flows within the Cony Creek or Sandy Creek system to drain to the goaf resulting from the proposed Stage 3 Modification mining is negligible.

This is supported by the fact that Quorrobolong Creek was previously undermined by LW1 to LW6 and LW SL1 at the Southland Colliery. In these locations the depth of cover varies between 310 and 370 metres. Following mining there was no reported loss of water from the creek and no reported surface cracking in the creek bed. Similarly, monitoring undertaken in the Stage 2 area to date indicates no loss of water from Quorrobolong Creek and no surface cracking in the creek bed.

7.4 Groundwater

A detailed Groundwater Impact Assessment for Stages 2 and 3 of Austar Coal Mine was undertaken by Connell Wagner (October 2007). Key aspects of Connell Wagner (October 2007) relevant to the proposed Stage 3 Modification development, are summarised in **Sections 7.4.1** to **7.4.5**.

7.4.1 Existing Groundwater Resources

As discussed in **Section 7.2.3** there are three potential sources of groundwater that form an integral part of the local hydrogeological regime in this area:

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

The distribution, characteristics and importance of these water sources are summarised in the following subsections.

7.4.1.1 Alluvial Aquifers

The alluvial aquifers in proximity to the proposed Stage 3 Modification mining area are associated with Quorrobolong Creek and its tributaries which flow in a general westerly direction across the mining area. The tributaries that cross the Stage 3 Modification mining area, including Sandy Creek and 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 the defined alluvium associated with this creek system and which covers only a small proportion of the extended Stage 3 Modification mining 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 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 Cony 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 is the Swamp Oak Riparian Forest areas above the proposed underground mining, which is restricted to the creek channels. Consequently, potential impacts on the alluvial aquifer and the dependent ecosystems must be determined.

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 at best. 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 proposed Stage 3 Modification mining 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.

There are three registered bores within the near vicinity of the Stage 3 Modification longwall panels that intersect the Branxton Formation strata. These bores range in depth from 9.1 to 55 metres and all three attempt to tap fractured zones in the upper Branxton Formation. All three bores are low yielding, with individual fractured zones producing 0.3 to 0.6 L/sec. The one bore in which salinity levels were measured had salinity estimate of 10,000 to 14,000 ppm. The poor groundwater quality in the Branxton Formation is largely due to the fact that the rocks were formed in a marine environment.

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 Stage 2 and Stage 3 Modification mining areas.

A search of the NSW Office of Water database of water bores indicates that there is only one bore within the Stage 2 area which intersected groundwater in the rock strata. This bore is 39.6 metres deep, and is located to the west of Longwall A3. The limited data from this bore (GW054676) 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 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.

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 between underground workings areas; 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

No additional depressurisation of the regional groundwater table associated with the coal seam is expected as a result of the proposed Stage 3 Modification mine plan compared with that of the Stage 3 mine plan as approved under Project Approval 08_0111. In terms of depressurisation of groundwater in the coal measures, it is considered that the Stage 3 Modification will have similar impacts to those set out in Connell Wagner (2007) for the Stage 3 mine plan as approved under Project Approval 08_0111.

In regard to the shallow alluvial aquifer, subsidence modelling under taken by MSEC (2011) indicates that hydraulically interconnected fracture networks above the longwall goaf is likely to extend to a height of approximately 245 to 285 metres. The depth of cover above the coal seam ranges from approximately 455 metres to 760 metres over the proposed Stage 3 Modification longwalls. 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. There is no change to predicted impacts on the shallow aquifer as a result of the proposed Stage 3 Modification mine plan compared with that of the Stage 3 mine plan as approved under Project Approval 08_0111.

Subsidence modelling (MSEC 2011) 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 increase in 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 Sandy, Cony and Quorrobolong Creeks and draw water from the associated alluvial aquifer.

7.4.3 Mine Water Balance

A Site Water Management Plan (Austar, 2009) including a revised water balance for the Austar Mine Complex was submitted by Austar to the Department of Planning and Infrastructure in April 2009. The SWMP was approved by the Director of Major Development Assessments on 13 November 2009. The SWMP included the water balance for mining operations in the Stage 2 and Stage 3 areas as described in Connell Wagner (2007) and Umwelt (2008a). The SWMP sets out the major components of the Austar Mine Complex water management system. As a part of this system, groundwater from the Stage 3 mining area will be pumped to the surface and handled using the existing Austar Mine Complex water management system. As described in Umwelt (2008a) and Austar (2009), the existing site water management system has sufficient capacity to handle groundwater from Stage 3. No significant changes to groundwater inflow are predicted as a result of the proposed Stage 3 Modification. Consequently, the existing Austar Mine Complex water management system is considered appropriate for ongoing management of water from the proposed Stage 3 Modification mining area.

Groundwater analysis undertaken by Connell Wagner (2007) indicates that the permeability of the Greta seam is assumed to range from approximately 0.1 m/day at a depth of 400 metres reducing to approximately 0.001 m/day at a depth of 700 metres. Permeability of the overlying Branxton Formation has been estimated to be substantially less than the Greta Coal Seam at approximately 0.00002 m/day.

Maximum predicted groundwater inflows into Stage 2 and Stage 3 workings have been estimated by Connell Wagner (2007) and are summarised in **Table 7.21**.

Table 7.21 – Estimated Groundwater Inflow Rates for Stage 2 and 3 (Source: Connell Wagner, 2007)

Inflow Location	Estimated Maximum Inflow (ML/day)
Stage 2	1.13 to 1.29
Stage 3	2.28 to 3.01 ML/day

The principal source of groundwater inflow into the proposed Stage 3 Modification area will be from the adjacent up dip abandoned workings via faults, dykes, maingates and tailgates. Inflows from adjacent workings are estimated to make up approximately 90% to 92% of the maximum predicted groundwater inflows. Maximum inflows to the proposed Stage 3 Modification goaf from the overlying Branxton Formation are estimated to be 0.18 ML/day to 0.26 ML/day or about 8% to 10% of the total maximum predicted inflow.

Mining within Stages 1 to 3 is effectively creating a flow path for the continued drainage of the adjoining abandoned mines. As a result, continued mining will for the life of the mining operation effectively reduce the rate at which the adjoining mines fill.

The changes to the longwall layout proposed as a part of the Stage 3 Modification will result in a total underground storage void that is consistent with that previously approved under Project Approval 08_0111. Consequently, inflows to the storage void for the proposed Stage 3 Modification longwall layout are predicted to be consistent with those predicted for the Stage 3 conceptual longwall layout as approved. According to Connell Wagner (2007), longwall mining within the Stage 3 area will create an additional underground storage void of approximately 25 Mm^3 (i.e. 25,000 ML) which will have sufficient capacity to store approximately 23 to 39 years of the total predicted maximum groundwater inflows to Stage 3. As discussed, approximately 90% of this inflow will be derived from adjacent abandoned workings with the remaining 10% resulting from inflows to the goaf from the overlying Branxton Formation.

As discussed in Umwelt (2008a), the Stage 3 underground mining will effectively increase the available underground storage capacity by approximately 22,500 ML (i.e. 90% of 25,000 ML) extending the period that it will take for the voids within the surrounding abandoned up dip mines to fill. This will extend the time it will take for water levels in these abandoned mines to reach the surface and potentially discharge to the surrounding drainage system.

The proposed Stage 3 Modification void is down dip from the surrounding abandoned mines and will be approximately 450 to 740 metres below the surface. Subsidence analysis and monitoring indicates that vertically interconnected cracking will extend less than 285 metres above the goaf. As a result the landform above the proposed Stage 3 Modification mining area will effectively remain sealed. Consequently any groundwater that flows directly into the proposed Stage 3 Modification mining area will be contained in the void and not discharge at surface level.

7.4.4 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**. The monitoring program will be updated to include the Stage 3 Modification prior to the commencement on secondary extraction in the Stage 3 area.

As described in Umwelt (2008a) the monitoring program for Stage 3 will form part of the Site Water Management Plan and include the following:

- Establish two shallow groundwater monitoring bores in the alluvial area, and monitor the groundwater levels on a continuous basis to give an indication of the impact of longwall mining on the groundwater in the alluvium. EC readings should be taken in these bores every three months.

- Establish two groundwater monitoring bores to check for any drawdown in the near-surface water-bearing zone in the Branxton Formation in the vicinity of the Stage 3 Modification extraction area. The groundwater level should be monitored continuously in these bores. EC readings should be taken in the bores every three months.

- Monitor daily rainfall in the vicinity of the site so that the timing of any groundwater level fluctuations can be compared with the occurrence of rainfall events.

- Review the results of the above monitoring at three monthly intervals and report results at the completion of each longwall panel.

The suggested locations of the proposed groundwater monitoring points are shown on **Figure 5.2**. The location of these bores is subject to landowner approval, and may also be altered to take advantage of proposed exploration bores.

As further described in Umwelt (2008a) and Connell Wagner (2007), the monitoring for Stage 3 will also include a verification program that involves a detailed review of all:

- data from groundwater monitoring bores;

- subsidence data;

- extensometer data;

- mine water balance data;

- shaft water level data; and

- surface water data.

The verification reviews for Stage 3 will include the following:

- assess the likely height of fracturing in the area under review (if possible);

- assess the condition of the aquifers in the area under review;

- determine the sources of groundwater inflow to the mine and their relative volumes;

- determine whether the assessed conditions differ in any way to the conditions predicted;
- determine whether the variant conditions indicate a potentially adverse outcome, or will have an adverse impact on the main aquifers;
- identify any necessary remedial measures that will mitigate the identified impact or prevent it from occurring (these measures will be drawn from methods that have proven successful in the past); and
- identify any necessary modifications to future operations or operational constraints that will assist in limiting future adverse impacts.

The proposed monitoring and management regime recommended for the Stage 3 project is considered suitable for the proposed Stage 3 Modification.

7.5 Aboriginal Cultural Heritage

A comprehensive Aboriginal Cultural Heritage and Archaeological Assessment of the proposed Stage 3 Modification is provided as **Appendix 10**.

The aim of the assessment was to further the understanding of the cultural Aboriginal heritage and archaeological values of the Stage 3 Modification Area, through consultation with Aboriginal stakeholders, background research and archaeological survey. The assessment builds on the previous Aboriginal Heritage Assessment undertaken for the Stage 3 Project (Umwelt 2008c). The archaeological assessment was conducted in compliance with relevant Planning policies and guidelines, specifically the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (2010), *Interim Community Consultation Requirements for Applicants* (DECC 2004a) and the Part 3A assessment guideline *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2004b).

The subsidence impact assessment conducted by MSEC (refer to **Appendix 9**) identifies the areas of Aboriginal Cultural Heritage significance and the associated and projected impact from subsidence.

7.5.1 Aboriginal Stakeholder Involvement

The proposed Stage 3 Modification Area is within the Country recognised as belonging to the Wonnarua People and lies within the Mindaribba Local Aboriginal Land Council (MLALC) boundaries. Fifteen Aboriginal parties had previously registered an interest in consultation for the Austar project under the *Department of Environment Climate Change (DECC) Interim Community Consultation Requirements for Applicants* (2004a). As consultation had been ongoing with the 15 Registered Aboriginal Parties since 2008, the DP&I advised that there was no requirement for a new notification process and therefore consultation continued with the same Registered Aboriginal Parties.

Registered Aboriginal Party consultation and participation in this current archaeological assessment has involved:

- the keeping of a Registered Aboriginal Party consultation log (refer to **Appendix 10**);
- a project inception meeting;

- a survey strategy workshop in which Registered Aboriginal Party representatives provided input into the development of field survey methods – specifically requesting a 100% survey of all accessible properties;
- participation in seven days of field survey;
- a review of site card information in order to obtain information relevant to the cultural values of the sites and potential archaeological deposits (PADs) located and their management;
- a review of the draft archaeological assessment report; and
- provision of input into the Aboriginal Cultural Heritage Assessment report.

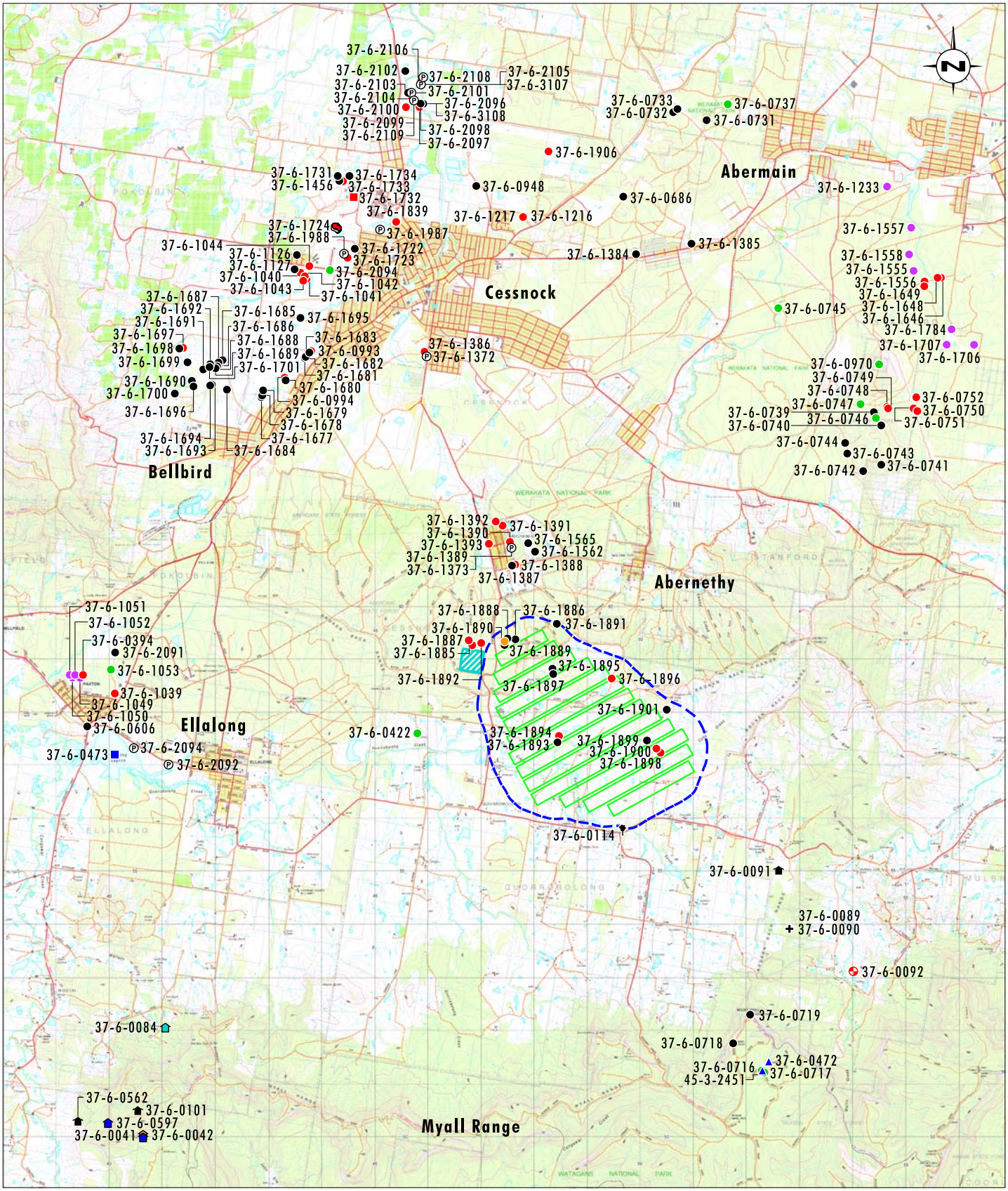
Aboriginal stakeholder views on management formed the basis of recommendations in this report.

7.5.2 Previously Recorded Sites within CML2

An AHIMS site register search identified 117 registered Aboriginal archaeological sites within the region surrounding the proposed Stage 3 Modification Area, 14 of which are located within the Stage 3 Modification Area (ACM3 to 6 and ACM8 to 17). A further three sites (ACM1, ACM2 and ACM 7) were assessed in the 2008 Aboriginal Cultural Heritage Assessment as a component of the Stage 3 EA (Umwelt 2008a). All of these sites are listed in **Table 7.22** and illustrated on **Figure 7.11**.

