mining development that are identified during monitoring.

- **Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands:** The proposed underground mining has the potential to cause alteration to the natural flow regime of waterways as a result of subsidence. Appropriate amelioration measures will need to be implemented if monitoring reveals any significant alteration to the natural flow regimes of the study area.

FM Act

- **The degradation of native riparian vegetation along New South Wales water courses:** the Stage 2 Extension Project may result in the degradation of riparian vegetation as a result of subsidence due to longwall mining. Appropriate amelioration measures will need to be implemented if monitoring reveals any significant alterations that will result in degradation of native riparian vegetation.

7.7.5 Management Measures

It has been concluded after careful analysis of the predicted levels of subsidence and associated changes to hydrology, that the proposed extension is not likely to result in impacts to the ecological features of the Stage 2 Extension Study Area, nor is it expected to have significant impacts on any threatened species, populations or Threatened Ecological Communities (TECs) recorded or with potential to occur within the study area.

To ensure the continued protection of significant ecological values of the Stage 2 area an ecological monitoring program as set out in Umwelt (2009) and summarised in **Appendix 8** is currently being implemented. The monitoring program is specifically targeted towards identifying changes to the potential *River-flat Eucalypt Forest* EEC. The monitoring program documents the pre-mining condition of the study area, and tracks any ecological impacts that may be attributable to underground mining.

The monitoring program incorporates three key survey methods: (1) permanent vegetation plots; (2) vegetation condition assessment; and (3) photo monitoring.

A total of three permanent vegetation plots and two condition assessment and photo monitoring sites were set up for the Stage 2 ecological monitoring program. An additional permanent vegetation plot on Cony Creek north of LW A5a was added to the Stage 2 monitoring program to take into account impacts on riparian vegetation associated with the Stage 2 Extension Project.

It is also recommended that an extra monitoring point be established as part of the existing program, so that baseline condition and ongoing impacts on the *Lower Hunter Spotted Gum – Ironbark Forest* EEC within the Stage 2 Extension Study Area can be monitored accordingly. A baseline monitoring event within the vegetation type should be undertaken a minimum of one month prior to the commencement of mining, as well as during the remainder of the existing monitoring program. It is recommended this monitoring program be reviewed five years after mining commences.

7.8 Socio-Economic

As discussed in **Section 3.1**, the Stage 2 Extension Project will involve the extraction of up to 6.5 metres of coal from LW A5a (**Figure 1.4**) using LTCC technology. The extraction of coal will take place within the DA 29/95 approval area, and will not result in an increase in the rate of coal extraction or total extraction tonnage approved under DA 29/95. No changes to surface infrastructure or the life of DA 29/95 are proposed as a part of the Stage 2 Extension Project.

Nonetheless the Stage 2 Extension Project will provide additional economic benefit to the State of NSW by:

- providing continuity between underground mining in the Stage 2 and Stage 3 areas while construction of the upcast and downcast shafts at the Stage 3 Surface Infrastructure Site is completed, resulting in continuity of employment for 200 people;
- maximising the recovery of coal resource from the DA 29/95 approval area through the use of LTCC technology, which will enable recovery of up to 70% more coal than could otherwise be recovered using conventional longwall mining methods; and
- minimising energy usage and greenhouse gas emissions per tonne of coal resource extracted as discussed in **Section 7.5**.

An assessment of the subsidence impacts for properties, built features and natural features within the Stage 2 Extension Project is provided in **Sections 7.1** to **7.7** above. As the subsidence impacts of the Stage 2 Extension Project are within the envelope of those set out in the 1995 EIS and approved in DA 29/95, additional socio-economic impact on residents and landholders above and beyond what was originally approved under DA 29/95 is considered unlikely.

7.9 Cumulative Impacts

An assessment of the impacts of the Stage 2 Extension Project is set out in **Sections 7.1** to **7.8** above. The assessment has been based on the cumulative impact of underground mining in LW A3 to A5 (Stage 2) and LW A5a (Stage 2 Extension). In addition, subsidence associated with the Stage 2 Extension Project will have a minor interaction with subsidence associated with Longwall A6 in the Stage 3 area.

