From:	Colin Phillips
To:	Thomas Watt
Subject:	FW: State Significant Project - Airly Mine Extension (SSD 12_ 5581)
Date:	Friday, 31 October 2014 2:27:03 PM
Attachments:	CVEG Submission Airly Mine Extension 2014.pdf Airly Mine Extension Project EISColocomSubFin(2).pdf Submission Pells 2014 Nr2.pdf

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From: Sanday <sanday@skymesh.com.au>
Sent: Friday, 31 October 2014 14:18
To: Colin Phillips
Subject: State Significant Project - Airly Mine Extension (SSD 12_ 5581)

Dear Mr Phillips,

State Significant Project - Airly Mine Extension (SSD 12_5581)

As discussed on the telephone attached please find Capertee Valley Environmental Group Inc's Submission in objection to the abovementioned mine extension.

Yours faithfully

Veronica Sanday

Please note additional Expert Reports emailed as annexures.

Hon. Secretary
Capertee Valley Environmental Group Inc.
Lot 2, Coorain Street
Glen Davis NSW 2846
Tel: 02 63797200

Capertee Valley Environmental Group Inc.

ABN 31 096 498 385
Email: sanday@skymesh.com.au
Telephone: 02 63797200
Postal Address
Lot 2: Coorain Street
GLEN DAVIS NSW 2846

31st October, 2014

Mining and Industry Projects
NSW Department of Planning & Infrastructure
GPO Box 39
Sydney NSW 2001

Dear Sir,

State Significant Project - Airly Mine Extension (SSD 12_5581)

Capertee Valley Environmental Group Inc. (CVEG Inc.) objects to the approval of the above mentioned mine extension and jointly with Capertee Valley Alliance (CVA) engaged the Environmental Defenders Office who in turn engaged Experts to review Airly Mine Extension's EIS.

CVEG Inc supports the submissions of CVA , and relies upon the expert opinion evidence contained in such submission with the knowledge an consent of CVA, and the authors of such expert reports.

In the interest of brevity, and to avoid repetition, CVEG Inc's submission does not refer expressly to the entirety of the expert opinion evidence presented by CVA.

Below are some of the reasons for this objection and attached are the Expert Review Documents:---

World Heritage Properties

The Application for Exploration will impact a huge portion of the Blue Mountains National Park, Gardens of Stone National Park, Wollemi National Park, within which is Wollemi Wilderness, a declared Wilderness Area. All of these National Parks are a part of The Greater Blue Mountains declared World Heritage Area and as such should be protected by the Precautionary Principle. Relevant to its World Heritage listing, UNESCO notes that The Greater Blue Mountains World Heritage Area contains primitive species of outstanding significance to the evolution of the earth's plant life. It is our understanding that it is against International Best Practice Guidelines to mine within, or adjacent to, a World Heritage Area. This is stipulated by the International Union for Conservation of Nature. Gardens of Stone Proposal Stage 2 covers an area with a range of environmental and heritage values either poorly represented or not represented in the World Heritage Area.

Threatened Species and Threatened Ecological Communities

The following are some of the threatened fauna in Capertee Valley, National Parks and World Heritage Areas which would be adversely impacted should this Mine Expansion be approved: --

Large-eared Pied Bat (Chalinolobus dwyeri,V)
Swift Parrot (Lathamus discolour, E)
Regent Honeyeater (Xanthomyza phrygia, E)
Booroolong Frog (Litoria booroolongensrs, E)
Brush -tailed Rock-wallaby (Petrogale penicillata, V)
New Holland Mouse (Pseudomys novaehollandiae, V)
Pink-tailed Wormlizard (Aprasia parapulchella, V)
Spotted-tail Quoll (Dasyurus maculatus maculatus, E)
Bathurst Copper Butterfly (Paralucia spinifera, V)
(CE-Critically Endangered, E-Endangered, V-Vulnerable)

The following are some of the threatened flora which would be adversely impacted should this Mine Expansion be approved in Capertee Valley:---

Pultenaea sp. Genowlan Point Pea (CE)
Mount Vincent Mintbush (Prostanthera stricta, V)
Grey Grevillea (Grevillea obustiflora, E)
Clandulla Geebung (Persoonia marginata, V)
Prasophyllum sp.Wybong (C. Phelps ORG 5269, CE)
Wollemi Mint Bush (Prostanthera cryptandroides subsp. cryptandroides, V)
Wollemi Pine (Wollemi nobilis, CE)
Austral Toadflax (Thesium austral, V)
Philotheca ericifolia (V)
Flockton Wattle (Acacia flocktoniae, V)
Evans Grevillea (Grevillea evansiana, V)
Rufous Pomaderris (Pomaderris brunnea, V)
(CE - Critically Endangered, E - Endangered, V - Vulnerable)

The following are some of the threatened ecological communities of flora, in Capertee Valley, which would be adversely impacted should this Mine Expansion be approved:---

White Box (CE)
Yellow Box (CE)
Blakely's Red Gum (CE)
Grassy Woodland and Derived Native Grassland (CE)
(CE - Critically Endangered.)