Table 7.22 – Aboriginal Archaeological Sites Registered within the Stage 3 Area and Proposed Stage 3 Modification Area

AHIMS #	Site Name	Site Type	Area Where Registered
37-6-1885	ACM1 (Quorrobolong)	Isolated find	Stage 3 Area
37-6-1887	ACM2 (Quorrobolong)	Isolated find	Stage 3 Area
37-6-1886	ACM3 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1888	ACM4 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1889	ACM5 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1890	ACM6 (Quorrobolong)	Grinding groove and Isolated find	Proposed Stage 3 Modification Area
37-6-1891	ACM7 (Quorrobolong)	Isolated find	Stage 3 Area
37-6-1892	ACM8 (Quorrobolong)	Artefact scatter	Proposed Stage 3 Modification Area
37-6-1893	ACM9 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1894	ACM10 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1895	ACM11 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1896	ACM12 (Quorrobolong)	Artefact scatter	Proposed Stage 3 Modification Area
37-6-1897	ACM13 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1898	ACM14 (Quorrobolong)	Artefact scatter	Proposed Stage 3 Modification Area



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

0 1.0 2.0 4km
1:100 000

Legend

- Proposed Stage 3 Modification Longwall Panels
- 20mm Subsidence Contour for Proposed Stage 3 Modification
- Surface Infrastructure Site
- Axe Grinding Groove
- Carved Tree
- Isolated Find
- Isolated Find with PAD
- Isolated Find and Grinding Groove
- Natural Mythological (Ritual)
- Artefact Scatter and PAD
- Artefact Scatter
- Open Camp Site
- PAD
- Shelter with Art
- Shelter with Art and Deposit
- Shelter with Deposit
- Shelter with Axe Grinding Groove, Rock Engraving and Art
- Burial/s
- Bora/Ceremonial
- Unidentified Site Type

FIGURE 7.11

AHIMS Sites (Regional)

File Name (A4): R64_V1/2274_1005.dgn

Table 7.22 – Aboriginal Archaeological Sites Registered within the Stage 3 Area and Proposed Stage 3 Modification Area (cont)

AHIMS #	Site Name	Site Type	Area Where Registered
37-6-1899	ACM15 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1900	ACM16 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area
37-6-1901	ACM17 (Quorrobolong)	Isolated find	Proposed Stage 3 Modification Area

In addition to the sites listed in **Table 7.22**, five Aboriginal archaeological sites have been recorded within the broader CML2 lease area managed by Austar. Three of these are not yet registered on the AHIMS sites database as site cards have only recently been submitted to the Office of Environment and Heritage (OEH, formerly NPWS, DEC, DECC and DECCW). These sites are listed in **Table 7.23**.

Table 7.23 - Archaeological Sites known to occur within the CML2 Lease

AHIMS #	Site Name	Site Type
na	ACM18	Artefact scatter
na	ACM19	Isolated find
na	ACM20	Isolated find
37-6-0422	Quorrobolong	Artefact scatter
37-6-0114	Quorrobolong	Carved tree

Of the above site locations, one – Quorrobolong (#37-6-0114), a carved tree – is positioned approximately 100 metres to the south of the proposed Stage 3 Modification Area (**Figure 7.11**). This site was registered by D Bell in 1980, but the site cards note that the site was first reported by B T McCarthy in 1959. The tree is described as destroyed on the AHIMS site card. No other information is provided on the site card.

7.5.3 Predictive Model

Predictive modelling indicates which site types are likely to be found in an area and specifies their likely distribution, content and integrity. The following site types were predicted to occur within the proposed Stage 3 Modification Area after a review of the archaeological and landscape context, ethnohistoric information and land use history:

- **artefact scatters** and **isolated finds** (the dominant site types within the local region identified in all landform contexts);
- **scarred trees** (have been previously recorded in the region and can occur in all landform contexts retaining mature, native vegetation);
- **PADs** located in areas where erosion has not acted to uncover archaeological material. Most likely to be located in slightly elevated areas (lower slopes or terraces) associated with more reliable water sources; and

- **grinding groove sites** (occur in the lower Hunter Valley in sandstone geological areas, such as those found within the north of the proposed Stage 3 Modification Area).

7.5.4 Archaeological Survey

Survey was conducted over seven days in February-March 2011. Surveys were conducted in properties where landholders gave access. The properties surveyed included 20 private properties, representing a significant increase in survey area from the surveys undertaken in 2008. The total property access from the 2008 and 2011 surveys is provided in **Figure 7.12**. Survey inspected all landforms, with 15 transects along streams, 70 transects on hillslopes (24 transects on mid hillslopes, 37 transects on lower hillslopes, 9 transects on upper hillslopes), 2 transects on crests, and 3 transects on flats. The vast majority of transects were pedestrian with only 2 vehicular transects undertaken.

The potential for burial sites and ceremonial sites in the Quorrobolong Valley was also examined after an earlier report (Needham 1981) placed them in the general area of Quorrobolong Creek. Primary sources were contacted to establish the veracity of this report and indicated the sites referred to were located to the southeast of the proposed Stage 3 Modification Area near Wallis Creek. Furthermore, the potential for skeletal remains to survive in the area was considered to be low as the soil is acidic, subject to wetting and drying cycles and disturbed by historic land use practices.

7.5.5 Survey Results

7.5.5.1 Artefact Scatters and Isolated Finds

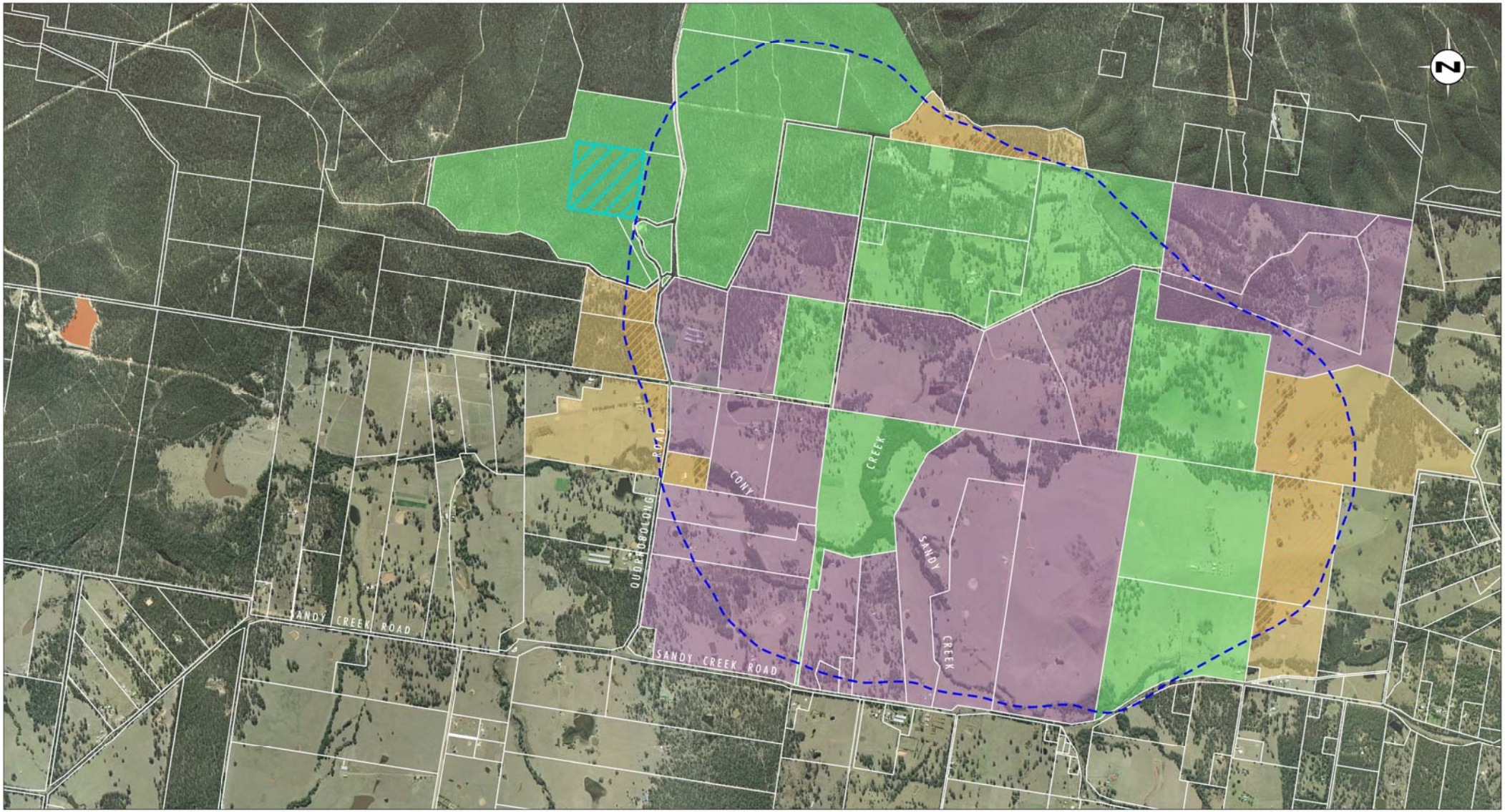
Artefact scatters and isolated finds were recorded at a low density throughout the landscape, with 23 sites identified within the proposed Stage 3 Modification Area in the 1210 hectares inspected during 2008, 2010 and 2011 (or 0.2 sites per hectare). An additional six sites were found in the original Stage 3 area (and now outside the proposed Stage 3 Modification Area) that included the Surface Infrastructure Site. A total of 13 artefact scatters and 16 Isolated Finds were found across the total areas surveyed in 2008, 2010 and 2011. Sites were recorded in all landform elements present within the proposed Stage 3 Modification Area, with sites recorded along lower hillslopes (17), stream banks (5), stream beds (2), flats (1), floodplains (1) and crests (1). Sites found associated with hillslopes were found in mid and lower slopes, but not on upper slopes.

Most artefact scatters and isolated finds were recorded no more than 100 metres from a watercourse, with the majority of sites (19 of 29) recorded within 25 metres of a watercourse. All sites have been found in areas of erosion or disturbance and some have been previously impacted by multiple factors including dam and channel construction, vehicular movement and livestock.

Sites were recorded at a low density throughout the landscape and low artefact numbers were recorded, with only three find locations containing more than four artefacts. Low site and artefact density within the proposed Stage 3 Modification Area suggests that although Aboriginal use of the landscape was widespread there is no evidence it was intensively used.

7.5.5.2 Potential Archaeological Deposits (PADs)

Four PADs were located during the survey of the proposed Stage 3 Modification Area (ACM25, ACM26, ACM29 and ACM30). All are located on possible terraces within one kilometre of the confluence of Sandy and Cony Creeks. All sites were located no more than 250 metres from a watercourse, with two located within 50 metres of a watercourse. The three Cony Creek sites were in proximity to its fifth order stream. All sites were located in



Source: Cadastre: LPI NSW, Aerial Photography: AAM Hatch 2006

Legend

- 20mm Subsidence Contour for Proposed Stage 3 Modification
- Areas not surveyed on Inaccessible Properties
- Approved Surface Infrastructure Site
- Properties Accessed in 2011 Survey
- Properties Accessed in 2008 Survey
- Inaccessible Properties

FIGURE 7.12

Inaccessible Properties and
Properties Surveyed in 2008 and 2011

File Name (A4): R64_V1/2274_1006.dgn

areas with minimal erosion or disturbance, yet had been subject to clearing and grazing and were dominated by pasture.

7.5.5.3 Scarred Tree

A single possible scarred tree was located during the assessment of the Stage 3 Modification Area (ACM21 – to be verified by an arboriculturalist). The tree occurred in a lower hillslope context near a confluence of two first order tributaries of Cony Creek. The tree has fallen, its roots are completely exposed and tree has been partially cut for firewood. The site and its immediate environment is considered highly disturbed with low archaeological potential and the possible scarred tree is in poor condition yet is likely to remain in a deteriorating state for many decades.

7.5.5.4 Grinding Groove

The 2008 survey identified one grinding groove, recorded at ACM6 (refer to **Figure 7.13**). Edge grinding of axes and other implements such as hatchets and adzes has been present in the archaeological record of northern Australia since the late Pleistocene; however, the antiquity of edge grinding in south-eastern Australia appears limited from the mid-Holocene to recent period (McBryde and Binns 1972: 65).

Based on this, the ACM6 grinding groove could date to anytime over the last 4000 years; however, as grinding grooves subject to waterborne sediments gradually wear away due to abrasion, it is hypothesised that the ACM6 groove is less than 1000 years old as it has not been subject to extensive erosion.

7.5.6 Significance Assessment

Aboriginal Cultural Significance

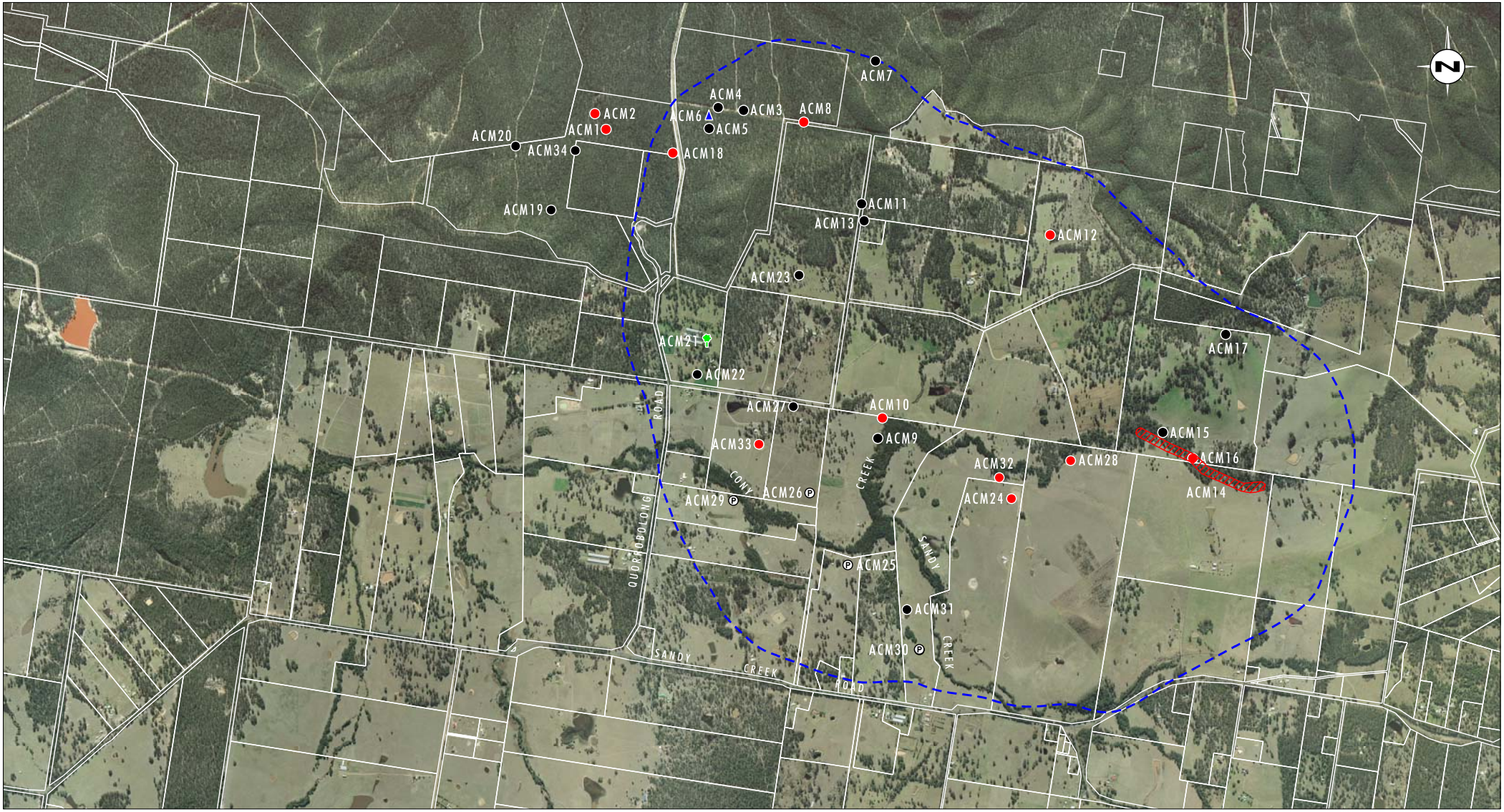
Aboriginal stakeholders involved in the survey stated that all archaeological sites identified are of cultural value, but that the ACM6 grinding groove site was of particular significance (refer to **Appendix 10**).