As discussed in **Section 7.1**, cumulative impacts of the Stage 2 Extension and Longwall A6 on houses, rural structures, farm dams and other built features are predicted to be negligible.

An assessment of the cumulative impacts of the Stage 2 Extension and Stage 3 on flooding and drainage included in **Appendix 7** indicates that the addition of LW A5a had negligible influence on the previously modelled flood depths, flow velocities and flood hazard categories estimated for the Stage 3 operations with predicted subsidence.

The cumulative impacts of the Stage 2 Extension Project and Stage 3 on the ecological and heritage attributes of the Stage 3 mining area are also predicted to be negligible.

8.0 Draft Statement of Commitments

If approval is granted under Part 3A of the EP&A Act for the proposed Stage 2 Extension Project, Austar Coal Mine will commit to the following controls:

8.1 Compliance with the EA

8.1.1 Operation of the Stage 2 Extension Project will be undertaken in accordance with the environmental controls and commitments as described in the EA.

8.2 Subsidence

8.2.1 Prior to carrying out any underground mining operations in longwall panel A5a that will potentially lead to subsidence of the land surface, Austar Coal Mine will prepare a Subsidence Management Plan (SMP) for those operations in accordance with the following DII documents (or their latest versions or replacements):

- New Approval Process for Management of Coal Mining Subsidence – Policy; and
- Guideline for Applications for Subsidence Management Approvals;

to the satisfaction of the DII.

8.2.2 Where a potential subsidence impact is identified on a private property as a result of the Stage 2 Extension Project, Austar Coal Mine will prepare in consultation with the property owner a Property Subsidence Management Plan (PSMP), or where an existing PSMP exists, update the PSMP. These plans will clearly outline impacts of mining on the property and the management and remediation measures to be implemented.

8.2.3 Austar Coal Mine will update the existing management plans in consultation with relevant service providers, for the protection of infrastructure and services within the potential Stage 2 Extension Project mine subsidence area to ensure these remain in a safe serviceable and repairable condition throughout the mining period. These plans will be submitted to the DII as a part of the SMP prior to undermining of the services.

8.3 Surface Water and Groundwater

8.3.1 Prior to mining commencing in longwall panel A5a, or other date agreed by the Director-General, Austar Coal Mine will revise its Site Water Management Plan for the mine in consultation with the DECCW, and to the satisfaction of the Director-General. The plan shall be implemented to the satisfaction of the Director-General and will include:

- a Site Water Balance;
- an Erosion and Sediment Control Plan;
- a Surface Water Monitoring Program;

- a Ground Water Monitoring Program; and
- a Surface and Ground Water Response Plan.

8.3.2 Drainage line monitoring within the Stage 2 Extension Study Area will be undertaken as an extension of the Stage 2 Ecological Monitoring Program.

8.3.3 Any subsidence impacts on drainage lines will be effectively remediated such that there is no significant impact on downstream water users and environmental flows.

8.3.4 An annual analysis of surface and groundwater monitoring data will be undertaken and will include:

- comparison of groundwater levels with rainfall information;
- identification of any changes or long-term trends in groundwater levels; and
- visual inspection of creeks and drainage lines as a part of the Stage 2 Ecological Monitoring Program.

8.3.5 The results of the surface and groundwater monitoring program will be reported annually in the Annual Environmental Management Report.

8.4 Reject Emplacement

8.4.1. Austar Coal Mine shall undertake reject emplacement from the Stage 2 Extension Area in accordance with the current Mining Operations Plan as updated and approved by the DII from time to time.

8.5 Ecology

8.5.1 Austar Coal Mine shall:

- undertake a monitoring program of riparian vegetation along Quorrobolong and Cony Creeks in the Stage 2 Extension Study Area with particular reference to River Flat Eucalypt Forest EEC;
- undertake a monitoring program of vegetation in the Lower Hunter Spotted Gum – Ironbark Forest EEC in the Stage 2 Extension Study Area ; and
- carry out any necessary ameliorative measures requested by the DECCW in relation to the findings of the vegetation monitoring program;

to the satisfaction of the DECCW.