Significant Landscapes

Capertee Valley is World-renowned as a birdwatcher's paradise with 245 different species of bird using the valley throughout the year. Its scenic beauty, geoheritage on the World level and its biodiversity of National Significance are highly valued by residents and visitors to this magnificent part of Australia. Pearson’s Lookout, just off Castlereagh Highway near Capertee, is a recently upgraded, well visited, site for many tourists and the visual impact of the mine, both from the Lookout and from the road into the Capertee Valley, would totally ruin the majestic views which draw people from the four corners of the World.

Water Resources

The continued --- and expansion --- of mining risks contamination of water supply. The area covered by this proposed expansion plays a vital part in water catchment for river systems,.The expansion area covers headwaters of creeks and rivers which ultimately flow into The Greater Blue

Mountains World Heritage Area and on, by way of Capertee River, into Colo River, a declared wild river. Many of these rivers and creeks are vitally important to Wollemi Wilderness and to the scenic beauty of The Greater Blue Mountains World Heritage Area. The Greater Blue Mountains is a designated World Heritage Area of Global Significance for the Conservation of Biodiversity. Its ecosystems depend on a reliable supply of surface water and upon groundwater from aquifers. These water resources would be placed in jeopardy should this Mine Expansion be approved. Farmers in Capertee Valley would have their livelihood threatened due to adverse impacts upon their water resources.

Social and Economic Impacts

In consideration of this proposed mine expansion, quality of life issues should also be prioritised, particularly as they will greatly affect residents of Capertee Valley. Economic impacts, due to loss of World Heritage status, could result if indeed Creeks and Rivers are poisoned as a result of the mine expansion being approved. The flow-on consequences of this and the actual despoliation of an area known Nationally and Internationally for its scenic and pristine beauty would be enormous. The tourism industry, a mainstay of this part of the Greater Blue Mountains World Heritage Area's economy would suffer greatly. An extensive range of structured and unstructured recreational activities take place in the Capertee Valley, e.g. bushwalking, canyoning, bird watching, camping and photography, as well as nature education programmes for schools and nature conservation programmes for adults. This proposed mine expansion is not compatible with such activities.

Airly Mine Extension – Expert Review Documents

Acquatic Ecology Review: Dr Alison Hunt

Overall comments

- Overall methodology are adequate although the sample design is spatially and temporally limited in relation to stygofauna (part 2.2)
- Airly creek and Torbane Creek sites are the most biologically impacted due to existing factors such as deforestation, agriculture and mining (part 2.3)
- The “scientific robustness” could be added to by providing additional assessment especially for stygofauna and hyporheic fauna (part 3.0)

Stygofauna (part 2.4)

- Stygofauna sampling did not reveal stygofauna, potentially due to the severely limited sampling effort and location of bores + no attempt made to sample hyporheic fauna

Potential impacts and Mitigation measures (Part 2.5)

- Mitigation measures proposed will probably mitigate against potential risks
- Report acknowledges sensitive receptors/potential for disruption of ecosystems including Genowlan Creek, Gap Creek, Village Spring and Grotto Creek
- Mitigation measures are considered appropriate and manageable

Impacts on Threatened Species (part 2.6)

- No assessment of impacts using the Significant Impact Criteria detailed in *Matters of National Environmental – Significant Impact Guidelines 1.1*. However, Alison Hunt notes that the conclusions would not have been altered.

Submission on Airly Mine Extension: Dr Haydn Washington

- Comparison of mine layouts for the various extraction zones show that extraction rates will be as much as 66% under the majority of the mesas rather than 50% as was verbally announced by the Colo Committee (page 2)
- EIS deliberately avoids stating anywhere the percentage coal extraction under the various mining zones because it is too high for the safety of the SCA (see page 3-4 for analysis of zones). (Page 3)
- Disputes what is stated on page 37 of the EIS regarding pagodas in the SCA. Says there are both smooth and platy pagodas present, with good examples of both types. Mugii Murum-ban SCA is an excellent showcase of pagoda geodiversity. Pagodas are also regularly greater than 20 metres in height (the EIS states they only reach this height). (Page 8)
- Says that the assertion on pages 345 and 354 of the EIS that the proposal poses no long-term risk of a decrease in the EPBC listed *Pultenaea sp. Genowlan Point* is a direct and blatant untruth as the only known population runs serious risk of being sent extinct via cliff collapse. (Page 9)
- Says the EIS failed to identify an aboriginal art site on the creek that runs up to Airly turret from the stone cottage (Page 12)

Review of Noise Management: John Bassett

Overall comments

- Report states that compliance measurements have been conducted on an annual basis however there is no data presented from these measurements. Therefore claims that the noise environment is the same as five years ago is contestable.
- Quiet recreation sites at Airly Gap camp ground and Nissen Hut on Glenowlan Mountain are not indicated in any of the modelling
- Assessment criteria for sites for "contemplative activities that generate little noise and where benefits are comprised by external noise intrusion, for example reading, meditation" is set at a higher standard than a school classroom (35dB(A)) or a place of worship (40dB(A)) (NSW INP, Table 2.1)