Areas of high archaeological potential were identified to be of cultural value due to the likely occurrence of archaeological sites. Additionally, artefact scatters located in the vicinity of Black Creek reflect periodic use of the area for activities such as hunting, fishing and retooling. However, due to the time that has passed since these areas have been used in a traditional manner, evidence of this use has been degraded. Areas around water courses were identified as culturally significant as they represent a livelihood and a connection to country. The identified grinding groove was perceived to be of particular significance as it represents a tangible link to past traditional use of the area.

Archaeological/Scientific Significance

The archaeological or scientific significance of Aboriginal archaeological sites is primarily assessed according to their value to contribute to the archaeological/scientific understanding of Aboriginal culture (their research potential). Six criteria underlie the scientific assessment process, being rarity, representativeness, integrity, connectedness, complexity, and potential for archaeological deposit.

Of the 29 artefact scatters and isolated finds recorded in the 2008, 2010 and 2011 assessments of the Stage 3 Project and its modification, 26 sites (ACM1-5, ACM6-8, ACM11-13, ACM15-17, ACM18-20, ACM22-24, ACM27 and 28, ACM31-34) are assessed as having low archaeological significance. Three artefact scatters and isolated finds recorded



Source: Cadastral: LPI NSW, Aerial Photo: AAM Hatch 2006

Legend

- 20mm Subsidence Contour for Proposed Stage 3 Modification
- Continuous Distribution of Artefacts
- Artefact Scatter
- Isolated Find
- PAD
- Potential Scarred Tree
- Axe Grinding Groove

FIGURE 7.13

Archaeological Sites Recorded during Austar Surveys 2008 - 2011

(ACM9, ACM10 and ACM14) are assessed as having low to moderate archaeological significance. The grinding groove site (ACM6) is assessed as having low to moderate archaeological significance. The possible scarred tree (ACM21) is assessed as having low to moderate archaeological significance.

7.5.7 Aboriginal Heritage Impact Assessment

The potential changes to the land surface from subsidence associated with the Stage 3 Modification were assessed by MSEC (2011) (see **Appendix 9**). A comparison between the predicted subsidence impact for archaeological sites as a result of the Stage 3 mine plan as approved and the proposed Stage 3 Modification mine plan is shown in **Table 7.24**.

Table 7.24 – Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites Resulting from the Extraction of the Stage 3 Longwalls (Source: MSEC, 2011)

Location	Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (1/km)	Maximum Predicted Total Conventional Sagging Curvature (1/km)
Artefact Scatters and Isolated Finds	Approved Stage 3 Mine Plan	1925	6.7	0.06	0.12
	Proposed Stage 3 Modification mine plan	1800	6.5	0.05	0.09
Grinding Groove Site	Approved Stage 3 Mine Plan	1450	3.5	0.03	0.13
	Proposed Stage 3 Modification mine plan	200	1.5	0.01	<0.01

Artefact Scatters and Isolated Finds

As shown in **Table 7.24** the maximum predicted mine subsidence movements for the proposed Stage 3 Modification mine plan are predicted to be similar to, but slightly less than those predicted based on the approved Stage 3 mine plan for artefact scatters and isolated finds. MSEC (2011) states that artefact scatter and isolated find sites may be affected by cracking of the soil, but that this is likely to be isolated and as minor cracking is rarely seen in areas where mining is more than 500 metres deep. MSEC (2011) further states that if cracks occur, they are likely to be small and dispersed due to the presence of soil. These small cracks will be partially closed following subsidence or subsequently filled in as a result of soil movement. Such minor cracking of soil may also affect areas of archaeological potential along Cony and Sandy Creek.

Grinding Groove

As described in Umwelt (2008c), an investigation undertaken by SCT (2008) of the potential fracturing of the rock bar upon which ACM6 is located indicated that '…there is likely to be

sufficient horizontal compression available to fracture rock as a result of the total predicted subsidence' for the approved Stage 3 mine plan. SCT (2008) further estimated the potential for perceptible fracturing to occur on the surface of the rockbar as a result of mining of the approved Stage 3 mine plan was in the range of 10 to 30 per cent. Natural jointing of the ACM6 rockbar is such that initial fracturing was considered most likely to occur along the projected location of the low angle joint visible on the southern side of the downstream rockbar (SCT 2008).

According to MSEC (2011) and as shown in **Table 7.24**, the assessed level of impact on ACM6 as a result of the proposed Stage 3 Modification mine plan is reduced compared to that for the approved Stage 3 mine plan as a result of the proposed longwall modifications. However, according to MSEC (2011) the maximum predicted curvatures and the range of potential strains for ACM6 could still be of sufficient magnitude to result in fracturing of the bedrock. Experience in the NSW Coalfields indicates that fracturing of bedrock at depths of cover greater than 400 metres, such as the case within the Stage 3 Modification Area, generally occurs in isolated locations and the likelihood that fracturing would be coincident with the grinding groove sites would be considered to be relatively low.

Scarred Tree

The archaeological assessment has identified a possible scarred tree (ACM21 – to be verified by an arboriculturalist). ACM21 is assessed as being of low to moderate archaeological significance. As the tree is already in an uprooted and deteriorating state it is not expected that any of the predictions for subsidence will impact upon its current state of preservation.

7.5.8 Aboriginal Heritage Management Strategies

As described in Umwelt (2008c), Austar and Aboriginal stakeholders agreed upon an offset strategy for potential impacts from the Stage 3 mining on the grinding groove. This offset was a monetary contribution of $100,000 to an Aboriginal project or program (to be decided by Aboriginal stakeholders) with the funds to be provided once all necessary approvals for mining were granted. While the predicted subsidence impacts on the grinding groove as a result of the proposed Stage 3 Modification have decreased compared with the Stage 3 mine plan as approved, Austar remains committed to the provision of a monetary contribution as an offset for the grinding groove. Aboriginal stakeholders have requested that no engineering works be conducted at the grinding groove site (Umwelt, 2008c).

Other recommendations made by the 2011 assessment and Umwelt (2008c), as discussed between Umwelt and Registered Aboriginal Parties, and committed to by Austar include:

- that an Aboriginal Cultural Heritage Management Plan (ACHMP) be prepared for the Austar Coal Mine to outline all Aboriginal heritage management strategies for the project, responsibilities of all parties and the timeframe for required heritage works;

- that no Aboriginal archaeological site be visited, or have remediation works undertaken, without Registered Aboriginal Party representatives in attendance;

- that known sites on accessible properties are included in a monitoring program. This will involve recording each site before and after subsidence to identify any impacts. This will be done by an archaeologist and Registered Aboriginal Party representatives;

- that if any future surface works are needed in properties that have not been previously inspected, or that may affect a known site or area, an archaeologist and Registered Aboriginal Party representatives will survey and assess the area and provide advice on any Aboriginal heritage works needed;

- that if any artefacts are recovered as a result of future works, they will be stored in a Keeping Place to be provided by Austar Coal Mine within the Stage 3 surface infrastructure site following recording and analysis;

- that Registered Aboriginal Party representatives (and an archaeologist if requested by the Registered Aboriginal Parties) provide relevant Austar personnel with a cultural heritage awareness training session;

- that if any additional sites are found within the Stage 3 Modification Area, these will be inspected by an archaeologist and Registered Aboriginal Party representatives to assess the site and decide on how it should be managed; and

- that if any human or possible human skeletal remains are found during surface works, that works cease immediately to allow for forensic assessment and management.

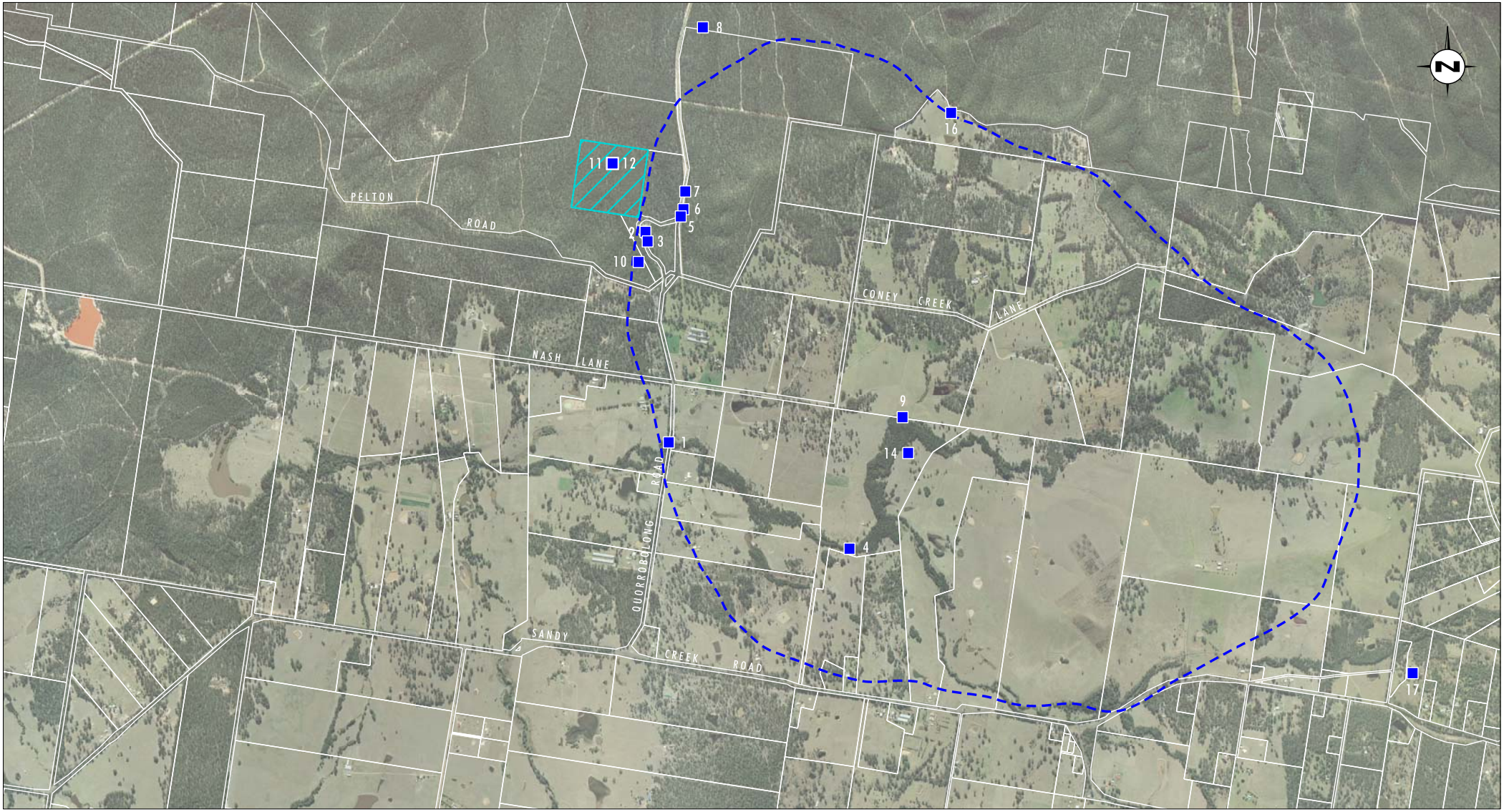
7.6 Historical Heritage

A comprehensive Historical Heritage Assessment (Umwelt 2008d) has previously been prepared as part of the EA for Stage 3 of the mining operations at the Austar Coal Mine. As a result of the proposed Stage 3 Modification, a number of the historical heritage items identified in the 2008 assessment will no longer be affected by the proposed mining operations. No additional known historical heritage items fall within the modified mining area. Notably, the predicted mine subsidence movements based on the proposed Stage 3 Modification mining area are similar to or slightly less than those predicted based on the approved Stage 3 extension (MSEC, 2011:iv). As a result, the recommended management strategy for the historical heritage items remains essentially the same as presented in the 2008 Historical Heritage Assessment (Umwelt 2008d).

The 2008 assessment was undertaken in accordance with guidelines set out in the *NSW Heritage Manual 1996*, produced by the Heritage Branch, Department of Planning (DoP), including *Archaeological Assessments* and *Assessing Heritage Significance* and with consideration of the principles contained in the *Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance*. The 2008 assessment should be referred to for the historical context of the project, survey results and significance assessment. A heritage impact statement and recommendations for the management of historical heritage items in relation to the proposed Stage 3 Modification are presented in **Sections 7.6.2** and **7.6.3** below to reflect the minor changes resulting from the modified longwall layout.

7.6.1 Heritage Items

Table 7.25 lists the potential heritage items assessed as part of the 2008 historical heritage assessment and indicates their location in relation to the Stage 3 Modification Area (refer also to **Figure 7.14**).



Source: Cadastre: LPI NSW, Aerial Photography: AAM Hatch 2006

0 0.5 1 1.5km
1:32 000

Legend

- 20mm Subsidence Contour for Proposed Stage 3 Modification
- Approved Surface Infrastructure Site
- Potential Heritage Item

FIGURE 7.14

Plan showing Location of Potential Heritage Items in Relation to the Study Area

File Name (A4): R64_V1/2274_873.dgn

Table 7.25 – Heritage Items Assessed as Part of 2008 Assessment

Item	Description	Within Stage 3 Modification 20mm Subsidence Contour	Within Surface Infrastructure Site
1	Cony Creek Bridge, Quorrobolong Road	Yes	-
2	Quarry 1	Yes	-
3	Quarry 2	Yes	-
4	Ford	Yes	-
5	Culvert 1	Yes	-
6	Culvert 2	Yes	-
7	Culvert 3	Yes	-
8	Artefact Scatter	No	-
9	Fencing 1	Yes	-
10	Fencing 2	Yes	-
11	Cut Tree	-	Yes
12	Cut Stump	-	Yes
14	Possible House Site	Yes	-
16	Potential Homestead Site	Yes	-
17	Potential Homestead Site	No	-
18	Early Roads	Yes	-

7.6.2 Heritage Impact Statement and Management Strategy for Inspected Heritage Items

Table 7.26 provides a heritage impact statement and management strategy for the potential heritage sites/items inspected as part of the 2008 assessment and located within the 20 mm subsidence contour for the proposed Stage 3 modification or surface infrastructure site. Items 8 (artefact scatter) and 17 (potential homestead site) are not within the 20 mm subsidence contour for the proposed Stage 3 modification or the surface infrastructure site (refer to **Table 7.26** and **Figure 7.14**) and as such are no longer included as part of the management strategy.

MSEC assessed the subsidence impacts from longwall mining on historical heritage items within the proposed Stage 3 Modification Area (MSEC 2011). The MSEC report has been used to assess the potential heritage impacts of the Stage 3 Modification Area.

Table 7.26 – Heritage Impact Statement and Management Strategy for Inspected Heritage Items

Item	Description	Heritage Impact Statement and Management Strategy
1	Cony Creek Bridge, Quorrobolong Road	The proposed long walls do not mine directly beneath the bridge. The bridge is expected to accommodate any mine subsidence movements resulting from the extraction of the proposed longwalls (MSEC 2011:62). The Cony Creek Bridge has been assessed as being of low local significance and as having no or low research potential (Umwelt 2008d:6.9). MSEC recommends the Cony Creek Bridge is periodically visually monitored during the extraction of the proposed longwalls (MSEC 2011:62). If any changes to subsidence predictions or if monitoring results indicate that the bridge may be impacted, a detailed recording of the bridge to Heritage Branch, DoP standards for archival recording should be completed by a qualified heritage consultant.
2 and 3	Quarries 1 & 2	There are unlikely to be any significant impacts to Quarries 1 and 2 resulting from the extraction of the proposed longwalls (MSEC 2011:87). The quarries have been assessed as being of nil to low local significance and as having no research potential (Umwelt 2008d:6.9). On this basis, no further heritage management of these items is recommended during the proposed works.
4	Ford	The Ford is located above the chain pillar between Longwalls A14 and A15. The site could potentially be affected by surface cracking as a result of mine subsidence movements (MSEC, 2011:87). The Ford has been assessed as being of nil to low local significance and as having no research potential (Umwelt 2008d:6.9). As such its significance is unlikely to be impacted by surface cracking. On this basis, no further heritage management of this item is recommended during the proposed works.
5 to 7	Culverts 1 to 3	Culverts 1 to 3 are located above the southwest end of Longwall A7. Subsidence movements could result in some minor cracking which could be readily repaired (MSEC, 2011:88). Culverts 1 to 3 have been assessed as having no significance or research potential (Umwelt 2008d:6.9). On this basis, no further heritage management of these items is recommended during the proposed works.
9 and 10	Fencing 1 & 2	Fencing sites 9 and 10 each comprise a single timber post and are not expected to be impacted by subsidence movements (MSEC, 2011:88). The sites have been assessed as being of nil to low local significance and as having no research potential (Umwelt 2008d:6.9). On this basis, no further heritage management of these items is recommended during the proposed works.