8.6 Environmental Management, Monitoring, Auditing and Reporting

8.6.1 Austar Coal Mine will update its existing Environmental Monitoring Program to incorporate any additional monitoring required for the Stage 2 Extension Project, to the satisfaction of the Director-General.

8.6.2 Austar Coal Mine will incorporate the Stage 2 Extension Project into the Annual Environmental Management Report for the Austar Mine Complex.

8.6.3 Austar Coal Mine will continue to maintain and work with the Austar Community Consultative Committee (CCC) in relation to the environmental performance of the Austar Mine Complex.

9.0 Justification and Alternatives

Austar currently has planning approval under DA 29/95 to extract coal from the Stage 2 Extension Study Area using conventional longwall mining methods (refer to **Section 2.3** for further details of the operations currently approved under DA 29/95). Extraction of the additional longwall panel is required to enable sufficient time for the completion of Surface Infrastructure Site construction prior to the commencement of longwall mining in the Stage 3 area. Austar seeks a modification of DA 29/95 to use LTCC technology in the LW A5a to enable optimal recovery of the coal resource in accordance with the principles of ecologically sustainable development. This will also result in increased economic return for both the State of New South Wales and Austar. An assessment of the Stage 2 Extension Project against the principles of Ecologically Sustainable Development (ESD) is provided in **Section 8.1**. A discussion of alternatives to the Stage 2 Extension Project is set out in **Section 8.2**.

9.1 Ecologically Sustainable Development

For the purposes of this EA, the definition of Ecologically Sustainable Development (ESD) as set out in Section 6(2) of the *Protection of the Environment Administration Act, 1991* and adopted by the EP&A Act, has been used. ESD requires the integration of economic and environmental considerations in decision making processes. The following ESD principles are integral to the Stage 3 Project:

a) the precautionary principle;
b) inter-generational equity;
c) conservation of biological diversity and ecological integrity; and
d) improved valuation, pricing and incentive mechanisms.

These principles are discussed further in **Sections 8.1.1** to **8.1.4** below.

9.1.1 The Precautionary Principle

Environmental assessment involves the prediction of potential environmental outcomes of a development. The precautionary principle reinforces the need to take risk and uncertainty into account, especially in relation to threats of irreversible environmental damage. A comprehensive definition of the precautionary principle is as follows:

> that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and an assessment of the risk-weighted consequences of various options.

An environmental risk assessment was undertaken for the Stage 2 Extension Project in November 2009, including the identification of potential impacts and required control measures. The results of the risk assessment are summarised in **Section 6** and provided in full in **Appendix 3**. Key areas for further impact assessment were identified and assessed as set out in **Section 7**. The development of appropriate mitigation measures and strategies was also undertaken as a part of the detailed impact assessment process. The Precautionary Principle has therefore been applied to the assessment of the Stage 2 Extension Project.

Key components of the project to minimise the potential for serious irreversible environmental damage include:

- careful design and review of the project;
- identification of the potential impacts and the likelihood and consequences of these impacts;
- development of management, reduction and mitigation measures that are designed to address the potential environmental impacts of the project; and
- implementation of monitoring and reporting mechanisms for the Stage 2 Extension Project.

A range of mitigation measures have been incorporated into the proposed development to minimise the potential for serious irreversible damage to the environment, including the development of environmental management and monitoring measures. Where residual risks are identified, contingency controls have been considered and will be further refined during subsequent preparation of Subsidence Management Plans and Property Subsidence Management Plans for the Stage 2 Extension Study Area.

9.1.2 Intergenerational Equity

Intergenerational equity is based on the principle that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Intragenerational equity is applied within the same generation. The principles of generational equity are addressed by the Stage 2 Extension Project through the proposed use of LTCC technology to minimise energy usage and greenhouse gas emissions generated in longwall extraction of coal from LW A5a.