Operational noise

- SoundPlan 3D is the software that has been used – it was released in 2011 and is an old version
- Noise indicators show that residence 2 will experience levels of 35-40dBA with REA1 2
- No noise contour maps presented for temperature inversions although they are recognised in NSW Industrial Noise Policy as a significant factor in noise propagation
- Recommend: current assessment of existing noise environment be conducted, modelling be conducted for all receiver sites, including recreational sites and modelling include meteorological conditions

Sleep disturbance

- No indication of modelling procedure or proof that analysis complies with NSW Industrial Noise Policy
- Recommend: modelling must include an indication of potential sleep disturbance and effects of construction noise at all receiver sites

Review of Surface Water Assessment: Andrew Marr

Overall comments/Summary (Page 1 and 2)

- *Overall:* Review of GHD document demonstrates that information on surface water and salt balances for the proposed mine extension in that report do not adequately address the DGs requirements as they do not adequately present the volume and frequency of discharges for a range of different rainfall sequences, stages of mine development and the range of possible groundwater inflows into the mine.
- Summary for presented of water and salt balance modelling is very limited and doesn't provide adequate information regarding the model outputs. This means the assessment doesn't cover the full range of rainfall sequences and possible groundwater inflows.
- Findings on water and salt balances for year 2030 presented in the hydrogeological model: In both Scenario 1 and 2, *salt discharge from LDP001 can be expected to be much higher than represented in the report*

- The terrain in the region (steep escarpments, plateaus) would mean variation in annual rainfall and intensity-frequency-duration rainfall over short distances. This is not recognised in the report.
    - This could impact long-term rainfall averages and shorter duration rainfall intensities for the mine site
- The results in the report are not adequate to present the performance of the surface water facility over the full range of rainfall sequences and stages of mine development.
- Water and salt balance assessment only used Scenario 2 from hydrogeological modelling for all the water and salt balance modelling – Scenario 1 case should also have been modelled to account for full range of rainfall sequences/mine development stages.
- Changes to catchment hydrology and hydraulics: the studies should estimate base-flow at these locations so that base-flow can also be presented as percentage change.
- Stream geomorphology: geomorphology assessment should also consider changes in baseflow as these also have the potential to impact on stream morphology.

<u>Approach</u>

- Approach to water and salt balance modelling was to use GOLDSIM model to stimulate the operation of surface water facility – this is considered adequate. However it's rigorousness depends on"
    - Input data
    - Operating rules in the model
    - Adequacy of representation of various processes including conversion of rainfall to runoff, generation of salt loads from rainfall-run off etc.
- Issues with input data:
    - Was mostly provided by Airly Mining and the report assumes this was accurate (can't really comment on this data as we don't have it).
    - The Report should have investigated variation in rainfall patterns in the region and demonstrated that data sequences adopted from Ilford

adequately represent both the long-term rainfall averages and shorter duration rainfall intensities.

- Simulation Model:
    - Goldsim model used – essentially accounting model.
    - Simulation uses as input 112 realisations of daily rainfall from the Ilford (Warragunyah) Station – this is a reasonable approach.
    - Catchment runoff is modelled using AWDM model. Widely used model, but the Report adjusts model parameters (which are based on work from Boughton and Chiew) without a discussion of how that would impact streamflow characteristics.
    - Sensitivity analysis: sensitivity testing shows the mean discharge is relatively insensitive to the value adopted but the model was tested on data from a gauging site on the Turon River at Sofala, a much larger catchment than that in the study area. Nonetheless the model under-estimated runoff at this site by 60% showing the inaccuracy of the model.
    - Modelling of salt transfers assume that salt concentrations from catchments are constant over time and do not vary – this assumption is not substantiated
    - Output has been summarised but some information has been lost which is evident from the small amount of output from a very large quantity of input.
    - For the proposed mine extension, the report presents only simulation results for the year 2030 (see dot points on page 4 for examples).
- Presentation of simulation results
    - The results presented are not adequate to present the performance of the surface water facility over a range of rainfall sequences
    - Statistical information presented in Figure 6-4 does not allow the water balance to be verified
    - The report should provide schematics similar to Figure 6-4 showing water and salt transfers within the entire facility
    - Figure 6-4 should also be presented so as to demonstrate what happens at

various stages of mine development

DGs requirements

- Information provided on surface water and salt balances for proposed mine extension in GHD report do not adequately address DGs requirements as the report does not adequately present volume and frequency of discharges for a range of different rainfall sequences and stages of mine development.

