Part 4C
Potential Stage 2 Mining Project

This part provides a conceptual outline of the potential impacts relating to subsidence associated with the Stage 2 longwall mining project, should it proceed. An overview of the Stage 2 mining project has previously been presented in Section 2.16.

It is noted that the proposed Stage 2 mining project would be the subject of a separate, comprehensive Environmental Assessment should the Proponent establish during Stage 1 it is technically feasible to proceed to Stage 2.

The information presented in this part is drawn from the specialist consultants studies referred to in Part 4B. Introductory and background information is not repeated, rather the text presented focuses on the potential Stage 2 mining project.

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4C.1 INTRODUCTION

In the event the technical and economic assessment of a potential longwall mining operation confirms it is feasible for a longwall mining operation to proceed within the Project Site, the Proponent would seek project approval for the operation. Section 2.16 has previously provided an overview of the Stage and related activities and **Figure 4C.1** reproduces **Figure 2.16** which identifies the main components of the indicative mining area.

This section of the *Environmental Assessment* is intended to provide readers with an appreciation of the types of potential impacts that would occur if the Narrabri Coal Project develops as a longwall mining operation, ie. following the initial development as Stage 1. It is re-iterated that, in the event a longwall mining operation is not feasible the Narrabri Coal Project would continue as continuous miner operation for its operational life. This section provides an overview of only those components of the local environment that would be influenced by the longwall mining operation.

It is noted at the outset prior to addressing each of the relevant environmental issues that coal mining using longwall methods is a well understood mining method used throughout the world for over four decades. The outline of the method in Section 2.16 reflects current longwalling practices. Given the considerable experience in designing longwall mining operations beneath villages, roads, railways, creeks and transmission lines, the Proponent is confident that each of the environmental issues discussed in this section would be adequately managed, particularly given the area of subsidence during any one year would be comparatively small, ie. 120ha.

4C.2 TOPOGRAPHY

The topography of the Project Site has previously been described in Section 4A1.2 and depicted on **Figure 4A.2**. The longwall mining operation is predicted to subside the existing land surface by a maximum 2.79m on the eastern side of the indicative mining area (195m to 215m below the ground surface) to 2.24m on the western side. It is noted that these predicted subsidence levels would be maximum levels as uncertainty exists about the extent of caving likely involving the volcanic basalt sill and conglomerate that lies above the Hoskissons Coal Seam. Both of these units are extremely competent in places and it is possible that subsidence may be much less than the maximum depth forecast.

In the event that the maximum subsidence levels do occur, the topography would be lowered by between 0m and approximately 2.8m, generally as a uniform layer with retained gateroads/pillars being reflected in lesser subsidence levels. The Australian coal mining industry has considerable experience in forecasting changes in ground levels and localised slopes. The *Environmental Assessment* for the Stage 2 operation would provide further detail about the changes in topography which in turn would assist to better describe the subsidence-related impacts.

4C.3 SURFACE WATER

The main surface water-related issue for the Stage 2 operation would continue to be the management of water pumped from underground. The volumes of water that would need to be dewatered would be re-assessed considering the observed in-flows from the Stage 1 project and additional information gained on local and regional groundwater flows through the establishment of groundwater monitoring locations. The assessment of the Stage 2 project would therefore be required to re-evaluate mine inflows and the management of this water either above or underground. All other surface water quality issues would be managed as proposed in Section 4B.1.4.

The Stage 2 project would have the potential to impact on local drainage as subsiding land would probably alter local flow patterns and catchment area and possibly local flooding patterns. In addition, changes to flow patterns may divert surface water flows over relatively unprotected areas of land leading to erosion and sedimentation. The change in topography would occur gradually and the Proponent would ensure that any potential adverse changes are managed to avoid or minimise the impacts of the changes. The assessment of the Stage 2 project would be required to determine the predicted level of subsidence and determine the likely impacts of this on local catchments, erosion potential and flooding patterns.