Table 7.26 – Heritage Impact Statement and Management Strategy for Inspected Heritage Items (cont)

Item	Description	Heritage Impact Statement and Management Strategy
11	Cut Tree	Item 11 is likely to be removed during the proposed construction of the surface infrastructure site. The cut tree trunk has been assessed as having no significance or research potential (Umwelt 2008d:6.10). On this basis, no further heritage management of this item is recommended during the proposed works.
12	Cut Stump	Item 12 is likely to be removed during the proposed construction of the surface infrastructure site. The tree stump has been assessed as being of nil-low local significance and as having no research potential (Umwelt 2008d:6.10). On this basis, no further heritage management of this item is recommended during the proposed works.
14	Possible House Site	The potential house site is located above a chain pillar between Longwalls A13 and A14. The site is a former house site with no standing structures or foundations. The site could potentially be affected by surface cracking as a result of mine subsidence movements (MSEC 2011:88). The potential house site has been assessed as being of nil to low local significance and as having no research potential (Umwelt 2008d:6.10). As such its significance is unlikely to be impacted by surface cracking. On this basis, no further heritage management of this item is recommended during the proposed works.

7.6.3 Heritage Impact Statement and Management Strategy for Areas and Items Not Inspected

As noted in the 2008 assessment (Umwelt 2008d:3.2), access was not available to all private property in the Stage 3 area. However, historical research undertaken as part of the 2008 assessment indicates there is a low likelihood of any further potential heritage items to be present within the Stage 3 Modification Area, with the exception of Items 16 (potential house site) and 18 (potential early roads). In the unlikely event any further potential items are identified they are unlikely to have any significance or research potential and any potential impact to the potential items would be negligible. **Table 7.27** outlines a heritage impact statement and management strategies for Items 16 and 18.

Table 7.27 - Management Strategy for Heritage Items (not inspected)

Item	Description	Heritage Impact Statement and Management Strategy
16	Potential Homestead Site	The potential homestead site 16 was not inspected as part of the 2008 assessment as access was unavailable. The site is located 450 metres east of the northeast edge of the proposed longwalls and is expected to experience approximately 75 millimetres of subsidence. The site is unlikely to experience any significant impacts as a result of the extraction of the proposed longwalls (MSEC, 2011:88). The site has been assessed as likely being of low local significance with no or low research potential (Umwelt 2008d:6.10). MSEC recommends that houses are periodically visually inspected during the extraction of the proposed longwalls (MSEC, 2011:96). If any changes to subsidence predictions or if visual inspection indicates that the site may be impacted, Item 16 should be inspected by a heritage architect to confirm low level of significance. If assessed by a heritage architect as having no significance or research potential, no further management of this item is required during the proposed works. If confirmed to be of local significance, a detailed recording of Item 16 to Heritage Branch, DoP standards for archival recording should be completed by a qualified heritage consultant.
18	Early Roads	The early roads (Item 18) potentially located within the proposed Stage 3 Modification Area were not inspected as part of the 2008 assessment as access was unavailable. Potential impacts on unsealed roads include cracking and heaving of unsealed surfaces. Any impacts could be repaired by infilling the cracks or by re-grading and re-compacting the surface (MSEC, 2011:60). Early roads would likely be of no or low local significance with no research potential (Umwelt 2008d:6.10). As such any significance is unlikely to be impacted by surface cracking. On this basis, no further heritage management of this item is recommended during the proposed works.

7.6.4 Management Strategy for Unexpected Finds

In the unlikely event that unexpected archaeological remains not identified as part of this report or the 2008 Historical Heritage Assessment (Umwelt 2008d) are discovered during the Project (for example during works associated with the construction of the new surface infrastructure facility), all works in the immediate area will cease, the remains and potential impacts should be assessed by a qualified archaeologist or heritage consultant and, if necessary, the Heritage Branch, OEH notified.

7.7 Ecology

A comprehensive Ecological Survey and Assessment for the Stage 3 Modification Project was conducted by Umwelt (see **Appendix 8**) and a summary of the main findings in relation to the proposed Stage 3 Modification mining area are outlined in **Sections 7.7.1** to **7.7.5**. The survey area included all areas potentially affected by the proposed Stage 3 Modification development that were not covered previously in the Ecological Assessment for the

approved Stage 3 mine project (Umwelt, 2008e). The extensive surveys undertaken as part of the Ecological Assessment for the approved Stage 3 mine project are also incorporated into the current Ecological Assessment.

7.7.1 Ecological Context

The Austar Mine Complex and surrounding area is within the Cessnock-Kurri vegetation area in the Lower Hunter Valley, as defined by Bell and Driscoll (2008). The Cessnock-Kurri area comprises part of the Hunter Subregion (SB02). Plant species that are characteristic of coasts, mountains, semi-arid areas and sandstone outcrops are evident (DEC, 2006). The major ecosystems of the Lower Hunter Valley include Wetlands, Dry forest and woodlands, Heath, Swamp forest and Moist forest/rainforest.

The native forests of the region have also experienced a long history of disturbance and management for timber. The Spotted Gum and Ironbark stands were specifically managed to provide pit props and other timber needs for the surrounding coal mines. This management technique has left forests in the area dominated by a young regrowth stand of even-aged trees (DEC 2005).

The Cessnock-Kurri area supports nearly 800 native plant taxa across 37 vegetation communities. A total of 23 of these taxa are considered of significance. Seven endangered ecological communities (EECs), are listed in the NSW *Threatened Species Conservation Act 1995* (the TSC Act), and present within the Cessnock-Kurri area. A total of 10 of these taxa are currently listed on the EPBC Act or the TSC Act. Eight of these the taxa are considered to be nationally rare. Several newly discovered taxa also exist in the Cessnock-Kurri area.

Many of these species are well conserved in the reserves systems of The Werakata National Park and the Werakata State Conservation Area. Both reserves represent significant conservation measures for the species of the region. These areas are both managed by OEH.

7.7.2 Flora Assessment

Flora fieldwork was undertaken during September 2010 to complement the extensive fieldwork completed as part of the approved Stage 3 Ecological Assessment (Umwelt 2008e). The flora survey locations are indicated in **Appendix 8**. The survey builds on previous studies undertaken for the surrounding area including the Werakata State Conservation Area and the Werakata National Park. The survey completed specifically for the proposed Stage 3 Modification incorporated both semi-quantitative plot-based methods, as well as non-quantitative methods such as walking transects.

During field surveys of the proposed Stage 3 Modification mining area, particular emphasis was placed on investigating riparian areas, as this is where the potential ecological impacts from subsidence were predicted to be concentrated. Notwithstanding this, all habitat areas were surveyed and assessed. Flora surveys were undertaken in accordance with the Department of Environment and Conservation (DEC) Draft Threatened Species Survey and Assessment Guidelines (DEC 2004c) where appropriate.

7.7.2.1 Vegetation of the Project Area

A total of 299 species were recorded within the Stage 3 Modification assessment area, of which 257 (86%) are native and 42 (14%) are introduced species. A full list of the flora species recorded during surveys of the landform above proposed Stage 3 Modification mining area is presented with **Appendix 8**. The landform above the proposed Stage 3

Modification mining area supports seven vegetation communities not including cultivated land, as shown in **Table 7.28** (refer to **Figure 7.15**).

Table 7.28 – Vegetation Communities of the Stage 3 Modification Area

Vegetation Community	Area (ha)
Riparian Red Gum Forest	48.7
Swamp Oak Riparian Forest	54.8
Lower Hunter Spotted Gum – Ironbark Forest	342.2
Derived Grassland/Pasture	482.2
Derived Grassland with Scattered Canopy Trees	237.2
Woollybutt Open Forest	5.6
Regeneration	9.2
Cultivated	17.5
TOTAL	1197.4

7.7.2.2 Threatened Species and Endangered Populations

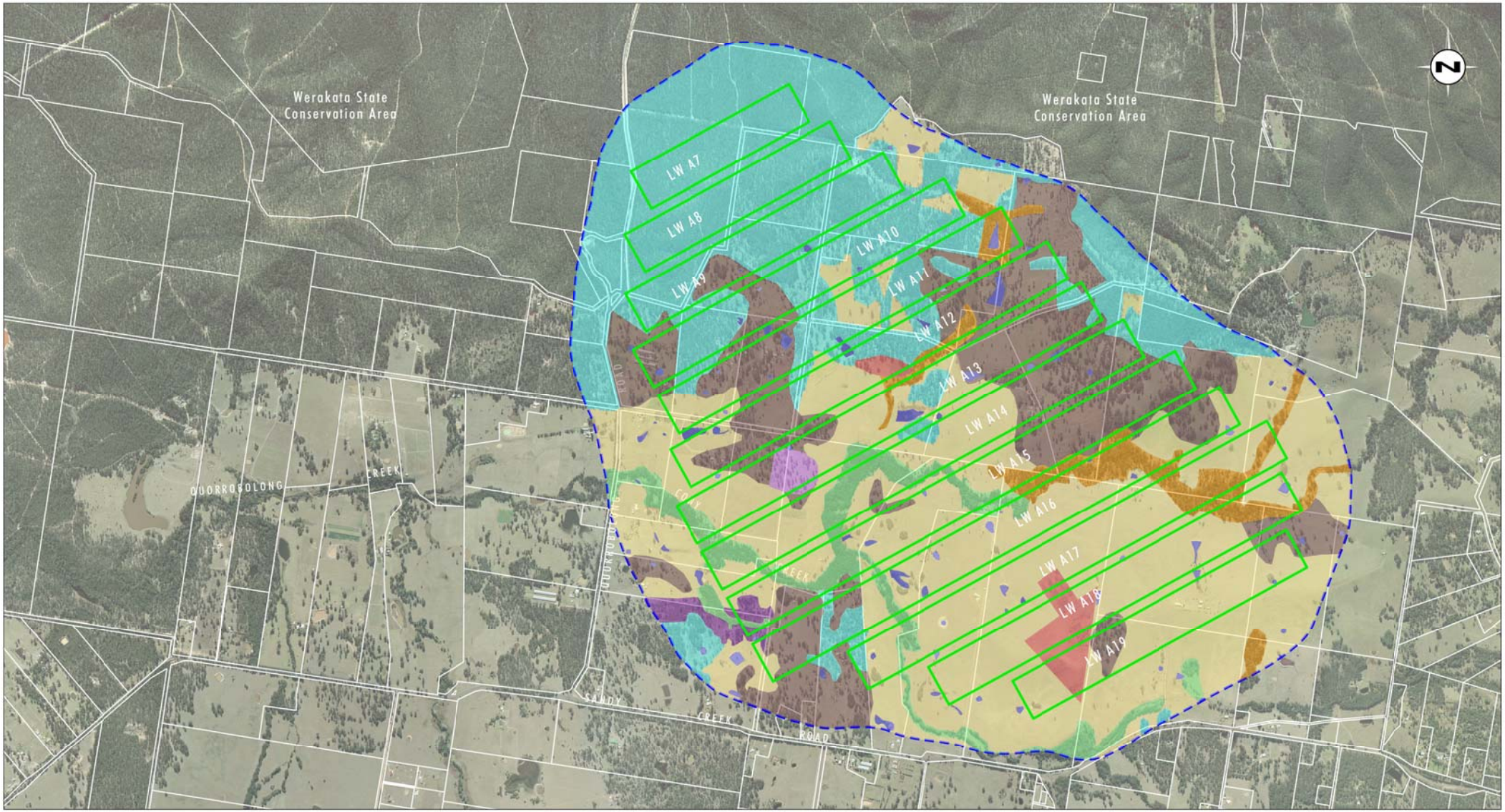
Two threatened flora species were recorded within the ecological assessment area during the field surveys, being heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). Both species were recorded in the northern portions of the proposed Stage 3 mining area. The recorded locations of these species are shown on **Figure 7.16**, however the actual extent of occurrence of each species is expected to be greater.

In order to provide context to the distribution of heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) within the locality, a map showing all records from the DECC Atlas of NSW Wildlife for the Cessnock 1:100,000 topographic map sheet is provided in **Appendix 8**. This shows that potential habitat for the two species is relatively widespread within the locality, particularly to the north-east of the assessment area. Assessments of significance for *Rutidosis heterogama* and *Grevillea parviflora* subsp. p*arviflora* are included within **Appendix 8**.

7.7.2.3 Regionally Significant Flora Species and Communities

Briggs and Leigh (1996) list species in Australia regarded to be a 'Rare or Threatened Australian Plant' (ROTAP). From this list, three species were recorded: *Grevillea montana*, *Macrozamia flexuosa* and *Eucalyptus fergusonii* subsp. *fergusonii*. Several individuals of each of the three species were observed throughout the approved Stage 3 mine area. Both *Grevillea montana* and *Macrozamia flexuosa* are reported to be widespread within the Cessnock area (Bell and Driscoll 2008).

A relictual population of woollybutt (*Eucalyptus longifolia*) occurs in the Quorrobolong area, which forms the northern limit to the species' known distribution. The significance of this population is currently being investigated by Bell and Driscoll (2008). The community may meet criteria for listing as an EEC, or, it may form a population that should be listed as an endangered population under the TSC Act. This species was found in a small remnant in low numbers within the approved Stage 3 Project area (refer to **Appendix 8**).