Review of "surface water impact assessment"

- Additional information on hydrogeological modelling used to estimate groundwater in the mine is in here.
- Water and salt balance assessment here used Scenario 2 from the hydrogeological modelling for all water and salt balance modelling. Scenario 1 should also have been used.
- Sub-section 6.4.1 provides estimate of changes to baseflow at various locations downstream of the mine: changes in baseflow should be recorded in ML/y and percentages.
- Geomorphological assessment should also consider changes in baseflow and the potential impacts

Subsidence: Pells Consulting

Executive summary/general comments

- There is an inconsistency between the Clarence Colliery and Airly Mine Extension modelling as the Clarence Colliery's 2014 paper records that the predicted subsidence range is 20mm to 30 mm prior to flooding
- Suggestion that there is a Zone 6 for proposed mining zones – where there would be no mining beneath Gap Creek and Genowlan Creek where cover is less than 40m. Failure to incorporate zone 6 in the mine planning presented in the EIS is a fundamental issue that warrants re-submission of EIS.
- Hydrogeology and groundwater: significant omissions in respect to factual data relevant to assessing likely impacts on groundwater system and associated impacts on springs and baseflows to the creek system.
- There may be errors in the application of the MODFLOW 2005 software in this particular mining situation – but Pells have been unable to resolve the conflict.

- Heritage: whole assessment of impacts on Aboriginal and European heritage is premised on the statement that subsidence will be limited to 0-10 mm. The statement is not given anywhere else in the EIS and appears to be incorrect – therefore calling into question conclusions on impacts on Aboriginal and European heritage.

Subsidence and mine plan

- The Environmental Protection Zone is not given the level of protection proposed for the 'cliff zone' (part 1.3)
- Figure 1-21 provided by Pells demonstrates that there might be geometric confusion where the boundary between Zone 2 and 3 is defined both by a distance of 30m from the toe of a cliff line and an angle of >8 degrees, especially where cliff bases are not shown on contour maps (part 1.3)
- There should be a zone 6 which constitutes areas where no mining will take place on Figure 1021A (part 1.3)

Groundwater Impacts

- Access to the processed field test data was requested so that the results could be tested but the information was not provided. (part 1.4.2)
- The report does not present adopted compressibility and volumetric water content parameters in the hydrauclic conductivity values for the predictive analyses in Table 2 (part 1.4.3)
- Figure 1-27: the term "average fracturing" is misleading

Assessment and opinions in respect to subsidence and hydrogeology

- EIS documentation does not set out in detail how the predictions of subsidence are made – but Pells has relied on information given in Section 6.2 of Appendix D of the EIS
- Estimates of subsidence above the panel (50m wide) and pillar workings in Zone 5 are empirical estimates based on a very limited NSW database + numerical model from USA. There is substantial uncertainty in respect to subsidence magnitudes.
    - There is significant probability that these magnitudes could be greater than the predicted ranges

- Conclusions that there will be no impacts on pagoda structures and smaller cliff lines is based entirely on assumptions that behaviour will mimic that at Clarence colliery
- However paper published by Clarence Colliery shows subsidence range is higher
- Recommendation: Airly mine panel and pillar design should target the same surface subsidence as at Clarence – 20 – 30mm.

- The estimation of subsidence for first workings beneath the cliff lines
  - Based on elastic theory for stable pillars – this is appropriate.
    - Concerned with the conclusion that where the workings may fill with water long term, settlements could reach about 65mm with tilts between 0.6 – 1mm/m. This will likely cause joint opening and instability. This is a major problem – if this happens, then the intent of the mine plan cannot be achieved.
- Recommend that mining beneath the old oil shale mine should be limited to first workings to reduce subsidence movements and additional cracking + cliff line instability.
- Recommend incorporation of a new Zone 6 – failure to do so in a fundamental issue and warrants resubmission of EIS

Conclusion

CVEG Inc. requests that the same evaluation should apply to this proposal as did the Coalpac Consolidation Project which the Department of Planning determined should be refused because impacts on the area's conservation values would be 'unacceptable'.

Yours faithfully

Veronica Sanday

Veronica Sanday
Hon. Secretary
For the Management Committee

Attached please also find Economic Impact Assessment : Rod Campbell, Australian Institute.

Submission on the Airly Mine Extension Project EIS (State Significant Development 5581)

By Dr Haydn Washington, on behalf of the Colo Committee, October 2014
(Contact: Hon. Sec. Colo Committee, Dr Haydn Washington, haydnwashington@bigpond.com)

Introduction

The Colo Committee has been involved is assessing the biodiversity and geodiversity significance of the Airly and Genowlan mesas since 1980. We attended and made submissions to the original Mining Warden's Court and the 1993 Airly Coal Project Commission of Inquiry (Simpson, 1993) (the proponent was then Novacoal). We have since given extensive submissions on all development proposals in the area. We lobbied since the early 1980s for reservation of this area of great biodiversity and geodiversity significance, which has now been recognised through the creation of Mugii Murum-ban SCA. The author of this submission nominated both the 'Genowlan Point Heathland' Endangered Ecological Community under the TSC Act and was involved in the discovery and then nomination of the critically endangered *Pultenaea sp.* 'Genowlan Point'. The author is also the lead author of:

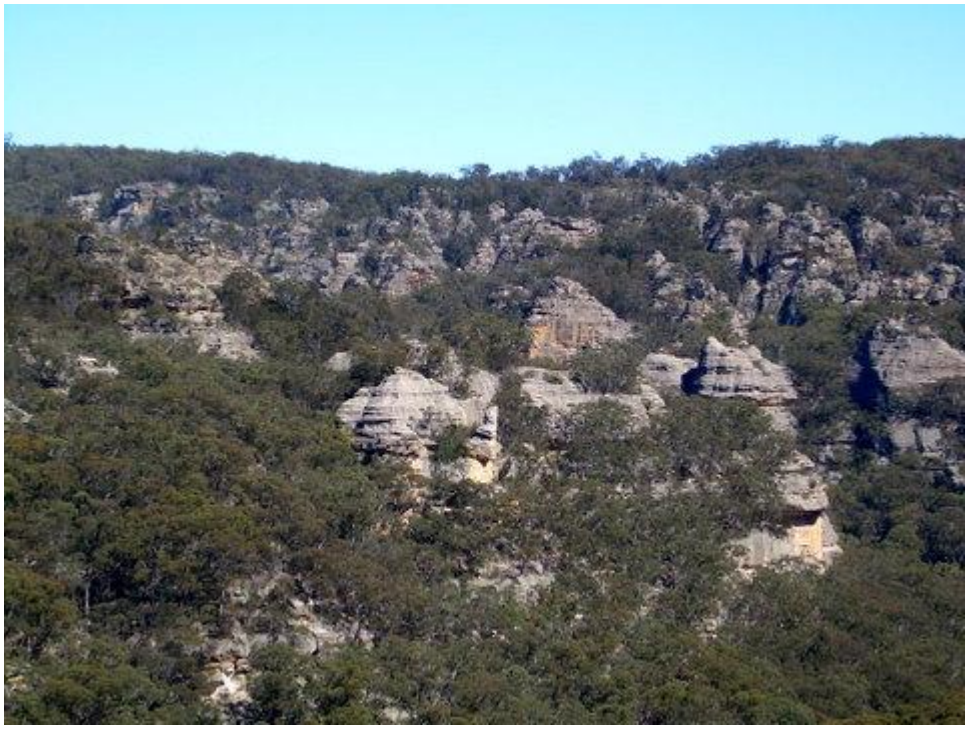
> Washington, H.G. and Wray, R.A.L. (2011). The geoheritage and geomorphology of the sandstone pagodas of the north-western Blue Mountains region (NSW). *Proceedings of the Linnean Society of New South Wales* **132**, 131-143.

This is the only peer-reviewed paper of the geodiversity significance of the 'pagoda' rock formations, and identifies the Airly and Genowlan mesas as the northern part of the pagoda heartland. This area thus has significant internationally geodiversity value. The Colo Committee (via the author) has been a member of the Subsidence Management Committee for Airly (now to be changed to a Consultative Committee). The Colo Committee has thus been involved intimately since 1980 with the research and discovery of the biodiversity and geodiversity significance of the proposal area. It can quite rightly be seen as a '***jewel in the crown***' of the whole area.

The lease proposal is immediately north of the World Heritage Area. The Greater Blue Mountains World Heritage Advisory Committee has also indicated that it would seek at a future time to *add* the Mugii Murum-ban SCA to the Greater Blue Mountains World Heritage Area once mining has completed – assuming its outstanding natural heritage values have not been damaged by mining. The author can confirm this as till recently he was a member of the Greater Blue Mountains World Heritage Advisory Committee. This area will most likely go on the National Heritage List when this is revised, certainly the World Heritage Advisory Committee recommends this. This SCA is not just of state significance but of *national significance*. Accordingly the **precautionary principle should be applied** to ensure the protection of the area and to minimise possible disturbance to the State Conservation Area.

Given the growing recognition of significance of the pagoda rock formation, and the other geodiversity and biodiversity of these mesas, the original Novacoal proposal for total extraction over most of the area (and 70% under cliffs) has been abandoned. The Colo Committee also acknowledges that Centennial Coal supported the creation of the SCA and has committed itself to a maximum of 125 mm subsidence rather than the 1.8 metre subsidence of past approvals. That is a major step forward to protect this area.

However, the Colo Committee's key concern remains the ***percentage of coal to be extracted*** under highly important pagoda and slot canyon areas and also under very high cliffs and associated very steep talus slopes that act as 'flying buttresses' to support these cliffs.



Pagodas, Genowlan Mountain

Concern regarding quality of information in the EIS

The author of this submission has been an environmental scientist for 40 years and has analysed many EIS's. This current EIS is light years ahead of the original appalling Novacoal EIS. We acknowledge the significant research undertaken to improve the knowledge of the area. However, given that Centennial in the past *verbally assured* the Colo Committee and the Colong Foundation for Wilderness that ***only 50% of coal would be mined*** under the mesas to ensure their protection, the EIS is woefully deficient in ***actually owning up to the percentage extraction*** under this area of great conservation significance. We have had to ourselves determine this percentage from comparing mine layouts for the various extraction zones. We are thus dismayed that extraction rates will be as much as **66%** under the majority of the mesas (panel and pillar zone). Such critical information should not have been *hidden* inside the EIS and breaches clarity and transparency requirements. The public has a right to know what is being proposed for this highly significant natural area. We had hoped that

Centennial would be forthcoming about percentage extraction given concerns we (and other groups) have expressed in the past on this matter, most recently in Airly Mod 3 only a few weeks ago.