4C.4 GROUNDWATER

Fracturing and Mine In-flows

Preliminary estimates of the extent of continuous fracturing induced by the longwall panels of the Stage 2 project are predicted to vary from 106m below surface for at 180m depth to 188m below the surface at 300m depth (Mining Geotechnical Services, 2007). Based on the geological data therefore, continuous fracturing would be contained within the Gunnedah Basin Permio-Triassic sediments extending approximately 10m to 20m vertically into the Napperby Formation above the volcanic basalt sill. The continuous fracturing induced by longwall mining has the potential to significantly increase the rates of groundwater in-flow into the underground workings from groundwater stored in the fractured rock aquifers above the mine. As a consequence, the yields and available drawdown for any existing registered groundwater bores which are screened over the formation predicted to affected by continuous fracturing, would be likely to be significantly impacted and alternative supplies may be required.

Preliminary estimates of the extent of discontinuous fracturing induced by the longwall panels of the Stage 2 project are predicted to vary from 27m below surface for at 180m depth to 54m below the surface at 300m depth (Mining Geotechnical Services, 2007). Based on the geological data therefore, discontinuous fracturing would extend through the Garrawilla Volcanics to approximately 5m to 15m into the Purlawaugh Formation. The volume of drainage from the discontinuous fractures cannot currently be estimated, but as the on-site testing indicated the Garrawilla Volcanics to have the highest hydraulic conductivity, it has the potential to result in significant inflows into the mine. Impacts on registered groundwater bores screened over the formations predicted to be impacted by discontinuous fractures may be impacted above the 15% threshold requiring an alternative water supply.