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

0 0.5 1 1.35km
1:30 000

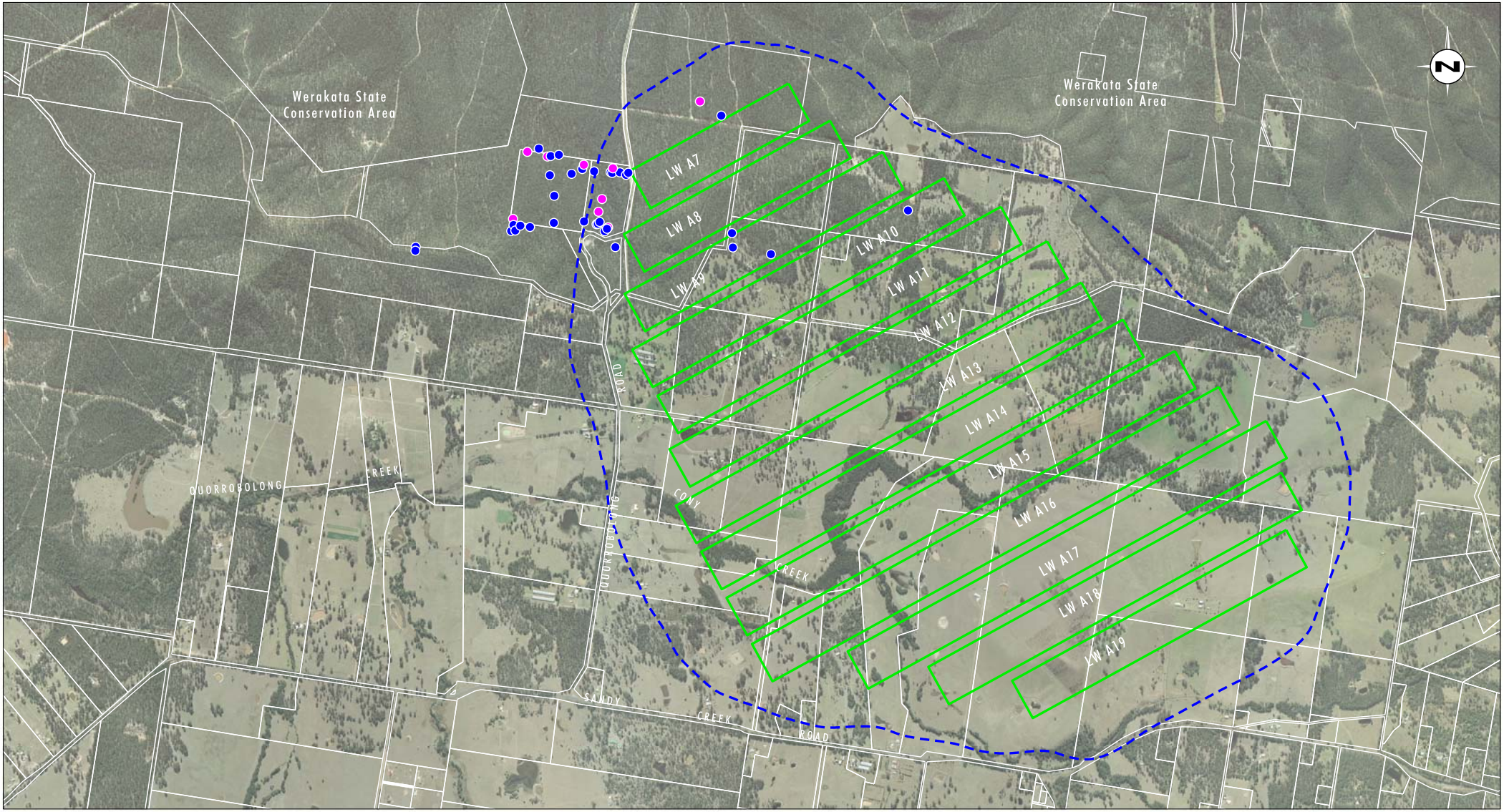
Legend

- Proposed Stage 3 Modification Longwall Layout
- 20mm Subsidence Contour for Proposed Stage 3 Modification
- Cultivated
- Dam
- Derived Grassland / Pasture
- Derived Grassland with Scattered Canopy Trees
- Regeneration
- Riparian Red Gum Forest
- Lower Hunter Spotted Gum Ironbark Forest
- Swamp Oak Riparian Forest
- Woollybutt Open Forest Remnant

FIGURE 7.15

Vegetation Communities

File Name (A4): R64_V1/2274_1001.dgn



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

0 0.5 1 1.35km
1:30 000

Legend

- Proposed Stage 3 Modification Longwall Layout
- 20mm Subsidence Contour for Proposed Stage 3 Modification
- *Rutidosis heterogama*
- *Grevillea parviflora* subsp. *parviflora*

FIGURE 7.16

Threatened Flora Locations

7.7.2.4 Endangered Ecological Communities

The two EECs that were found to be present within the Stage 3 Modification Area are the Lower Hunter Spotted Gum – Ironbark Forest EEC and the River-flat Eucalypt Forest EEC (refer to **Figure 7.17**). A summary of the extent of the two EECs is provided in **Table 7.29**.

Table 7.29 – EECs Recorded within the Assessment Area

Endangered Ecological Communities	Area (ha)
River-flat Eucalypt Forest	48.7
Lower Hunter Spotted Gum – Ironbark Forest	342.2
TOTAL	**390.9**

There are no aquatic EECs listed under the FM Act occurring within or with potential to occur within the assessment area.

No endangered flora species were identified within the assessment area. Four endangered flora populations are relevant to the Hunter Valley catchment (in which the proposed Stage 3 Modification occurs):

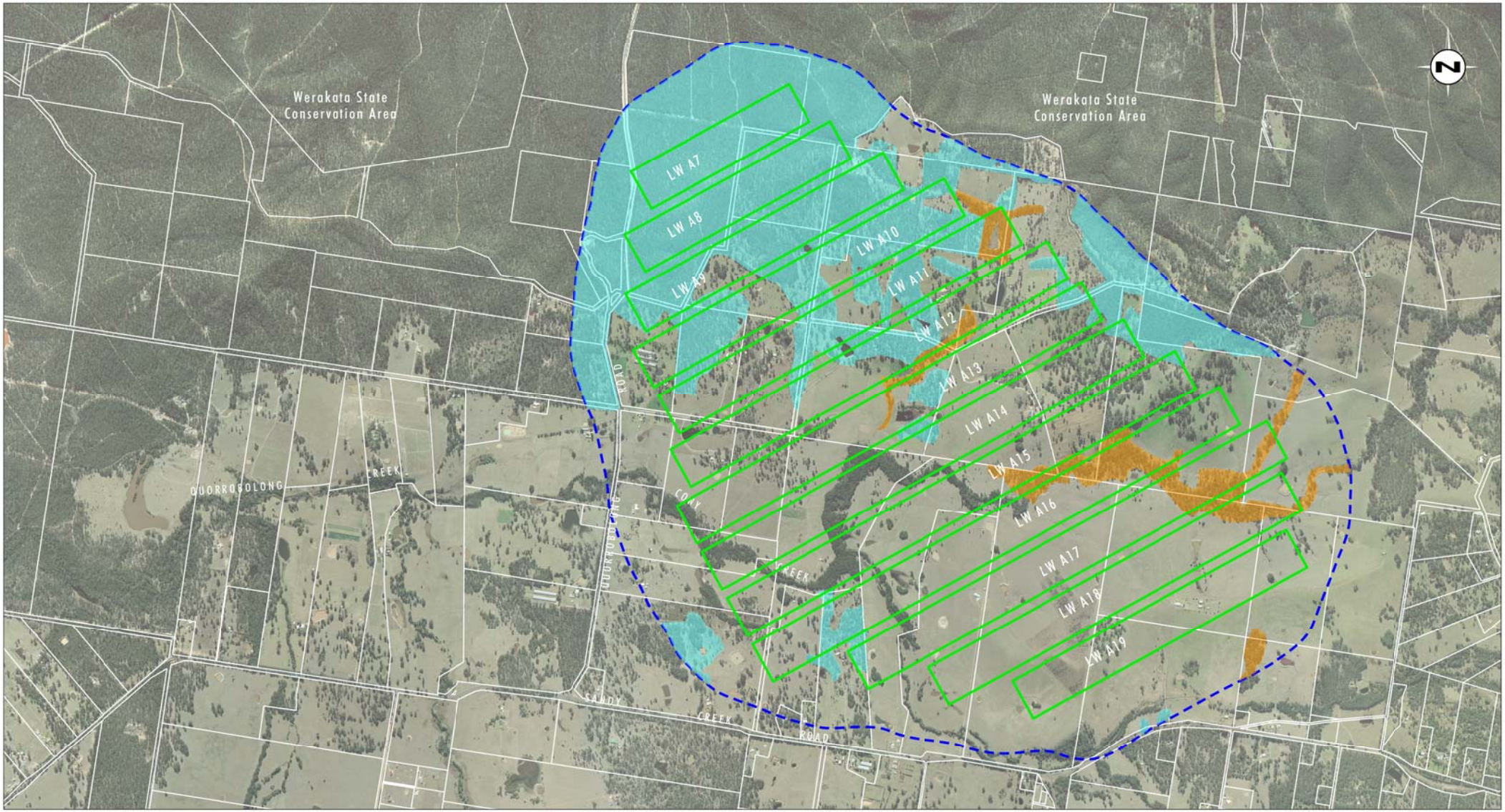
- weeping myall (*Acacia pendula*) population in the Hunter Valley;
- river redgum (*Eucalyptus camaldulensis*) population in the Hunter Valley;
- tiger orchid (*Cymbidium canaliculatum*) population in the Hunter Valley; and
- *Leionema lamprophyllum* subsp. *obovatus* population in the Hunter Valley.

The assessment concludes that no endangered flora populations have potential to occur within the Stage 3 Modification Area (refer to **Appendix 8**).

7.7.3 Fauna Assessment

In addition to the fieldwork for the approved Stage 3 Project, Fauna fieldwork was undertaken during September 2010. The fauna survey locations are indicated in **Appendix 8**. Given that extensive fauna surveys were undertaken for the Original Stage 3 Mine Area assessment (Umwelt 2008e), the survey for the Stage 3 Modification Area comprised opportunistic observations only.

An assessment of the aquatic habitats within the proposed Stage 3 Modification Area consisted of both field surveys and desktop review of previous studies and relevant legislation. The aquatic field surveys were undertaken on 26 September 2007 and 18 December 2007. Six sites within Project area were sampled. Aquatic ecology survey and assessment was undertaken in accordance with the legislative requirements of the FM Act, the TSC Act, EPBC Act, the EP&A Act and relevant policies and guidelines. Further detail regarding the aquatic surveys undertaken is available in **Appendix 8**.



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

0 0.5 1 1.35km
1:30 000

Legend

- Proposed Stage 3 Modification Longwall Layout
- 20mm Subsidence Contour for Proposed Stage 3 Modification
- River-flat Eucalypt Forest
- Lower Hunter Spotted Gum Ironbark Forest

FIGURE 7.17

Endangered Ecological Communities

7.7.3.1 Fauna Habitat within the Stage 3 Modification Project Area

Local Habitat Connectivity

Historically, much of the vegetation within the open forest habitats in the northern parts of the proposed Stage 3 Modification Area has been logged and is now predominantly composed of relatively young native vegetation (estimated to be younger than fifty years old). A large proportion of the proposed Stage 3 Modification Area is dominated by grassland and pasture and continues to be used for agricultural purposes. Consequently, the existing native remnants within the proposed Stage 3 Modification Area are highly fragmented and isolated. The vegetation and associated habitats along Cony Creek, crossing the site in a general east-west direction, represent the most sizable and significant habitat corridor across the proposed Stage 3 Modification Area.

Regional Habitat Connectivity

The NPWS Key Habitats and Corridors (Scotts 2003) project does not identify any fauna movement corridors or key habitats for threatened species within the assessment area or nearby locality. Nonetheless on a regional scale large remnant areas within Werakata State Conservation Area ultimately link with larger bush land areas to the south including Pokolbin State Forest, Corrabare State Forest, Watagan National Park and Yengo National Park.

7.7.3.2 Fauna of the Project Area

A full list of the fauna and aquatic species recorded in the Project area is provided in **Appendix 8**. The results included:

- A total of 83 bird species recorded within the Stage 3 Modification Area. The species recorded are typical of those associated with open woodland and grassland habitats, such as the Australian magpie (*Gymnorhina tibicen*), noisy miner (*Manorina melanocephala*), masked lapwing (*Vanellus miles*) and Australian magpie-lark (*Grallina cyanoleuca*). A number of birds more commonly associated with wetland habitats were recorded, including white-faced heron (*Egretta novaehollandiae*), Australian white ibis (*Threskiornis molucca*), Eurasian coot (*Fulica atra*), Australian wood duck (*Chenonetta dubata*) and the Pacific black duck (*Anas superciliosa*).

- Nine frog species were recorded during the winter and spring 2007 surveys. This primarily included locally common species such as the common eastern froglet (*Crinia signifera*), striped marsh-frog (*Limnodynastes peroni*) and the spotted marsh-frog (*Limnodynastes tasmaniensis*);

- Six reptile species were recorded within the proposed Stage 3 Modification Area during the surveys.

- A total of 25 mammal species were recorded within the proposed Stage 3 Modification Area. Commonly recorded species included common brush-tail possum (*Trichosurus vulpecula*), eastern grey kangaroo (*Macropus giganteus*) and common wombat (*Vombatus ursinus*).

- A total of 39 taxa of macroinvertebrates were recorded across the six sampling sites. No freshwater vertebrates were recorded.

7.7.4 Threatened Species, Migratory Species and Endangered Populations

Appendix 8 provides a full list of threatened fauna species (derived from literature review and expert knowledge) that were assessed for their potential to occur within the assessment area. EPBC Act listed threatened fauna species are also considered in **Appendix 8**.

The twelve threatened fauna species recorded within the Project are listed in **Table 7.30.** The location where these species were recorded is provided in **Appendix 8**. **Table 7.30** also indicates whether each species has any reasonable potential to be impacted by the proposed Stage 3 Modification, and therefore would require a further assessment of significance

Table 7.30 – Threatened Fauna recorded in the Stage 3 Modification Area

Species	Status	Method of Record	Potential to be Impacted?
gang-gang cockatoo *Callocephalon fimbriatum*	V (TSC)	sighted and heard	No
grey-crowned babbler *Pomatostomus temporalis temporalis*	V (TSC)	sighted and heard	No
speckled warbler *Chthonicola saggittatus*	V (TSC)	sighted	No
little lorikeet *Glossopsitta pusilla*	V (TSC)	sighted	No
scarlet robin *Petroica boodang*	V (TSC)	sighted	No
powerful owl *Ninox strenua*	V (TSC)	identification of call during call-playback survey	No
squirrel glider *Petaurus norfolcensis*	V (TSC)	hair analysis and trap capture	No
little bentwing-bat *Miniopterus australis*	V (TSC)	Anabat echolocation analysis	No
eastern bentwing-bat *Miniopterus schreibersii oceanensis*	V (TSC)	Anabat echolocation analysis	No
large-footed myotis *Myotis adversus*	V (TSC)	Anabat echolocation analysis	**Yes – significance assessment in Appendix 3**
eastern freetail-bat *Mormopterus norfolkensis*	V (TSC)	Anabat echolocation analysis	No
eastern false pipistrelle *Falsistrellus tasmaniensis*	V (TSC)	Anabat echolocation analysis	No

Notes:

V=vulnerable

TSC = *Threatened Species Conservation Act 1995*

The survey and assessment found that:

- There are no endangered fauna populations known to occur within the landform above the proposed Stage 3 Modification mining area. There are no endangered fauna populations with potential to occur within the assessment area.

- There are no areas of critical habitat occurring within or in proximity to the Project area.

- No *Fisheries Management Act 1994* listed threatened species or endangered populations were recorded within the Project area during surveys, and there is no record of any having been previously recorded within the locality. There is no potential for any FM Act listed threatened species or endangered populations to occur in the aquatic habitats of the ecological assessment area.

7.7.4.1 Endangered Ecological Communities

There are no endangered fauna populations known to occur within the Stage 3 Modification Project area. There are no endangered fauna populations with potential to occur within the ecological assessment area.

7.7.4.2 EPBC – Listed Migratory Species

A search of the DSEWPC Protected Matters Database was undertaken in order to identify any EPBC Act listed threatened, migratory or listed marine species which could potentially occur within a 10 kilometre radius of the centre of the Stage 3 Modification Area (based on DSEWPC habitat modelling).

The EPBC Act-listed migratory and marine species with potential to be impacted by the proposed Stage 3 Modification returned from the DSEWPC database search are listed in **Table 7.31** below. A complete list of migratory and marines species with potential to occur within the Stage 3 Modification are can be found in **Appendix 8**.

Table 7.31 - Migratory and listed Marine Species potentially occurring within a 10 kilometre radius of the Stage 3 Modification Area (DSEWPC Protected Matters Database)

Species	Status	Potential to Occur in Stage 3 Modification Area
regent honeyeater *Anthochaera Phrygia*	Migratory	High
great egret *Ardea modesta*	Migratory Marine	Moderate
cattle egret *Ardea ibis*	Migratory Marine	High
swift parrot *Lathamus discolor*	Marine	High

Of the 13 EPBC-listed migratory and marine species with potential to occur in the area, three were recorded during surveys. Four species were found to have potential to be impacted by the proposed Stage 3 Modification as shown in **Table 7.31** and have been further assessed in **Appendix 8**.

SEPP 44 (Koala Habitat) Assessment Results

Two SEPP 44 listed tree species, forest red gum (*Eucalyptus tereticornis*) and grey gum (*Eucalyptus punctata*), were recorded within vegetation communities of the ecological assessment area. These species, also hybridising, account for greater than 15% of trees in

the area. Given the connectivity with large tracts of bushland to the north and south of the ecological assessment area, there is potential for the koala to utilise the resources of the area when travelling between habitats within this larger remnant.