A *sorry history* of impact on the Western coalfields

We also note the long and sorry history of lies about subsidence and collapse and other impacts (such as water pollution) on the Western Coalfields. Mining companies initially refused to acknowledge that longwall mining *caused* massive subsidence until it was proven to be the case by the Department of Mineral Resources. Mining companies (Centennial included) have sought to deny that full subsidence under upland swamps damages these areas (a recent report by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, IESC 2014, confirms such damage). Mining companies regularly downplay the impact of their activities on water quality and quantity (even though Centennial was fined over $1 million for this on Newnes Plateau). Mining companies regularly somehow 'fail to find' threatened species that amateur biologists trip over in quite obvious locations.

Regularly, environment groups are essentially called on to 'trust us' by mining companies. However, history has shown again and again that statements such as 'not predicted' or 'no impact' have ***proven to be false***. At that point the mining company essentially says 'oops - sorry' and seeks to blame it on natural erosion or unknown factors. In the interests of maximising their profits, mining companies *fail to employ the precautionary principle* at a level that properly protects high conservation areas such as this SCA. We believe the same process still continues in this EIS. It *looks* very comprehensive and professional (especially if one doesn't know the area and its history well). It seeks to use the strategy of most recent EISs, which is to drown the reader with masses of information in the hope that they give up and accept the proponent knows what they are talking about. However, the EIS seeks to ***hide the fact that too much coal is being extracted to ensure that significant damage does not occur to an area of national and international significance.***

Key points

1) **Subsidence**

The key failing of this proposal is its attempt to mislead the reader as to the percentage of coal to be extracted under this 'jewel in the crown' of the Capertee valley. The EIS deliberately avoids stating anywhere the percentage coal extraction under the various mining zones – **because it is too high for the safety of the SCA**. One can spend time and infer what percentage extraction will take place by consulting the mine plan layouts and looking at void and pillar widths (as we have done). This tells us:

- **Panel and pillar area** – most of mesas including pagodas, the Grotto and slot canyons such as Valley of the Kings and heathland Endangered Ecological Community – 61 metre void and 29.5 metre chain pillars so essentially ***66% of coal is being extracted***.

- **Cliff zone** – first workings only, so around **30% extraction,** but this is planned to happen even under the very high cliffs (over 100 metres) of Genowlan Pt and Pt Hatteras
- **Partial Pillar extraction zones** – depends on the depth as to how much they take off the pillar, but looks like it will range from **50-60% extraction.** From the diagrams in the EIS this is the hardest to estimate percentage extraction. This is set to happen under the steep talus slopes that act as flying buttresses to hold up the cliffs.
- **Shallow zone** – first workings so around **30% extraction.**
- **New Hartley mine zone -** panel and pillar mining so 66% coal extraction under an area that already has had subsidence.

There are **key issues** involved here, being:

1) The largest area of mining is **Panel and Pillar mining zone**, where two thirds of coal is proposed to be mined and voids are proposed to be 61 metres. This is ***wider than three cricket pitches end to end***. The commitment of only mining half the coal - given verbally by Centennial to the Colo Committee and the Colong Foundation for Wilderness when Mugii Murum-ban SCA was created has been ***abandoned***. The price of coal has dropped and Centennial is now seeking to *maximise coal extraction* under slot canyons and superb pagodas and many overhangs (e.g. Valley of the Kings on Genowlan Mountain). Centennial considered in the EIS reducing this to 50 metres wide – which had less subsidence, but settled on 61 metre wide voids *purely to maximise coal extraction*. It describes this as 'optimum' but in fact the table on p. 228 clearly shows that a 50 metre void is more optimum in having less subsidence and substantially less tilt. 66% extraction would not be considered acceptable under a water storage or under a cathedral. These mesas are 'natural cathedrals, so 66% extraction is not acceptable here either. The EIS goes to great effort to seek to downplay subsidence impacts from these 61 metre voids. However, the geodiversity of Mugii Murum-ban needs to be protected for *thousands of years*, not just the life of this mine. With two thirds extraction, a major earth tremor or mini-quake in the future could well cause major subsidence and cliff collapse. By seeking to maximise coal extraction, *Centennial has abandoned the precautionary principle* and is increasing the risk of damage to the SCA. Void widths **should be only 40 metres wide with 40 metre pillars**. P. 228 of the EIS does not consider the reduced subsidence for a 40 metre wide void but does show that a 50 metre void has less subsidence (and a lot less tilt) than the 61 metre void proposed.
2) **Cliff line zone** – where it seems 30% of coal will be extracted (p. 224) in first workings. However, the EIS notes that cliffs on the mesas can be up to **120-150 metres high**. Genowlan Point and Point Hatteras are key examples of such superb cliffs. The EIS notes (e.g. p. 245) that up to ***5% of cliff lines could be damaged*** by subsidence. It seeks to suggest that this would just be 'isolated rock falls', but this is just wishful thinking. 5% damage to these high superb cliffs is unacceptable in a SCA. It is simply ***not acceptable to mine any coal under cliffs over 50 metres in height***. If this occurs under the tip of Genowlan Point (where there is faulting and jointing) then there is a very good chance that the only known population of *Pultenaea sp. Genowlan Point*, a critically endangered species rarer than the Wollemi Pine will be destroyed as this area collapses.
3) **Partial pillar extraction zone** – which is under the very steep talus slopes that effectively act as flying buttresses to hold up the high cliffs. The EIS is even harder to comprehend in terms of percentage extraction (going on the mine layouts) and there