9.1.3 Conservation of Biological Diversity

A detailed assessment of the ecology and biodiversity of the landform within the Stage 2 Extension Study Area has been undertaken for this EA. The Stage 2 Extension Project will be conducted underground with negligible detrimental impact to the land surface, and impacts will be within the envelope of those set out in the 1995 EIS and approved under DA 29/95.

A range of environmental control measures already in place for the Stage 2 area will be extended to encompass the Stage 2 Extension Project. Environmental monitoring will be undertaken to determine whether the environmental control measures are operating effectively and enable timely detection of issues and implementation of appropriate management measures if and where required.

9.1.4 Valuation and Pricing of Resources

The efficient and non-wasteful management of resources to maximise the welfare of society, both now and for future generations is central to ESD. The Stage 2 Extension Project maximises the efficient use and management of resources through the following factors:

- maximising resource utilisation though the extraction of one additional longwall in the DA 29/95 area thereby including coal resources at the eastern edge of Stage 2 that would be otherwise sterilised;

- use of LTCC mining equipment that enables the full coal seam thickness in LW A5a of up to 6.5 metres to be extracted. Prior to 2006, longwall equipment used at Austar mine was limited to an extraction height of 3.5 metres. In a panel by panel comparison, this would equate to a recovery of only 64% of the coal resource that could otherwise be extracted by LTCC technology based on an average seam thickness of 6.2 metres; and

- minimisation of energy usage in coal extraction through the utilisation of LTCC technology which within the proposed Stage 3 area will allow up to 70% more coal to be extracted compared to conventional longwall mining for only a 5% increase in energy usage.

9.2 Alternatives

9.2.1 Alternative of Not Proceeding

The Stage 2 Extension Project involves the extraction of coal resource from a single longwall within the DA 29/95 subsurface application area (refer to **Figure 1.3**) using LTCC technology. The alternative of not proceeding would result in the sterilisation of a 1 million tonne coal resource that is easily accessible from currently approved Stage 2 workings. It would also result in a delay of up to 9 months between the completion of longwall mining in the currently approved Stage 2 area and commencement of mining in the Stage 3 area due to the timeframe for construction of the ventilation shafts at the Stage 3 Surface Infrastructure Site (refer to **Figure 1.2**). This would result in:

- under-utilisation of the existing coal extraction, handling, processing and transport infrastructure at the Austar Mine Complex;

- loss of revenue for the State of NSW and Austar; and

- risk to employment of Austar personnel.

Analysis of potential environmental risks and impacts as set out in **Sections 5**, **6** and **7** indicates that the Stage 2 Extension Project can be undertaken in a controlled and predictable manner without having a significant adverse impact on the surrounding area. Impacts are predicted to be within the envelope of those set out in the 1995 EIS and approved in DA 29/95. Analysis also indicates that the proposed development will make a contribution to the regional economy. As a result, it is considered that the alternative of not proceeding is not preferred or warranted.

9.2.2 Alternative of Using Conventional Longwall Mining Techniques

As outlined, the use of LTCC technology to extract coal from LW A5a is intended to optimise resource recovery whilst limiting subsidence impacts to within the envelope of those outlined in the 1995 EIS and approved in DA 29/95. The alternative of using conventional longwall mining techniques in LW A5a with a maximum coal extraction height of 4.5 metres would result in:

- under utilisation of existing LTCC mining equipment currently being used within the Stage 2 area;

- a reduction in the total tonnage of coal which could be extracted from LW A5a thereby resulting in less economic benefit for the State of NSW and Austar;

- an increase per tonne of coal in the energy usage and greenhouse emissions associated with coal extraction in LW A5;
- environmental impacts within the Stage 2 Extension Study Area which would not be significantly different to those set out in **Sections 5** to **7** above; and
- increased speed of retreat still leaving an issue of discontinuity between Stage 2 and Stage 3.

The alternative of using conventional longwall mining techniques to extract coal from LW A5a will result in similar environmental impacts for less resource recovery. Consequently, this alternative is not preferred.