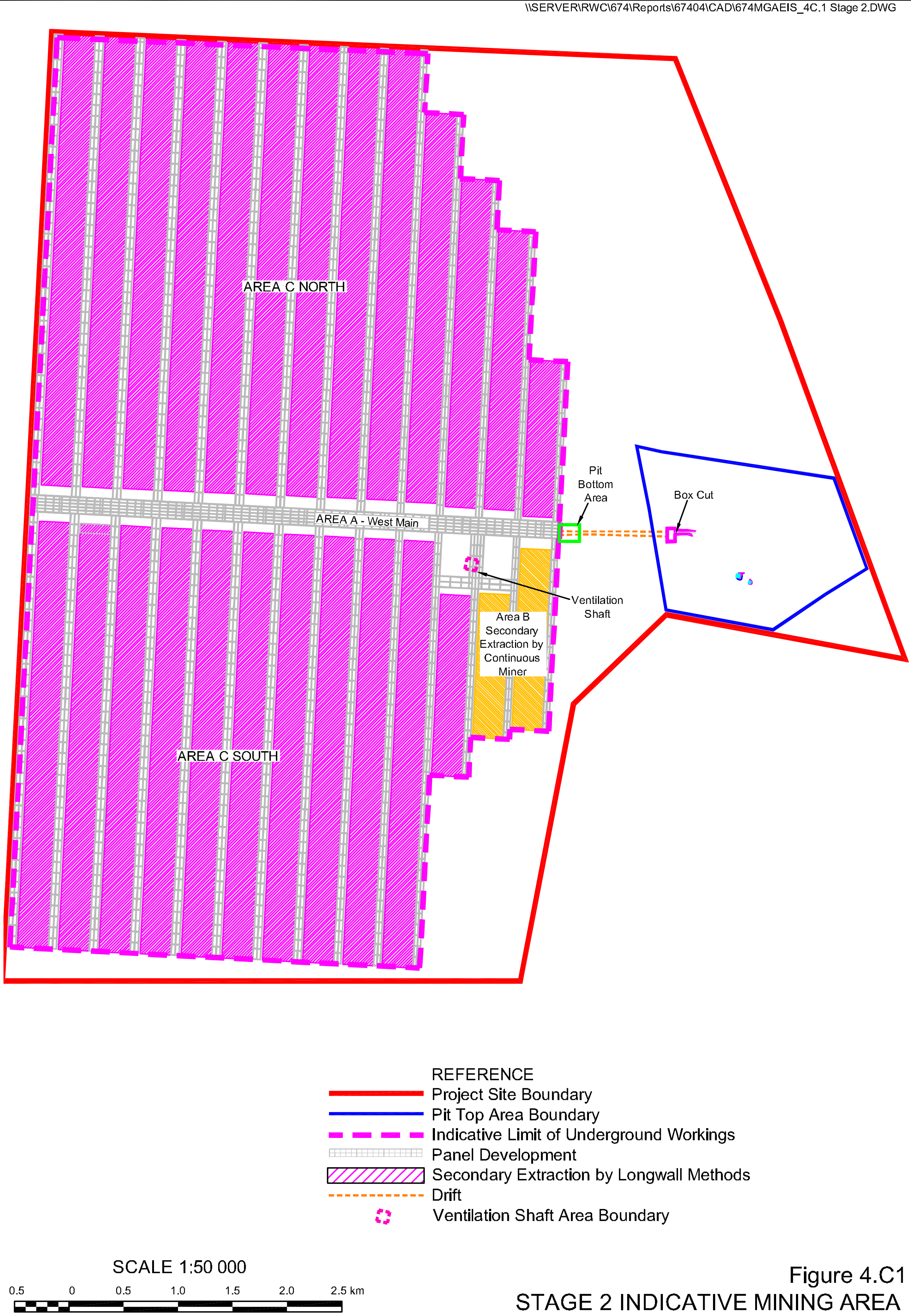

Figure 4.C1
STAGE 2 INDICATIVE MINING AREA

Impacts on the Great Artesian Basin (GAB) Intake Beds Groundwater Management Areas (GWMA)

The Garrawilla Volcanics and Purlawaugh Formation are located at the base of the Surat Basin sequence which defines the extent of the GAB GWMA. As there is currently an embargo on new groundwater extraction from the GAB intake beds, more definitive information on the potential in-flow of groundwater from the GAB intake beds GWMA would be required as part of an *Environmental Assessment* of Stage 2 of the project. In the event that in-flows from the GAB intake beds GWMA are predicted, licensing in accordance with the draft aquifer interference policy is likely to be required.

While there may be some impact on the aquifers of the Garrawilla Volcanics and Purlawaugh Formation, any impact of Stage 2 of the project is considered by GHD (2007) to be less than the underlying Surat Basin formations. This is due to the limited extent of the Pilliga Sandstone within the Project Site (the eastward extent of the Pilliga Sandstone into the Project Site is estimated to be approximately only half of what is shown on the regional 1:250 000 geological map (J. Beckett, pers. comm.) and current prediction that discontinuous fracturing will not extend into the Pilliga Sandstone (GHD, 2007). Also, as the sandstone unit is likely to be the uppermost aquifer where it exists in the Project Site, topography and in particular the elevated ridge to the west of the Project Site, could result in localised northeasterly flow to the Namoi River. In this case, direct recharge to the GAB sandstone aquifer would occur only to the west of the ridge and Project Site, ie. outside the area of Stage 2 longwall mining.

Stage 2 Assessment Requirements

A more detailed assessment of Stage 2 mining impacts would need to be modelled when further information on longwall design and potential fracturing induced changes to aquifer characteristics is available.

4C.5 ECOLOGY

The ecology of the Project Site and its management has previously been described in Sections 4B.3 and 4C.3.

There are two native vegetation community types which occur within the Stage 2 indicative mining area (**Figure 4B.15**). These communities also reflect the type of faunal habitat, with both listed as follows.

- Community 1 - Bimble Box / Grey Box Woodland. The associated faunal habitat is described as Lowland and Floodplain Woodland.
- Community 3 - Brown Bloodwood / Red Ironbark / Mallee Woodland. The associated faunal habitat is described as Sandstone Slopes and Ridgetop Woodland.