are two variants – ‘single sided lifts’ and ‘double sided lifts’. However it seems extraction here will be around 50% for the former and 60% for the latter. Under steep talus slopes supporting high cliffs, we feel **these areas should be first workings only** – with 30% extraction. The precautionary principle tells us that this is appropriate to ensure the long term integrity of talus slopes and the cliffs they support. The maps provided in the EIS are inaccurate but the key historic ruins seem to lie above this zone (possibly the shallow zone). These ruins are of such significance that there should only be first workings (30% extraction) under all the ruins in whatever zone they are located.

High cliffs, Genowlan Point

4) **New Hartley shale mine zone** – this proposes to extract two thirds of coal under an area that has already had subsidence due to past oil shale mining. As a result it predicts ***half a metre subsidence***. The EIS states there has been prior subsidence (estimated around 300 mm) and argues there will not be further damage (other than additional surface cracking, p. iii) caused by 500 mm subsidence. This is irrational and no proof is provided. The cliffs in this zone are *directly upslope* of the historic oil shale mining ruins. The EIS points out that there are cracks caused by the earlier subsidence and that a major rock fall occurred in 1911 (from that estimated 300 mm subsidence). With half a metre subsidence planned, this is likely to be more severe, with possible further cliff collapse that damages these nationally significant ruins. 66% extraction is clearly inappropriate under this area, which *should be limited to first workings* (30% coal extraction).

In considering the above, the statement on p. 250 that 'sensitive features' will not be impacted on cannot be seen as the truth. Significant risk remains of major damage to a superb natural area. Centennial staff drew the attention of a colleague of mine to pillars in the Clarence Colliery bord-and-pillar extraction area, where the fretting of pillars too place until a stable slope was reached, such that the top of the pillar (that supporting the roof) is narrower than the base. This process was happening during the life of the mine. This indicates the need for wider pillars (such as the 40 metres proposed here). This is reinforced by the report of Dr Pells (2014) on the Airly EIS that referred to the destabilising influence of flooded voids on pillar strength. He noted this was especially relevant to first workings under high cliff-lines. Dr Pells has also pointed out that Clarence mine was sited extensively as a model for what is proposed at Airly. He points (Pells, 2014) out that:

> *a paper published in 20147 on Clarence Colliery records that the predicted subsidence range is 20mm to 30mm prior to flooding, with the average maximum above 31 different panels since 2003 being 24mm. Given that the experience at Clarence Colliery is the basis for the Airly Extension mine design, it is my opinion that the panel and pillar design should target the same surface subsidence as at Clarence, namely 20mm to 30mm, and therefore warrants redesign.*

However, the EIS indicates that subsidence could be up to 65 mm, more than twice that at Clarence colliery. Hence why the void widths need to be decreased and the pillar widths widened (where only 50% of coal is mined) to reduce subsidence to a similar level as at Clarence. While Centennial regularly points to their record in minimal subsidence at Clarence, given its desire to maximise coal extraction it seems to be pushing coal extraction beyond the level at Clarence and hence creating greater subsidence and much greater risk. This is unacceptable under an area of such high conservation significance.

However, by reducing the amount of coal extracted by some 10-15% by the changes suggested above, the precautionary principle would be brought into play and the risk of major damage strongly reduced.

2) Historic ruins

The oil shale ruins on the side of Mt Airly are not just of state significance (on the State Heritage list) but actually of *national significance*, though the EIS attempts to downplay their

significance and to downplay any likely impact on them, despite the fact that pp. 366-373 show many good photos of this fascinating heritage. P. 374 shows that 9 sites have 'high contribution'. The conclusion of this section that the heritage of the oil shale ruins is only of local significance is a travesty. They are already on the state heritage list, so clearly the claim they are of only local significance is incorrect. The National Trust Register lists these ruins and notes:

> *The Airly township is a rare example of an abandoned mining town uncompromised by later development and the remains of the miners' houses are both technically interesting and evocative of the hardships endured by miners in these locations. The Torbane refinery was significant for its role in the development of retorting technologies in the early twentieth century and for its prototyping of retorts later used at Newnes.*

The EIS makes the claim that subsidence under historic sites will only be between 0 and 10 mm, however this does not conform with any of the subsidence figures for the mining zones and is clearly an error. It sounds good but is not supported elsewhere in the document. Extraction should be **limited to first workings** (30% extraction) only under this important heritage (though 50-60% extraction seems to be proposed on p. 375).