9.2.3 Alternative Location

The alternative of mining the remaining portion of longwall SL4, located adjacent to longwall A1 in the Stage 1 mining area (refer to **Figure 1.2**), rather than longwall A5a was also considered. Mining in longwall SL4 was originally undertaken by Southland Coal Pty Limited in 2003. However, a fire broke out in longwall SL4 causing the longwall to be sealed and production to cease prior to the mine being placed into receivership (refer to **Section 2.1**).

Benefits of mining in longwall SL4 include:

- mining location within the approved DA 29/95 area;
- retrieval of previously sterilised coal resource; and
- less impact on landholders due to the location of the longwall beneath a State Conservation Area.

While the environmental impacts of mining the remaining portion of longwall SL4 are considered to be manageable, the safety risk of mining longwall SL4 was considered to be unacceptably high. Consequently, the alternative of mining longwall SL4 is not preferred.

10.0 Glossary and Abbreviations

10.1 Glossary

AHD: Australian Height Datum.

Alluvium: Sediment deposited by a flowing stream, e.g., clay, silt, sand, etc.

Amenities: Lunch room, showers, toilets.

Amenity: An agreeable feature, facility or service which makes for a comfortable and pleasant life.

Aquifer: A water-bearing rock formation.

Arboreal: Adapted for living and moving around in trees.

Archaeological: Pertaining to the study of culture and description of its remains.

Average Recurrence Interval (ARI): The statistically calculated interval likely to be exceeded once in a given period of time. A term used in hydrology, also known as return period.

Catchment Area: The area from which a river or stream receives its water.

Coal Resources: All of the potentially useable coal in a defined area, based on geological data at certain points and extrapolations from these points.

Conglomerate: A rock type comprising greater than 50 per cent rounded water-worn fragments (>2 mm in size) of rock or pebbles cemented together by another mineral substance.

Conservation: The management of natural resources in a way that will preserve them for the benefit of both present and future generations.

Cumulative Subsidence The accumulated subsidence, tilts, curvatures and strains which occur due to the extraction of all longwalls within a single seam.

Dip: The direction in which rock strata is inclined.

Drift A tunnel used to access coal resources.

Ecology: The science dealing with the relationships between organisms and their environment.

Ecosystem: Organisms of a community together with its non-living components through which energy and matter flow.

Effluent: The liquid waste of sewage and industrial processes.

Electrical Conductivity: The measure of electrical conduction through water or a soil-water suspension generally measured in millisiemens per centimetre or microsiemens per centimetre. An approximate measure of soil or water salinity.

Environmental Planning and Assessment Act 1979: NSW Government Act to provide for the orderly development of land in NSW.

Environment Protection and Biodiversity Conservation Act 1999: Commonwealth legislation that regulates development proposals that have an actual or potential impact on matters of national environmental significance.

Fault: A fracture or fracture zone along which there has been displacement of the sides relative to one another. Displacement can be vertical and/or horizontal.

Fauna: All vertebrate animal life of a given time and place.

Floodplain: Large flat area of land adjacent to a stream which is inundated during times of high flow.

Flora: All vascular plant life of a given time and place.

Geology: Science relating to the earth, the rocks of which it is composed and the changes it undergoes.

Geotechnical: Relates to the form, arrangement and structure of geology.

Groundwater: Sub-surface water which is within the saturated zone and can supply wells and springs. The upper surface of this saturated zone is called the water table.

Habitat: The environment in which a plant or animal lives; often described in terms of geography and climate.

kV (Kilo Volt): One thousand volts.

Landform: Sections of the earth's surface which have a definable appearance (e.g. cliff, valley, mountain range, plain, etc).

Mean: The average value of a particular set of numbers.

Megalitre (ML): One million litres.

Meteorology: Science dealing with atmospheric phenomena and weather.

Mitigate: To lessen in force, intensity or harshness. To moderate in severity.

Native: Belonging to the natural flora or fauna in a region.

Outcrop: Bedrock exposed at the ground surface.

Peak Discharge: Maximum discharge down a stream following a storm event.

pH: Scale used to express acidity and alkalinity. Values range from 0-14 with seven representing neutrality. Numbers from seven to zero represent increasing acidity whilst seven to fourteen represent increasing alkalinity.