Two artificial (cleared/semi-cleared or cultivated) communities make up the balance of the Stage 2 indicative mining area, namely:

- Community 4 - Cleared open pasture with or without scattered native trees. The associated faunal habitat is described as Open Pasture.
- Community 5 - Cultivated cropland with no native vegetation. The associated faunal habitat is described as cropland.

No endangered ecological communities or flora and fauna species were recorded within the Stage 2 indicative mining area.

Although separated by a wide fire trail along the State Forest boundary, the Stage 2 indicative mining area is associated with extensive woodland areas to the west and could therefore provide habitat for threatened species. Further field surveys would be undertaken within this area to target identifying potential threatened flora and fauna species, the relevant ecological impacts and the management measures required to effectively manage these impacts.

In particular, a section 5A assessment (7-part test) would be conducted for the relevant species particularly with respect to the relevant key threatening process (determined under the *TSC Act 1995*) "Alteration of habitat following subsidence due to longwall mining". Based on the current assessment, no threatened species or ecological communities listed by the Final Determination (NSW Scientific Committee 2005) as potentially suffering alterations to their habitats due to subsidence are likely to occur in the indicative mining area. However, biodiversity in general could be impacted if substantial subsidence occurs, (for example frog habitat could be affected if pools and watercourses dry up and any threatened flora species that may occur within the Stage 2 indicative mining area, may not adapt to the altered habitat).

The subsidence resulting from longwall mining in Stage 2 has the potential to cause the loss of hollow-bearing trees, particularly in the western part of the indicative mining area. The extent of tree loss and therefore potential roost/nest sites, cannot be predicted at this stage of the project.

4C.6 ABORIGINAL HERITAGE

4C.6.1 Existing Environment

Stage 2 mining operations include all three zones identified using the predictive model (see Section 4B.4.3 and **Figure 4B.17**) and includes Aboriginal cultural heritage Site No. 7 (see Section 4C.4.1).

4C.6.2 Management Safeguards

Where applicable, the general management measures outlined in Section 4B.4.5 would be implemented. In addition to these general management measures, to ensure the protection of Aboriginal cultural heritage the following management safeguards would also be implemented.

1. The potential damage from subsidence during Stage 2 to all Aboriginal cultural heritage sites located in each zone would be assessed and a management plan compiled to mitigate any damage that may occur to them.
2. A detailed study would be initiated as soon as possible in an area of current or projected subsidence, either within the Project Site or at another mine, to determine the nature of the impact of subsidence on archaeological sites. The study would involve experimental archaeology, using modern manufactured artefacts to assess the impact that subsidence has on an Aboriginal heritage site over a given period of time, providing a baseline for assessing impact within the Stage 2 area. The study would be undertaken on a small scale and would be monitored.
3. Based on the results of the experiment, and modelling from the results of the present field assessment, further Aboriginal heritage surveys would be undertaken, if required, as part of the Stage 2 assessment process.

4C.6.3 Impact Assessment

The potential subsidence (2.24m to 2.79m) that might occur during Stage 2, may have a direct damaging impact and may compound the amount of damage to any Aboriginal cultural heritage sites that exist within each of the archaeological zones within the Stage 2 area. Within Zones 2 and 3, the potential risk to Aboriginal cultural heritage sites is considered to be low, however, within Zone 1 (Watercourses) the risk is considered to be high.

The watercourses within archaeological Zone 1 which have not been previously impacted by farming and clearing are where Aboriginal cultural heritage sites are most likely to be found. Sites are likely to be similar in nature to those identified within the Pit Top Survey Area though the exact impact of subsidence on these types of sites is largely unknown and would be further investigated using the experiments described in Section 4D.5.2 and further cultural heritage works as necessary.

4C.7 SOILS, LAND CAPABILITY AND AGRICULTURAL SUITABILITY

It was not necessary that the soils above the Stage 2 indicative mining area be subjected to a detailed soil survey. Rather, GCNRC (2007) relied upon existing published information and the detailed investigations in the Pit Top Area were to provide a conceptual account of the relevant aspects of Stage 2.