7.7.5 Ecological Impact Assessment

7.7.5.1 Flora Impact Assessment

Subsidence impacts are not expected to have a significant impact on the ecology or ecological communities of the proposed Stage 3 Modification Area. In addition, due to the depth of cover and relative predicted uniformity of subsidence over the Stage 3 Modification Project area, it is predicted that surface mitigation works along creeks and drainage channels will not be required and hence disturbance of these areas is not likely to be necessary.

Mining of the Stage 3 Modification Project area is not expected to significantly impact on runoff regimes, bank stability, channel alignment, in-channel and out of channel ponding or groundwater availability. Drainage line analysis of the predicted subsided landform indicates that all creek systems will remain free draining without mitigation works.

Impact on Threatened Species

Heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*) were found within the Stage 3 Modification Area, and a seven part test in accordance with the EP&A Act and assessment under the EPBC Act guidelines is detailed in **Appendix 8**.

Subsidence predictions indicate that there will be no impacts associated with longwall mining that could result in the significant alteration of surface landforms, vegetation or habitats. The impacts are expected to be very minor and focused in riparian environments. All five threatened flora species with potential to occur in the Stage 3 Modification Area occupy drier environments on slopes and ridges and would not occur in the riparian environments of the Stage 3 Modification Area. As such, there is no reasonable potential for any of these potentially occurring threatened flora species to be impacted by the proposed Stage 3 Modification. It is noted that subsidence predictions as a result of the proposed Stage 3 Modification mine plan are similar to or slightly less than those proposed as a result of the Stage 3 mine plan approved under Project Approval 08_0111.

Impact on Endangered Ecological Communities

The potential for the proposed underground mining to have an impact on River-flat Eucalypt Forest EEC and the Lower Hunter Spotted Gum – Ironbark Forest was assessed using the seven part test of significance (in accordance with the EP&A Act). The assessment concluded that the proposed Stage 3 Modification will not have a significant impact on the River-flat Eucalypt Forest or Lower Hunter Spotted Gum – Ironbark Forest EECs such that it would place the local occurrence of the EECs at risk of extinction.

No EPBC Act listed EECs were found within the proposed Stage 3 Modification mining area, and therefore an assessment of significance under that Act is not required for any EECs.

7.7.5.2 Fauna Impact Assessment

Impact on Threatened Species

Twelve threatened fauna species were recorded within the Stage 3 Modification Area, while 18 were found to have potential to occur.

Subsidence predictions and flooding and drainage assessments indicate that there will be no impacts associated with longwall mining that could result in the significant alteration of surface landforms, vegetation or habitats. The impacts are expected to be very minor and focused in riparian environments only. The majority of threatened fauna species recorded or with potential to occur in the Stage 3 Modification Area occupy and/or utilise drier environments on slopes and ridges and would not occur in the riparian environments of the Stage 3 Modification Area. As such, there is no reasonable potential for these threatened fauna species to be impacted by the proposed Stage 3 Modification.

A seven part test of significance, in accordance with the requirements of the EP&A Act, has been prepared for the five threatened fauna species which potentially utilise the riparian habitats of the Stage 3 Modification Area for foraging resources, and as such could be impacted by the proposed Stage 3 Modification. These species are the grey-headed flying-fox (*Pteropus poliocephalus*) (potentially occurring), large-footed myotis (*Myotis adversus*) (recorded), the green-thighed frog (*Litoria brevipalmata*) (potential), regent honeyeater (*Anthochaera phrygia*) (potential) and the swift parrot (*Lathamus discolor*) (potential).

The outcome of the seven part test provided in **Appendix 8** concludes that the proposed Stage 3 Modification will not have a significant impact on any recorded or potentially occurring threatened fauna species.

There are three threatened fauna species listed under the EPBC Act that has potential to be impacted by the proposed Stage 3 Modification. An assessment of significance under the EPBC Act for the grey-headed flying-fox (*Pteropus poliocephalus*), regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*) is also provided in **Appendix 8**. This assessment also concludes that there will be no significant impact on these species as a result of the proposed Stage 3 Modification.

Impact on Endangered Populations

There are no endangered flora or fauna populations present within the Stage 3 Modification Area, therefore there will be no impacts on endangered populations as a result of the proposed Stage 3 Modification.

Key Threatening Processes

A number of Key Threatening Processes (KTPs) listed under the Schedules of the TSC Act, the EPBC Act and the FM Act, are relevant to the proposed Stage 3 Modification. Longwall mining is identified as the most relevant KTP. A discussion of the implications of the relevant KTPs under each Act is detailed in **Appendix 8**. The assessment concludes that the proposed Stage 3 Modification is unlikely to have a significant impact on the ecology or ecological values of the proposed Stage 3 Modification Area.

7.7.6 Ecological Mitigation and Monitoring

Subsidence as a result of the proposed Stage 3 Modification will occur reasonably consistently over the breadth of the Stage 3 Modification Area, and will result in similar, but slightly lower maximum predicted subsidence, tilt and curvature than the original Stage 3 Mining Area approved in Project Approval 08_0111 (MSEC 2011). The proposed Stage 3 Modification is not predicted to result in significant changes to the surface and groundwater patterns within the Stage 3 Modification Area, and therefore the potential for impacts on the vegetation and habitats is very low. It is expected that there will be no loss of or modification to any vegetation community in the Stage 3 Modification Area. As such, there will be no significant impact on any recorded or potentially occurring threatened species, populations or threatened ecological communities (TECs).

Ongoing monitoring will be undertaken as mining proceeds to ensure that any actual impacts of mining within the proposed Stage 3 Modification Area are discovered quickly and managed appropriately. Monitoring will be undertaken as an extension of the existing Stage 2 monitoring program. In the event that monitoring does reveal impacts, modifications to the project and mitigation measures where appropriate will be implemented accordingly. In addition, monitoring will ensure that any mitigation measures recommended are successfully implemented.

7.8 Greenhouse Gas and Energy

A comprehensive greenhouse gas and energy assessment for the Stage 3 project is set out in Umwelt (2008f). The assessment was undertaken on the basis of the maximum annual ROM coal throughput of 3.6 Mt, with a time estimate of 14 years to extract the identified coal resource. As discussed in **Section 3**, the proposed Stage 3 Modification project is a proposed reorientation of the mine plan only, with no proposed changes to the annual production rate or life of the operation. The estimates of energy usage provided in Umwelt (2008f) and summarised in **Table 7.32** are relevant for the proposed Stage 3 Modification.

Table 7.32 – Greenhouse Gas and Energy Assessment Summary (Umwelt 2008f)

Scope	Emission Type	Annual Emissions (t CO2-e)	Total Emissions (t CO2-e)
Scope 1	Onsite fuel combustion	1,392	19,488
	Fugitive emissions from underground mining	28,800	403,200
Scope 2	Consumption of Electricity	65.337	914.718
Scope 3	Offsite fuel combustion	1,345.455	18,836.37
	Offsite and offshore fuel combustion		7,170,000

7.9 Exploration Program

As described in **Section 3**, ongoing exploration works and resultant refinement of the Stage 3 mine plan will be required over the life of the Stage 3 Project. Exploration works will be undertaken so as to avoid significant surface impacts, in accordance with the provisions of the relevant Austar environmental management plans. Based on the environmental studies set out in **Section 7**, the key areas sensitive to surface disturbance works are:

- riparian zones within approximately 50 metres of drainage lines, including but not limited to the area classified as River flat Eucalypt Forest EEC on **Figure 7.17**;
- forested areas within the Stage 3 Modification Area classified as Spotted Gum Ironbark Forest EEC on **Figure 7.17**, and
- areas within 50 metres of creek lines and all archaeological sites identified on **Figure 7.13**.

All exploration works will be undertaken to ensure surface disturbance within environmentally sensitive areas are avoided. If surface disturbance works within environmentally sensitive areas cannot be avoided, further environmental impact assessment will be undertaken. To ensure surface disturbance works within environmentally sensitive areas are avoided, a surface disturbance procedure will be undertaken, incorporating the following aspects:

- Locational aspects:
  - exploration activities to avoid surface disturbance works within 50 metres of drainage lines;
  - exploration activities to avoid clearance of native vegetation; and
  - exploration activities to avoid disturbance of Aboriginal artefacts.
- Ecological management:
  - location checked against **Figure 7.17** to ensure clearance of EECs is avoided; and
  - if clearing of ecological communities other than derived grassland is required, further assessment will be undertaken.
- Aboriginal heritage management:
  - location checked against **Figure 7.12** to determine whether property has been previously surveyed as a part of an Aboriginal Heritage Assessment;
  - location checked against **Figure 7.13** to ensure known artefacts and PADs are avoided;
  - location inspected by site personnel;
  - if property has not been previously surveyed, or surface disturbance works may affect a known site or area, a suitably qualified archaeologist and Registered Aboriginal Party representatives will survey and assess the area and provide advice on any Aboriginal heritage works needed; and
  - if disturbance of artefacts is unavoidable, an Aboriginal Heritage Impact Permit application process will be undertaken.
- Soil and water management:
  - erosion and sediment controls in accordance with the requirements of *Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volumes 2A, 2C, 2D and 2E (DECC, 2008) (the Blue Book)*; and
  - no earth works will commence at the exploration site until the erosion and sediment controls are in place.

7.10 Cumulative Impacts

An assessment of the impacts of the proposed Stage 3 Modification Project is set out in **Sections 7.1** to **7.8** above.

As described in **Section 7.1**, the proposed Stage 3 Modification will result in a decrease in the overall area of impact of underground mining in the Stage 3 area, with subsidence impacts remaining similar to, or slightly less than those approved under Project Approval 08_0111. Minor interactions between the Stage 2 and Stage 3 areas (specifically between LWA5a and A6) have been removed as a result of the proposed removal of LWA6 from the Stage 3 mine plan. The proposed Stage 3 Modification Area remains sufficiently distant from Stages 1 and 2 underground mining operations not to result in any potential cumulative impacts in terms of subsidence.

The flooding assessment for the proposed Stage 3 Modification set out in **Appendix 7** and **Section 7.3** has included consideration of Stage 2 subsidence in the flood modelling

undertaken, thus ensuring that cumulative impacts of landform changes as a result of subsidence on flooding in the Quorrobolong Valley are appropriately considered.

Groundwater inflows into the Stage 3 area are also potentially affected by previous and proposed underground mining. These potential cumulative impacts have been considered as a part of the groundwater assessment undertaken for the proposed Stage 3 Modification, as summarised in **Section 7.4**.

As described in **Section 7.5** and **Appendix 10**, the proposed Stage 3 Modification will result in a significant reduction in impact to the Grinding Groove, while subsidence impacts on artefact scatters, isolated finds and potential archaeological deposits will remain similar to, or slightly less than that previously approved under Project Approval 08_0111. The proposed Stage 3 Modification is therefore unlikely to result in an increase in cumulative impact on Aboriginal heritage sites within the area. Similarly, as described in **Section 7.6**, there is no significant change to impacts on items of historic heritage value.

The ecological assessment undertaken for the proposed Stage 3 Modification indicates that the main area of potential ecological impact is on riparian areas, and that the potential for impacts on the vegetation and habitats is very low. It is expected that there will be no loss of or modification to any vegetation community in the Stage 3 Modification Area. As such, there will be no significant impact on any recorded or potentially occurring threatened species, populations or TECs. The potential cumulative impact of underground mining operations being undertaken by Austar on the ecological values of the Quorrobolong Valley is also very low. This is being verified by the Stage 2 ecological monitoring program, which to date has shown no discernable changes to riparian vegetation within the riparian areas of the Stage 2 area (refer to **Section 7.7**).

8.0 Draft Statement of Commitments

The EARs for the proposed Stage 3 Modification require that the EA includes a Statement of Commitments which details the measures proposed by Austar Coal Mine for environmental management and monitoring of the proposed Stage 3 Modification. This section provides a draft Statement of Commitments made by Austar Coal Mine. The draft Statement of Commitments provided here is for the entire Stage 3 Project and has been created using the Statement of Commitments provided as Appendix 5 to Project Approval 08_0111.

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

8.1 Compliance with the EA

8.1.1 Operation of the Stage 3 development will be undertaken in accordance with the environmental controls and commitments as described in:

- the *Austar Coal Mine Environmental Assessment – Proposed Stage 3 Extension to Underground Mining and Associated Infrastructure (Volumes 1 to 3)* dated October 2008, including the response to submissions; and
- this EA.

8.1.2 If there is any inconsistency between the above documents, the most recent document shall prevail to the extent of the inconsistency.

8.2 Life of Stage 3 Concept Mine Plan

Project Life

8.2.1 The project approval life will be until 31 December 2030. Closure and rehabilitation activities may continue beyond this period and will be undertaken in accordance with an approved Mining Operations Plan.

Production Limits

8.2.2 Underground mining in Stage 3 will produce up to 3.6 Mtpa ROM coal by LTCC methods. This coal will be conveyed, handled, processed and transported using Austar Mine Complex infrastructure.

Hours of Operation

8.2.3 Mining and associated activities for the Stage 3 Project may be undertaken 24 hours a day, seven days a week.

Refinement of Mine Plan

8.2.4 Any material changes to the concept mine plan outlined in this EA report will be detailed and assessed as part of Extraction Plans (EPs) and Mining Operations Plan (MOP) prepared by Austar Coal Mine.

8.2.5 Mining parameters for the proposed mine plan as detailed in the EP will be designed to ensure that predicted systemic subsidence in terms of subsidence, tilt, and hogging and sagging curvatures will comply with or be less than the Upper Bound predictions detailed in the EA. Those being:

- 3000 mm subsidence;
- 11 mm/m tilt;
- 0.09 km^{-1} total conventional hogging curvature; and
- 0.15 km^{-1} total conventional sagging curvature.

8.2.6 The locations of any minor surface infrastructure that may be required to implement the project will be detailed and assessed as part of MOPs prepared by Austar Coal Mine.

8.3 Subsidence

8.3.1 Austar Coal Mine will manage the impacts of mining subsidence as required by the conditions of the consent, conditions of the ML and other DTIRIS conditions.

8.3.2 The Mine Plan submitted as part of the EP for longwall extraction will take into consideration monitoring results from previous Austar Mine Complex operations and will be designed to ensure that subsidence as a result of mining does not exceed Upper Bound predictions as set out in the EA for subsidence, tilt, and hogging and sagging curvatures. Those being:

- **Maximum Upper Bound** subsidence ranges from approximately 825 mm for LWA7 to approximately 3000 mm for LWA19.
- **Maximum Upper Bound** tilt ranges from approximately 4.0 mm/m for LWA7 to approximately 11 mm/m for LWA19.
- **Maximum Upper Bound** conventional hogging curvature ranges from approximately 0.4 mm/m for LWA7 to approximately 0.09 km^{-1} for LWA19.
- **Maximum Upper Bound** conventional sagging curvature ranges from approximately 0.06 km^{-1} for LWA7 to approximately 0.15 km^{-1} for LWA19.

8.3.3 Where a potential subsidence impact is identified on private property, Austar Coal Mine will prepare a Built Features Management Plan in consultation with the property owner. These plans will clearly outline impacts of mining on the property and the management and remediation measures to be implemented.

8.3.4 Subsidence management measures to be implemented as part of the project will include:

- subsidence monitoring lines to be located as determined as part of the EP process where access is granted;
- 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;
- detailed subsidence monitoring in accordance with DTIRIS – Mineral Resources & Energy requirements. This data will be utilised to regularly update the subsidence predictions for Stage 3;
- remediation and rehabilitation of subsidence impacts will be carried out, where required, as soon as practicable following subsidence using methods specified in the EP where access is granted;
- building structures located within the subsidence affectation area will be inspected by a structural engineer prior to and after undermining and appropriate management measures implemented where access is granted;
- informing all relevant service providers of the potential impacts of mining subsidence on services;
- farm dams within the subsidence affectation area will be monitored during and following undermining to ensure they remain in a safe and serviceable condition. Remediation works will be undertaken as required;
- in the event of any significant loss of water from a privately-owned farm dam, Austar Coal Mine will provide an alternate source of water, as required, until the dam is repaired by MSB where access is granted; and
- any privately-owned bores within the subsidence affectation area will be monitored during and following undermining. If the capacity of any utilised private bore is reduced to unacceptable level as a result of subsidence, Austar Coal Mine will provide an alternative supply of water until such time as the MSB re-establishes or replaces the bore.