Protection of the Environment Operations Act 1997: NSW legislation administered by DEC that regulates discharges to land, air and water.

Rehabilitation: The process of restoring to a condition of usefulness. In regard to quarrying, relates to restoration of land from a degraded or quarried condition to a stable and vegetated landform.

Revegetation: The process of re-establishing vegetation cover.

Run of mine (ROM): Bulk material extracted from a mine, before it is processed in any way.

Salinity: A measure of the concentration of dissolved solids in water.

Seam: An identifiable discrete coal unit.

Sedimentation: Deposition or settling of materials by means of water, ice or wind action.

Socio-economic: Combination of social and economic factors.

Spontaneous Combustion: Spontaneous ignition of some or all of a combustible material.

Stage 2 Extension Project The extraction of up to 6.5 metres of coal from LW A5a using Longwall Top Coal Caving technology as described in **Section 3.1**.

Surface Infrastructure: Any man made object, facility or structure on the surface of the land.

Tailings: Fine residual waste material separated in the coal preparation process.

Topography: Description of all the physical features of an area of land and their relative positions, either in words or by way of a map.

Woodland: Land covered by trees that do not form a closed canopy.

10.2 Abbreviations

μS/cm	microseimens per centimetre
AEMR	Annual Environmental Management Report
AFC	armoured face conveyor
AHD	Australian height datum
AHIMS	Aboriginal Heritage Information Management System
ARI	average recurrence interval
Austar	Austar Coal Mine
BoM	Bureau of Meteorology
CCC	Community Consultative Committee
CHPP	coal handling and preparation plant
CML2	Consolidated Mining Lease 2
CSCP	Cessnock Social and Community Plan November 2004 to November 2009
CWSS	Cessnock City Wide Settlement Strategy 2004
DA	Development Application
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEWHA	Department of Environment, Water, Heritage and the Arts
DII	Department of Industry and Investment (formerly Department of Primary Industries)
DoP	Department of Planning
DWE	Department of Water and Energy
EA	environmental assessment
EC	electrical conductivity
EECs	endangered ecological communities
EIS	environmental impact statement
EMP	Environmental Monitoring Program

EPA	Environment Protection Authority of NSW (former, now DECC)
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPL	Environment Protection Licence
ESD	ecologically sustainable development
FM Act	Fisheries Management Act 1994 (NSW)
ha	hectares
HVAS	high volume air sampler
INP	Industrial Noise Policy
IPM	Incremental Profile Method
KTP	key threatening process
kV	kilovolt (1000 volts)
L/sec	litres per second
LEP	Local Environment Plan
LHRCP	Lower Hunter Regional Conservation Plan 2006
LHRS	Lower Hunter Regional Strategy 2006
LGA	Local Government Area
LTCC	Longwall Top Coal Caving
LW	longwall
m	metres
m^2	metres squared
m/s	metre per second
ML	Mining Lease
mm	millimetres
mm/m	millimetres per metre
MOP	Mining Operations Plan
MSB	Mine Subsidence Board

MSEC	Mine Subsidence Engineering Consultants Pty Ltd
Mt	mega tonne (one million tonnes)
Mtpa	million tonnes per annum
MVA	Megavolt ampere
NNTR	National Native Title Register
NPWS	National Parks and Wildlife Service
NT Act	Native Title Act 1993
PAD	potential archaeological deposit
PoEO Act	Protection of the Environment Operations Act 1997 (NSW)
PPV	Peak Particle Velocity
PRP	Pollution Reduction Program
PSMP	Property Subsidence Management Plan
RCP	Regional Conservation Plan
ROM	run of mine
SCA	State Conservation Area
SEE	Statement of Environmental Effects
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
SMP	Subsidence Management Plan
SWMP	Site Water Management Plan
TEC	Threatened Ecological Community
tpa	tonnes per annum
TSC Act	Threatened Species Conservation Act 1995 (NSW)
Umwelt	Umwelt (Australia) Pty Limited
WMA	Water Management Act 2000 (NSW)
Yancoal	Yancoal Australia Pty Limited
Yanzhou	Yanzhou Coal Mining Company Limited

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