4C.7.1 Soil Occurrences

Soil data covering the Project Site is contained in Anon (1978). The soils investigations reported upon in Sections 4B and 4C indicate that both clayey soils and sandy soils are likely to occur across the indicative mining area. These soils are discussed in Section 3 of Part 5 of the *Specialist Consultant Studies Compendium*. They vary from red brown earths on gently undulating areas to the various sandy surfaced Pilliga Scrub Soils that are typical of that in Jacks Creek State Forest and the uncleared private lands adjoining it.

In addition to the common sandy soils, there are some red earth soils within the Pilliga Scrub Soils group that have silty clay loam surface soils and silty light clay subsoils

4C.7.2 Land Capability and Agricultural Land Suitability

4C.7.2.1 Land Capability

The Stage 2 indicative mining area comprises a mixture of Class III, Class IV, Class VI and Class VII land. Descriptions of these land classes are as follows.

- **Land Class III** - land suitable for regular cultivation but requiring structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.
- **Land Class IV** – land suitable for grazing with occasional cultivation and requiring use of soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture.
- **Land Class VI** – land suitable for grazing with no cultivation. Soil conservation practices are required, including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. Productivity would vary due to the soil depth and the soil fertility. This class comprises the less productive grazing lands.
- **Land Class VII** - comprises land best protected by green timber. Generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire. Destruction of trees is not generally recommended, but partial clearing for grazing purposes under strict management controls can be practised on small areas of low erosion hazard. Where clearing of these lands has occurred in the past, unstable soil and terrain sites should be returned to timber cover.

It is evident from the airphotos of the potential subsidence area that much of the open farm land has been treated with structural soil conservation works to minimize soil erosion indicating that this land is Class III land.

The areas mapped by DNR as Class IV lands are generally associated with drainage lines and are areas that should be regarded as Class VII land.

Given the potential erodibility of the sandy soils of the Pilliga Scrub Soils associated with the largely uncleared section of the potential subsidence area, it is considered that the areas mapped by DNR as Class VI and Class VII lands should be regarded as Class VII land.

4C.7.2.2 Agricultural Land Suitability

The mapped agricultural suitability of the lands above the indicative mining area record the presence of Classes 2, 3, 4 and 5 (Agricultural Suitability) lands within its boundaries.

The better class agricultural lands are concentrated on the eastern side while the lesser quality land is located to the west. Descriptions of the different land classes are as follows.

- **Class 2** land *is arable land suitable for regular cultivation for crops but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but edaphic (soil factors) or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures*.
- **Class 3** land is *'grazing land that is well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall level of production is moderate as a result of edaphic (soil related) or environmental constraints. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance, and conservation or drainage works may be required.'*
- **Class 4** land is *'land suitable for grazing but not for cultivation. Agriculture is based on native pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic (soil related)'.*
- **Class 5** land is *'land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low to zero as a result of severe constraints, including economic factors, which preclude improvement'.*

The erodibility of the soils of the whole area is relatively high but the areas where remnant native vegetation remains (generally Classes 4 and 5) would be relatively well protected in the long term against erosion. Conversely, on the areas currently farmed, the presence of some areas of soil conservation bank and waterway systems on individual farms indicates the erodibility of these areas in the past and their likely erodibility in the future under cropping in particular.

4C.7.3 Soil and Land Management

Stereoscopic aerial photo interpretation indicates that there are some soil conservation bank and waterway systems constructed within the Stage 2 indicative mining area. The areas where soil conservation bank and waterway systems currently exist would have to be regularly inspected. Because of the potential land surface distortions caused by subsidence, the grades on the bank systems are likely to be changed with potential for serious soil erosion consequences. The detailed predictions of the topographic changes discussed in Section 4C.2 would assist to manage localised changes in drainage lines and where soil erosion could be increased such that any problems are resolved to the landholders' satisfaction.