8.3.5 Austar Coal Mine will, prior to undermining of Quorrobolong Road, Big Hill Road, Coney Creek Lane or longwall mining adjacent to Sandy Creek Road prepare and implement a Traffic Management Plan to manage any subsidence impacts on the roads and associated culverts and bridges in consultation with Cessnock City Council and DTIRIS – Mineral Resources & Energy and to the satisfaction of the Director-General.

8.3.6 Austar Coal Mine will prepare management plans in consultation with relevant service providers, for the protection of infrastructure and services within the potential Stage 3 mine subsidence area to ensure these remain in a safe and serviceable condition throughout the mining period. These plans will be submitted to the DTIRIS – Mineral Resources & Energy for approval as part of the EP prior to undermining of the services.

8.4 Ecology

8.4.1 Austar Coal Mine will establish and manage the proposed Biodiversity Offset Area (refer to Figure 7.1 of 2008 EA) to protect and enhance its ecological values in perpetuity, to the satisfaction of the Director-General. .

8.4.2 A Weed Management Plan will be developed for the Surface Infrastructure Site.

8.4.3 The Austar bushfire management strategy will be revised to include the specific requirements of the Surface Infrastructure Site during the construction and operation phases.

8.4.4 Prior to the commencement of construction of the Surface Infrastructure Site (other than for those works identified in the Shaft Construction Management Plan), an Austar Mine Complex Ecological Management Plan which integrates management of ecological issues associated with construction of the Surface Infrastructure Site, Stage 3 underground mining and with the remainder of Austar Coal Mine operations will be submitted to the Director-General for approval. This will include:

- clearing procedures for establishment of the Surface Infrastructure Site and associated access road/services easement;
- replacement of arboreal habitat within surrounding areas or within the Biodiversity Offset Area, should the removal of any hollow-bearing trees be required; and
- extension of the existing Austar Coal Mine ecological monitoring program to include monitoring of vegetation condition within subsidence affected areas.

8.4.5 Clearing of vegetation will be restricted to the minimum area necessary to construct the proposed infrastructure and provide adequate fire protection and will be undertaken in accordance with the tree felling procedure outlined in Section 7.5.3 of the 2008 EA.

8.4.6 An appropriate speed limit on access roads will be implemented to minimise the risk of vehicle collision with ground-dwelling fauna dispersing between adjacent habitats.

8.4.7 An appropriately designed nest box will be erected (either within remaining bushland areas or within the Biodiversity Offset Area) for the compensation of each tree hollow removed as a result of clearing required for construction of the proposed Surface Infrastructure Site.

8.4.8 Any outbreaks of invasive weeds observed on the property boundary will be appropriately controlled to avoid their escape into the surrounding Werakata State Conservation Area and subsequently competing with threatened flora species. Early detection will ensure the management required is not extensively onerous.

8.4.9 Any landscaping undertaken around infrastructure areas will use only locally occurring native plant species to reduce the risk of invasive plant species escaping into the adjacent reserve and competing with threatened flora species. Particular care will be taken to avoid planting species which are known to escape and naturalise into native bushland.

8.5 Heritage

8.5.1 An Aboriginal Cultural Heritage Management Plan (ACHMP) will be prepared for the Austar Mine Complex to outline all Aboriginal heritage management strategies for the project, responsibilities of all parties and the timeframe for required heritage works.

8.5.2 Austar will make a monetary contribution of $100,000 to an Aboriginal project or program (to be decided by Aboriginal stakeholders) as an offset for any subsidence impacts that affect the grinding groove site. Austar will make this contribution when all necessary government approvals for the Project have been obtained.

8.5.3 No Aboriginal archaeological site will be visited, or have works done there, without Aboriginal stakeholders in attendance.

8.5.4 Known sites on accessible properties will be included in a monitoring program. This will involve recording each site before and after subsidence to identify any impacts. This will be done by an archaeologist and Aboriginal stakeholders.

8.5.5 Aboriginal stakeholders (and an archaeologist if requested by Aboriginal stakeholders) provide relevant Austar personnel with a cultural heritage awareness training session.

8.5.6 If any additional sites are found within the Project area, these will be inspected by an archaeologist and Aboriginal stakeholders to assess the site and decide on how it should be managed.

8.5.7 If remediation works are required on any of the creeklines within the Stage 3 Modification Area, an archaeological survey with Aboriginal stakeholders will be undertaken prior to commencement of any works where access is granted.

8.5.8 Historic Heritage Management Plan incorporating all of Austar Mine Complex will be developed.

8.6 Surface Water and Drainage

8.6.1 Austar will develop a detailed Soil and Water Management Plan for the Surface Infrastructure Site prior to commencement of construction.

8.6.2 Erosion and sediment control measures will be designed and implemented for construction of surface infrastructure to a standard consistent with Managing Urban Stormwater: Soils and Construction (NSW Landcom 2004) (the Blue Book) and Guidelines for Establishing Drainage Lines on Rehabilitated Minesites (Draft) (DLWC 1999).

8.6.3 Any subsidence impacts on drainage lines will be effectively remediated where access is granted such that there is no significant impact on downstream water users and environmental flows. Drainage line monitoring and remediation protocols will be developed as part of the EP process, and in consultation with NOW, to guide the management of subsidence impacts and drainage line remediation works on surface water systems. The drainage line monitoring and remediation protocols will include:

- detailed monitoring protocols;

- a program to complete drainage remediation works in a timely manner post-subsidence to limit the potential for surface water capture;
- details of the design of drainage line remediation works such that the rehabilitated drainage lines maintain a similar channel form and sinuosity to the pre-mining environment, to ensure that the overall erosive power of the creek system is consistent with that existing pre-mining;
- assessment of the viability and benefits of applying proactive measures such as the installation of liners or geo-fabrics in drainage lines prior to subsidence; and
- the existing Austar Site Water Management Plan will be extended to include the Surface Infrastructure Site and Stage 3 underground mining. The plan will be updated in consultation with NOW and DTIRIS – Mineral Resources & Energy and submitted to the Director-General prior to the commencement of construction of the Surface Infrastructure Site.

8.6.4 Surface water monitoring results will be reported annually in the Annual Environmental Management Report.

8.7 Groundwater

8.7.1 A groundwater monitoring program will be implemented for the project as outlined in Appendix 14 of the 2008 EA and **Section 7.3**, or as otherwise agreed by the Director-General in consultation with the NOW.

8.7.2 The results of groundwater monitoring and a comparison of measured and predicted impacts will be reported annually in the Annual Environmental Management Report.

8.7.3 Impacts on privately-owned bores will be assessed by monitoring where access is granted and in the event that any utilised privately-owned bore is significantly affected, an alternative water supply will be provided by Austar Coal Mine until such time as the bore is re-established or replaced.

8.7.4 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

8.7.5 The monitoring results and analysis findings will be reported in the Annual Environmental Management Report.

8.8 Noise and Blasting

8.8.1 Unless otherwise agreed with the landowner, Austar Coal Mine will manage operations associated with the Stage 3 underground mining and Surface Infrastructure Site such that the noise emissions from these activities comply with the noise criteria included in **Table 8.1** at surrounding residences for the range of meteorological conditions modelled in the EA.

Table 8.1 – Project Specific Noise Criteria

Location	Period	Intrusiveness Criteria $L_{Aeq(15minute)}$	Amenity Criteria $L_{Aeq(Period)}$	Project Specific Noise Criteria $L_{Aeq(15minute)}$
Kitchener Residences	Day	38 dBA	50 dBA	38 dBA
	Evening	35 dBA	45 dBA	35 dBA
	Night	35 dBA	40 dBA*	35 dBA
Serradilla Residence, Kauter Residence, Penney and Linton Property	Day	37 dBA	50 dBA	37 dBA
	Evening	37 dBA	45 dBA	37 dBA
	Night	35 dBA	40 dBA	35 dBA

8.8.2 Unless otherwise agreed with the landowner, Austar Coal Mine will manage the construction phase of the Surface Infrastructure Site in accordance with the requirements of DECCW's Interim Construction Noise Guideline (2009).

8.8.3 Acoustic bunding will be constructed to a height of 3.5 metres above ground level along the northern boundary adjacent to the car park and bathhouse.

8.8.4 The ventilation fan outlet will be directed to the west.

8.8.5 Man and materials winder and second egress winder motors will be enclosed.

8.8.6 Blasting will generally take place only once per day and will be undertaken between the hours of 9.00 am to 5.00 pm Monday to Saturday with no blasting on Sundays or Public Holidays.

8.8.7 Airblast overpressure from blasting associated with shaft development at the Surface Infrastructure Site when measured at residences not associated with the development will not exceed a maximum of 120 dBL Linear Peak at any time and will not exceed 115 dBL for more than 5% of blasts over a 12 month period.

8.8.8 Peak particle velocity from blasting associated with shaft development at the Surface Infrastructure Site when measured at residences not associated with the development will not exceed a maximum of 10 mm/s at any time and will not exceed 5 mm/s for more than 5% of blasts over a 12 month period.

8.9 Air Quality

8.9.1 Austar Coal Mine will manage operations associated with the operation of the Surface Infrastructure Site so that dust deposition as a result of the development does not exceed levels set out in **Table 8.2** at nearest non-project related residences.

Table 8.2 - Dust Deposition Criteria

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Note: Deposited dust is assessed as insoluble solids as defined by Standards Australia, 1991, AS 3580.10.1-1991: Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method.

8.9.2 Austar Coal Mine will expand the existing dust monitoring network to include dust deposition gauges at locations to the south and north of the proposed Surface Infrastructure Site. Dust monitoring findings relating to the Surface Infrastructure Site will be reported annually in the Annual Environmental Management Report.

8.10 Energy and Greenhouse Gas

8.10.1 Austar Coal Mine will develop and maintain an internal energy and GHG management plan for Stage 3 operations in accordance with Austar Coal Mine requirements. This will include reviewing:

- energy efficiency in plant and equipment procurement, consideration be given to the life cycle costs advantages obtained by using energy efficient components;
- the opportunity to install additional sub-metering for offices, workshops and winders;
- operational initiatives such as turning off idling plant equipment;
- control and temperature settings for air conditioning units in offices and switchrooms;
- automatic control of external and internal lighting;
- potential energy efficiency opportunities in water pumping and dust suppression systems (for example, variable speed drive pumps);
- review changes in power consumption with installation of new equipment and install power factor correction equipment to suit; and
- review workshop and bathhouse lighting and office and high bay lighting.

8.11 Visual

8.11.1 Austar Coal Mine will implement the following visual controls to screen or reduce the visual impact from views of the Surface Infrastructure Site from residential areas and public road locations:

- Maintain a vegetative screen along the edges of the access road to the Surface Infrastructure Site.
- Limit clearing on the Surface Infrastructure Site to that required for construction and bushfire protection purposes.
- Use appropriate natural tones on the winder building to ensure that it blends into the backdrop of native forest when viewed from Kitchener and sections of Quorrobolong Road.
- Direct night-time security lights into the site and ensure that all lighting is located and directed so as to not directly impact on residential or road locations. Lighting will be designed to minimise excessive night glow in a manner consistent with AS 4282 Control of the Obtrusive Effects of Outdoor Lighting.

- All buildings potentially visible to the public to be coloured in suitable natural tones.

8.12 Transport

8.12.1 To mitigate potential traffic impacts associated with the development of the Surface Infrastructure Site, Austar Coal Mine will:

- Construct an Austroads type AUR intersection treatment with an auxiliary passing lane for through traffic on Quorrobolong Road around right turning traffic at the proposed Surface Infrastructure Site access.
- Provide lighting at the proposed pit top facility access intersection on Quorrobolong Road.
- Erect a left side road junction (W2-4) warning sign for northbound traffic approaching the proposed Surface Infrastructure Site access intersection to compensate for less than desirable Safe Intersection Site Distance (SISD).
- Prepare a traffic management plan for oversize vehicle movements to and from the Surface Infrastructure Site during construction of the Stage 3 development. This Plan will take into consideration specific measures that may be required in regard to address school bus movements in Quorrobolong Road during the construction phase.

8.13 Community

8.13.1 Austar Coal Mine will continue to work with Cessnock City Council, DP&I and Community Consultative Committee to maintain representatives from the Stage 3 Project area on the committee. Austar Coal Mine will provide the Community Consultative Committee with regular information regarding the environmental management performance of the Stage 3 Project and any relevant matters regarding community relations.

8.13.2 Maintain a 24 hour per day community information and complaint line.

8.13.3 Provide regular updates of mine development and monitoring on the Austar Coal Mine website.

8.13.4 Austar Coal Mine will in consultation with Cessnock City Council contribute to the upgrade of the Wollombi Road/West Avenue intersection prior to commissioning of the Surface Infrastructure Site to provide a designated right turn lane into West Avenue to formalise traffic movements in this area and improve existing traffic problems associated with the right turn movement using the through lane and through vehicles passing in the bicycle lane/parking area.

8.13.5 Install a type F flashing light control at the Vincent Street railway level crossing.

8.13.6 Provide support to Kitchener Public School through the provision of sporting equipment and contributions to school/community projects.

8.13.7 Contribute to the ongoing maintenance of Poppet Head Reserve, Kitchener.

8.14 Decommissioning and Rehabilitation

8.14.1 A decommissioning plan will be prepared for the Surface Infrastructure Site as part of the MOP process and submitted to the DTIRIS – Mineral Resources & Energy for approval approximately five years prior to the commencement of decommissioning works.

8.15 Continuous Improvement of Existing Operations

8.15.1 Austar Coal Mine will review and extend its current Site Water Management Plan for Austar Mine Complex to include Stage 3 operations and operation of the Surface Infrastructure Site. The water performance of the water management system will be reported in the Annual Environmental Management Report.

8.15.2 Activities within Austar Mine complex will be undertaken in accordance with approved Mining Operation Plan that will be reviewed and updated at least every seven years.

8.15.3 Austar Coal Mine will continue to implement the voluntary Noise Pollution Reduction Program for Pelton CHPP in consultation with OEH.

8.15.4 Austar Coal Mine will commit to a Noise Management Plan that incorporates current noise monitoring, the voluntary Noise Pollution Reduction Program and associated noise management for Austar Mine Complex operations and will investigate reasonable and feasible noise mitigation strategies where appropriate.

8.15.5 Austar Coal Mine will investigate opportunities for reduction in energy use and greenhouse gas emissions from the Austar Mine Complex. This will include:

- ongoing review of emissions monitoring and management technology;
- review of coal operations and potential for improvement as part of producing clean coal through coal preparation to reduce moisture and ash content, sulphur, nitrogen and other contaminants. This results in reduced emissions of greenhouse gases and other pollutants when the coal is used; and
- consider the application of the in-force National Greenhouse and Energy Reporting System (NGERS) and the Carbon Pollution Reduction System (CPRS) on Austar operations.

8.16 Environmental Management, Monitoring, Auditing and Reporting

8.16.1 Austar Coal Mine incorporate the Stage 3 Project into the Annual Environmental Management Report for Austar Mine Complex.

8.16.2 By the end of 2011, and every three years thereafter, Austar Coal Mine will commission and pay the full cost of an Independent Environmental Audit of the project in consultation with the Director-General of the Department. A copy of the audit report will be provided to the Director-General of the Department and DTIRIS – Mineral Resources & Energy, OEH, Cessnock City Council, NOW and members of the Community Consultative Committee for the Stage 3 Project. This audit may be

combined with other independent environmental audits required by the Director-General of the Department.

9.0 Justification and Alternatives

The proposed Stage 3 Modification is an optimisation of the conceptual Stage 3 mine plan finalised in mid 2008 and approved under Project Approval 08_0111. As discussed in **Section 1**, based on the geological information gained during Austar's exploration program over the last three years, the proposed modification to the mine plan will result in:

- reduction in overall strata failure and business interruption risk due to alignment of longwall orientation with the principal stress direction;
- reduction in roadway failure risks and subsidence impact risks due to an increase in chain pillar width from 45 metres to 55 metres;
- access to high quality, thick seam coal to the west of approved longwalls A7 to A17 that would otherwise have been sterilised by the approved mine plan thus maximising resource recovery; and
- reduction in risk to longwall production between geologically structured zones in approved longwall A6 by moving the main headings to this location.