In order to establish what measures are required to rectify the effects of subsidence on the system functionality, the areas where subsidence occurs would need to be monitored after mining. Depending on the individual landowner's requirements, the situation might be rectified by redesigning the bank systems after subsidence is complete to achieve appropriate bank and waterway grades and system configurations similar to those existing prior to mining. Alternatively, the issue might be addressed by construction of completely new systems that direct water to new farm dams etc. that take advantage of subsidence areas that provide a potential for extra storage.

Because of the potential for soil erosion on areas which soil conservation systems have become dysfunctional due to subsidence, it may be prudent for such areas to be used as purely livestock grazing areas on a temporary basis after mining and until subsidence is complete after about 12 months. Such land use may require erection of temporary fencing to separate areas of the same paddock that have not been mined and are still being used for crop production. Areas where livestock are not being grazed would not require such precautions.

Once subsidence is complete, and protective soil conservation systems are installed / re-installed where appropriate, it should be possible to resume normal farming activity over much of the mined area.

There would, however, be areas around the perimeter of the Stage 2 Proposed Mining Area (and elsewhere) where the final landform may not allow cropping in future for a variety of reasons associated with water ponding and potential soil erosion.

4C.7.4 Impact Assessment

Once subsidence is complete, and protective soil conservation measures are installed where appropriate, the lands in general would be generally classified as having similar land capability and agricultural land suitability as existed prior to mining.

After subsidence, the bulk of the Class III land may well remain Class III land with additional soil conservation inputs to re-install bank systems. Some areas may, however, be changed to Class IV lands because of water management problems.

The Class VII land would remain Class VII land.

Nevertheless, there is the possibility that the classification of some areas as **Class 2** and **Class 3** areas would be changed to a classification between 3 and 4 (respectively) depending on the severity of the subsidence impact and their location within the overall landform. This would particularly be the situation with land associated with drainage areas.

The timbered Class 4 and 5 lands after subsidence would most likely be classed as Class 5 lands that would be only lightly grazed, if at all. This is particularly the case in the years following subsidence to allow re-establishment of any tree, shrub and ground layer cover that might be affected by soil and moisture regime changes associated with subsidence. The cleared Class 4 lands would remain Class 4 lands.

The likely impacts of a 'worst-case' scenario drop in the land surface level of a maximum of 2.79m are likely to be:

- no change in soil texture;
- no change in soil nutrient status;
- change in Land Capability Classification to Class III, IV and VII;
- change in Agricultural Land Suitability Classification to Classes 3, 4 and 5;

- a possibility of more arid growth conditions developing, at least for a number of years in both remnant native vegetation and farmland until the soils and their hydrological attributes stabilise. The Proponent would employ appropriate management techniques should this possibility eventuate;
- depending on the degree of rock fracture beneath the surface, there may be surface cracks or holes that develop and divert water through the soil and rock to subsurface areas - how long this process would operate depends on the size of the void beneath and whether or not it fills with soil material from the surface. In any event, the Proponent would act to immediately fill any such formations which develop;
- possible erosion of areas near major drainage line inlet and egress; and
- possible ponding of water in a section of the subsidence area where surface flow is impeded – probably only for a short time but nevertheless would have some impacts on the vegetation community currently present and some changes may be permanent.

4C.8 CONCLUSION

The components of the local environment discussed in Section 4C.2 to 4C.7 are regularly managed during longwall mining operations throughout NSW, interstate and overseas. The experience at these numerous sites has effectively confirmed that longwall mining which is carefully designed and implemented is able to proceed without any major disruptions to landholders or land users. The Proponent would adopt best practice longwall predictive scientific methods to predict subsidence so that impacts are minimal. In any event, the Proponent would work closely with each potentially affected landowner to ensure that each issue and concern and practicalities for each individual landowner are discussed in advance of any subsidence on their property. The Department of Primary Industries (Mineral Resources) will require all of these matters to be addressed and appropriate compensation agreements to be in place prior to mining beneath the subject properties.