As identified by the relevant 20 mm subsidence contours shown in **Figure 1.5**, the area of surface impact from the proposed Stage 3 Modification mine plan will be generally within the envelope of the approved Stage 3 mine plan for the majority of the underground mining area. Surface impacts are proposed to be decreased in the west of the approved Stage 3 area via the removal of Longwall A6, decreased in the south-east and north-west by reorientation of longwall panels, and increased for a section of land between the approved Longwall A6 and the western extent of approved Longwalls A7 to A17.

The proposed mine plan modification is therefore anticipated to reduce risk and provide for more consistent production with less interruption, whilst having no significant increase in overall environmental impact levels over and above what was previously assessed, and approved under Project Approval 08_0111. An assessment of the proposed Stage 3 Modification against the principles of Ecologically Sustainable Development (ESD) is provided in **Section 9.1**. A discussion of alternatives to the proposed Stage 3 Modification is set out in **Section 9.2**.

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 which are discussed further in **Sections 9.1.1** to **9.1.4**, have been incorporated into planning and assessment of the Stage 3 Project and the subsequent proposed Stage 3 Modification through:

- incorporation of risk assessment and analysis within the environmental assessment and decision-making processes for the project;
- adoption of environmental assessment and management procedures that are cautious, well understood, predictable and result in high standards for environmental and occupational health and safety performance. This includes site specific calibration of the subsidence prediction model using in excess of five years of subsidence measurements specific to the Greta Coal Seam and Branxton Formation;
- ongoing consultation with regulatory authorities and community stakeholders since 2005 when Austar purchased the mine and through subsequent modifications to the development consent for Stages 1 and 2, development of associated Subsidence Management Plans and Property Subsidence Management Plans and consultation with government agencies, Aboriginal stakeholders, land holders and community stakeholders for the Stage 3 project and the current proposed Stage 3 Modification;
- optimisation of resource utilisation and the economic benefits to the State and community arising from the development of the Stage 3 Project through:
  - refinement of the 2008 conceptual mine plan for Stage 3 to optimise coal extraction while minimising risks to the longwall operation, thus enabling the extraction of coal resources to the west of the previous Stage 3 longwall finish lines that would be otherwise sterilised if not extracted as a part of Stage 3 underground mining;
  - increasing chain pillar widths within the Stage 3 area, thus minimising overall subsidence;
- refining the design of the Stage 3 mine plan to ensure minimal short term and long term impacts through an iterative process involving:
  - assessing potential impacts through consideration of land use, water management, cultural heritage, ecology and land resources;
  - review and refinement of previously proposed environmental control measures in consultation with the relevant government agencies to mitigate adverse impacts and monitor the performance of underground mining; and
  - review and refinement of contingency measures that can be implemented if unforeseen or unpredicted impacts occur.

Environmental assessment undertaken as part of the proposed Stage 3 Modification indicates that the proposed modification is a refinement of the underground mining component of the Stage 3 Project approved under Project Approval 08_0111. The proposed mine plan modification is anticipated to reduce risk and provide for more consistent production with less interruption, whilst having no significant increase in overall environmental impact levels. Underground mining can be undertaken in accordance with ESD principles through the application of identified mitigation and management measures to minimise environmental impacts.

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 proposed Stage 3 Modification Project in March 2011, 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 6**. 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 proposed Stage 3 Modification.

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 3 Modification Project.

A range of mitigation measures have been incorporated into the proposed Stage 3 Modification 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 Extraction Plans and Built Features Management Plans for the Stage 3 Modification 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 proposed Stage 3 Modification through:

- optimisation of the Stage 3 mine plan to ensure minimum risk to the operation, thus enabling underground mining to operate more safely and reducing the potential interruptions to the continuity of the longwall operation and therefore reducing the amount of time longwall impacts are experienced by all landholders being undermined;

- reduction in the total area of subsidence impact compared to the Stage 3 Project as approved under Project Approval 08_0111;

- refinement of environmental management and monitoring measures identified for the Stage 3 Project to minimise potential environmental impacts; and

- significant reduction in subsidence impact to the axe grinding groove (ACM6) located in the north of the Stage 3 Modification Area.

9.1.3 Conservation of Biological Diversity

A detailed assessment of the ecology and biodiversity of the landform within the Stage 3 Modification Area has been undertaken for this EA. The proposed Stage 3 Modification 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 2008 EA and approved under Project Approval 08_0111.

A range of environmental control measures already proposed for the Stage 3 area have been reviewed to ensure their continuing suitability for the proposed Stage 3 Modification. 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 3 Modification Project maximises the efficient use and management of resources through maximising resource utilisation through the movement of longwall finish lines to the west, thereby including high quality coal resources to the west of the current longwall finish lines that would otherwise be sterilised. Furthermore, the reorientation of the longwalls and increase in pillar dimension is predicted to result in less surface disturbance due to subsidence.

9.2 Alternatives

9.2.1 Alternative of Not Proceeding with Modification to the Mine Plan

The conceptual Stage 3 mine plan, finalised in mid 2008 and approved under Project Approval 08_0111 (**Figure 1.3**), was based on the available geological information regarding the stress orientation, geological structures and coal quality within the Stage 3 area. Since that time further geological information has become available as a result of Austar's ongoing exploration program. On the basis of this further information, the mine plan can be further optimised to reduce overall risk to the operation while ensuring that environmental impacts are no greater than currently approved. The alternative of not proceeding with a modification to the mine plan, that is, continuing with the existing, conceptual Stage 3 mine plan as approved would result in the extraction of coal occurring without regard to information that allows reduction of risk to the operation and extraction of an area of high quality thick seam coal without increase to the environmental impacts of the operation.

Extraction of coal using the conceptual Stage 3 mine plan as approved poses increased risk to the operation when compared with the proposed Stage 3 Modification mine plan in the following ways:

- higher risk of overall strata failure and business interruption due to longwall orientation being out of alignment with the principal stress direction;
- increased risk of roadway failure risks and subsidence impact risks due to narrower chain pillar width;
- sterilisation of high quality, thick seam coal to the west of approved longwalls A7 to A17 that would otherwise be extracted in the proposed Stage 3 Modification mine plan;
- increased risk to longwall production between geologically structured zones in the approved location of longwall A6; and
- increased risk of abnormal subsidence within the area of the approved longwall A6 should that panel have been mined between two geological structures.

Environmentally the impacts of the conceptual Stage 3 mine plan as approved are similar to those likely to result from the proposed Stage 3 Modification mine plan. The key differences are set out in **Table 9.1**.

9.2.2 Alternative Mine Plan

A second but less preferred mine plan option would be to retain the main headings and longwall A6 in the position as approved but re-orientate the A7 to A17 longwall panels to that proposed in **Figure 1.4**. This would achieve the same key outcome of realigning the panels with the principal stress direction to reduce the risk of roadway failures; however risk associated with the extraction of panel A6 would still remain. Other limitations of this mine plan over the preferred option as detailed in **Figure 1.4** include:

- Does not facilitate full extraction of the highest quality resource in the west of the project area as it would now be occupied by main headings.
- The potential extraction of A6 panel would still have increased risk to longwall production and abnormal subsidence behaviour as it is being extracted between two major geological structures.
- Access to the new pit bottom area below the Kitchener SIS would be delayed having an impact on connecting critical mine infrastructure (ventilation shafts) to support the ongoing operations in Stage 3.

Table 9.1 – Comparison of Environmental Impacts for Conceptual Stage 3 Mine Plan as Approved and Proposed Stage 3 Modification Mine Plan

	Parameter	Conceptual Mine Plan (as approved)	Proposed Modification Mine Plan	Comment
Overall Subsidence	Area within 20 mm subsidence contour (ha)	1350 ha	1210 ha	The area within the 20mm subsidence contour reduces by 11% as a result of the proposed Stage 3 Modification mine plan
	Maximum Predicted Total Conventional Subsidence (mm)	1925	1800	Overall subsidence impacts are similar to, but slightly less than those for the conceptual Stage 3 mine plan (as approved)
	Maximum Predicted Total Conventional Tilt (mm/m)	6.7	6.5	
	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	0.6	0.5	
	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})	0.12	0.09	
Houses	Total number of houses within 20mm subsidence contour	32	26	The total number of houses affected by the maximum predicted subsidence is predicted to decrease by approximately 19%. The maximum predicted mine subsidence movements at the houses, based on the proposed Stage 3 Modification mine plan, are similar to or slightly less than those predicted based on the conceptual Stage 3 mine plan. The predicted movements for each individual house slightly increase or decrease, as a result of the proposed longwall modifications, depending on the locations of each structure relative to the proposed longwalls.
	Maximum Predicted Total Conventional Subsidence (mm)	1875	1675	
	Maximum Predicted Total Conventional Tilt (mm/m)	5.5	5.5	
	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	0.6	0.4	
	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})	0.8	0.8	
Cony Creek	Maximum Predicted Total Conventional Subsidence (mm)	1865	1675	The maximum predicted mine subsidence movements along Cony Creek, based on the Modified Layout, are similar to but slightly less than those predicted based on the Previous Layout. In consequence, the assessed level of impact for this creek reduces as a result of the proposed longwall modifications.
	Maximum Predicted Total Upsidence	320	3000	
	Maximum Predicted Total Closure	250	2000	

Table 9.1 – Comparison of Environmental Impacts for Conceptual Stage 3 Mine Plan as Approved and Proposed Stage 3 Modification Mine Plan (cont)

	Parameter	Conceptual Mine Plan (as approved)	Proposed Modification Mine Plan	Comment
Sandy Creek	Maximum Predicted Total Conventional Subsidence (mm)	1410	1600	The maximum predicted mine subsidence movements along Sandy Creek, based on the Modified Layout, are a similar order of magnitude to but slightly greater than those predicted based on the Previous Layout. The potential impacts on this creek, therefore, are not expected to change significantly as a result of the proposed longwall modifications.
	Maximum Predicted Total Upsidence	65	80	
	Maximum Predicted Total Closure	25	40	
Flooding	Flooding and Drainage	No significant change to surface water patterns	No significant change to surface water patterns	The magnitude of impacts of the proposed Stage 3 Modification on flooding and drainage will remain within the envelope of that previously assessed and approved under Project Approval 08_0111. Flood depths and velocities are predicted to return to pre-mining conditions in some areas, while minor increases in depth and velocity are predicted in other areas compared to the conceptual Stage 3 mine plan as approved. All drainage lines will remain free draining with no change to catchment boundaries or channel realignment predicted.
Groundwater	Groundwater	No significant change to groundwater patterns	No significant change to groundwater patterns	No additional depressurisation of the regional groundwater table associated with the coal seam is expected as a result of the proposed Stage 3 Modification mine plan compared with that of the Stage 3 mine plan as approved. 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. There is no change to predicted impacts on the shallow aquifer as a result of the proposed Stage 3 Modification mine plan compared with that of the Stage 3 mine plan as approved

Table 9.1 – Comparison of Environmental Impacts for Conceptual Stage 3 Mine Plan as Approved and Proposed Stage 3 Modification Mine Plan (cont)

	Parameter	Conceptual Mine Plan (as approved)	Proposed Modification Mine Plan	Comment
Grinding Groove Site	Maximum Predicted Total Conventional Subsidence (mm)	1450	200	The maximum predicted mine subsidence movements at the grinding grove site for the proposed Stage 3 Modification mine plan are much less than those for the approved Stage 3 mine plan. Consequently, the assessed level of impact on the grinding groove site as a result of the proposed Stage 3 Modification mine plan is reduced compared to that for the approved Stage 3 mine plan as a result of the proposed longwall modifications.
	Maximum Predicted Total Conventional Tilt (mm/m)	3.5	1.5	
	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	0.03	0.01	
	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})	0.13	<0.01	
Historic Heritage Sites	Maximum Predicted Total Conventional Subsidence (mm)	1850	1550	The maximum predicted mine subsidence movements at the historical sites, based on the proposed Stage 3 Modification mine plan, are similar to but slightly less than those predicted based on the conceptual Stage 3 mine plan as approved. The predicted movements for each individual site slightly increase or decrease, as a result of the proposed longwall modifications, depending on the locations of each feature relative to the proposed longwalls.
	Maximum Predicted Total Conventional Tilt (mm/m)	5.5	3	
	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	0.04	0.03	
	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})	0.06	0.04	
Biodiversity	Biodiversity	No significant impact on threatened species, populations or threatened ecological communities	No significant impact on threatened species, populations or threatened ecological communities	The Proposed Stage 3 Modification is not predicted to result in significant changes to the surface and groundwater patterns within the Stage 3 Modification Area, and therefore the potential for impacts on the vegetation and habitats is very low. It is expected that there will be no loss of or modification to any vegetation community in the Stage 3 Modification Area. As such, there will be no significant impact on any recorded or potentially occurring threatened species, populations or TECs.

10.0 Abbreviations

ACHMP	Aboriginal Cultural Heritage Management Plan
AEMR	Annual Environmental Management Report
ARI	Average Recurrence Interval
Austar	Austar Coal Mine Pty Limited
BFMP	Built Features Management Plan
CAP	Catchment Action Plan
CCC	Cessnock City Council
CCO	Chemical Control Order
CMHS Act	Coal Mine Health and Safety Act 2002
CMHS Regulation	Coal Mine Health and Safety Regulation 2006
CHPP	Coal Handling Preparation Plant
CML2	Consolidated Mining Lease 2
CPRS	Carbon Pollution Reduction System
CSCP	Cessnock Social and Community Plan 2009–2014
CWSS	Cessnock City Wide Settlement Strategy 2004
DCP	Development Control Plan
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water (now Office of Environment and Heritage)
DGRs	Director-General's Requirements
DoP	Department of Planning
DP&I	Department of Planning and Infrastructure
DPI	Department of Primary Industries (now part of Department of Trade and Investment, Regional Infrastructure and Services)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DTIRIS	Department of Trade and Investment, Regional Infrastructure and Services

DWE	Department of Water and Energy
EA	environmental assessment
EARS	Environmental Assessment Requirements
EC	electrical conductivity
EECs	endangered ecological communities
EHC Act	Environmentally Hazardous Chemicals Act 1985
EMP	Environmental Monitoring Program
EP	Extraction Plan
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	ecological sustainable development
FM Act	Fisheries Management Act 1994 (NSW)
ha	hectares
HCRCMA	Hunter-Central Rivers Catchment Management Authority
HREP	Hunter Regional Environmental Plan 1989
HVAS	high volume air sampler
ILUA	indigenous land use agreement
INP	Industrial Noise Policy
IPM	Incremental Profile Method
KTP	key threatening process
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
MLALC	Mindaribba Local Aboriginal Land Council
mm	millimetres
mm/m	millimetres per metre
MOP	Mining Operations Plan
MSB	Mine Subsidence Board
MSC Act	Mine Subsidence Compensation Act 1961
MSEC	Mine Subsidence Engineering Consultants Pty Ltd
Mtpa	million tonnes per annum
NGERS	National Greenhouse and Energy Reporting System
NNTR	National Native Title Register
NOW	NSW Office of Water
NPE Act	National Park Estate (Lower Hunter Region Reservations) Act 2006
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
NT Act	Native Title Act 1993
OEH	Office of Environment and Heritage
OHS Act	Occupational Health and Safety Act 2000
OTDR	Optical Time Domain Reflector
PAD	potential archaeological deposit
PoEO Act	Protection of the Environment Operations Act 1997
PPV	Peak Particle Velocity
PRP	Pollution Reduction Program
RCP	Regional Conservation Plan
ROM	Run of mine
ROTAP	rare or threatened Australian plant
RTA	Roads and Traffic Authority

SCA	State Conservation Area
SEPP	State Environmental Planning Policy
SIS	Surface Infrastructure Site
SWMP	Site Water Management Plan
SMP	Subsidence Management Plan
TEC	Threatened Ecological Community
TSC Act	Threatened Species Conservation Act 1995 (NSW)
Umwelt	Umwelt (Australia) Pty Limited
WMA	Water Management Act 2000
WMP	Water Management Plan
Yancoal	Yancoal Australia Pty Limited
Yanzhou	Yanzhou Coal Mining Company Limited

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