German bake-house, Mt Airly historic ruins

3) Flora

I am a plant ecologist by training and have done many flora surveys throughout the Greater Blue Mountains, and carried out the original flora survey for Gardens of Stone NP. Both myself and Jan Allen of Mt Tomah Botanic Gardens (an accomplished field botanist) have made many trips to Genowlan mountain. We co-discovered *Pultenaea sp.* 'Genowlan Point' and investigated the She-oak/ Grasstree heathland. I later nominated both the Pultenaea under both the TSC Act and EPBC Act and the heathland under the TSC Act as an EEC. I am thus

intimately familiar with the flora of the plateau-top. The EIS in regard to its flora and flora study is a major step up from EAs such as that for Coalpac (which missed 100 plants). However, the flora list in Appendix H misses 13 plants, being:

Astrotricha obovata (uncommon plant, found on tip of Gen Pt)
Billardieara procumbens (heathland)
Callitris rhomboidea (Gen Pt)
Cryptandra amara (heathland)
Dampiera purpurea
Gonocarpus longifolius (**ROTAP** 3RC)
Grevillea arenaria subsp arenaria (on basalt near Gen Pt)
Isopogon prostratus (uncommon plant but common in heathland)
Micromyrtus sessilis (limit of range, heathland)
Persoonia myrtilloides (heathland)
Pseudanthus divaricatissimus (**ROTAP** 3RC heathland and Gen Pt)
Pultenaea sp. 'Genowlan Point' (**critically endangered**!)
Xanthorrhoea johnsonii (limit of range, heathland)

It thus fails to record two ROTAP species found in the SCA – *Pseudanthus divaricatissimus* and *Gonocarpus longifolius*. It does record the presence of the Pagoda Daisy *Leucochrysum graminifolium* but fails to acknowledge that this is ROTAP listed 2R. There are thus **three other ROTAP listed rare plants in the SCA** that are not acknowledged. Indeed the species list actually fails to list the critically endangered *Pultenaea sp.* 'Genowlan Point' plus fails to list the presence of *Xanthorrhoea johnsonii* and *Micromyrtus sessilis* (heathland), both at the limit of their range. *Xanthorrhoea johnsonii* was identified for us by David Bedford of the Tasmanian Botanic Gardens (the expert on this genus). The EIS also failed to note the presence of the uncommon *Astrotricha obovata* (IDed by RBG) found on the tip of Genowlan Point. This uncommon plant should probably be listed as vulnerable, it is just that nobody has got around to nominating it. On the road to Genowlan Point on the small basalt section one walks through a grove of *Grevillea arenaria subsp. arenaria* (identified by Bob Makinson of the RBG for me) yet this obvious large patch of the 2-3 metre shrub is not listed. It is of interest that previously the mint bush found at Airly Turret and near Genowlan Point in some abundance was IDed by Barry Conn of the RBG as *Prostanthera howelliae*. It has been now been correctly identified in the EIS as *Prostanthera stricta* (***vulnerable***), though both the drawings in the Flora of NSW and the PlantNet website do not resemble the reality, which is why we originally sent a collection in to the RBG. This adds yet another unusual plant to the list found in this area that is a hotspot for both biodiversity and geodiversity.

Genowlan Point heathland EEC

Genowlan Mountain and Point are actually hot spots of botanic biodiversity (as well as geodiversity). The failure to find 13 plants, 3 of which are ROTAP listed and two of which are very uncommon **raises concern as to the *thoroughness* of the botanical survey**. The failure to find an obvious species – *Grevillea arenaria subsp. arenaria* adds to this concern.

4) Pagoda description inaccuracies

As the co-author of the only real paper on pagoda geomorphology (Washington and Wray, 2011), I would dispute what is stated on p. 37 of the EIS regarding pagodas in the SCA. There are ***both*** smooth and platy pagodas present, with good examples of both types. Mugii Murum-ban SCA is an excellent showcase of pagoda geodiversity. Pagodas are also regularly greater than 20 metres in height (the EIS states they only reach this height).

‘City in the Sky’ north of Genowlan Mountain trig shows both excellent smooth pagodas as well as platy pagodas.

The suggestion on p. 38 that pagodas will typically crack but that total collapse does not happen is ***not*** a rule. In fact pagodas undercut by caves or that are tilted have collapsed from subsidence in other parts of the Western coalfields. As p. 38 notes, pagodas are ‘sensitive surface features’, for this reason one does not remove two thirds of the coal in voids 61 metres wide underneath them. The plan to remove 50-60% of coal under talus slopes (depending on depth of cover in partial pillar extraction areas) is reprehensible. One can liken it to removing half the flying buttresses that hold up tall cathedral walls. The claim on p. 38 that 66% coal extraction will have no effect on talus slope vegetation is also questionable as major cliff collapse will have major effects on this community.

Well-developed ***platy pagodas*** (centre of picture) on Genowlan Mountain, looking towards start of Genowlan Point

5) Hydrology, water flow and water quality

The EIS is quite dismissive of the impact that mining will have on the permanent water supplies on the mesas. It suggests that all creeks are ephemeral. While this is mostly true, the Grotto *always* has water in our experience in the pool below the slot canyon. There are also seeps and springs on other parts of the mesas. P. iv states there will be no draw down on the Grotto or Genowlan creek (other than a 100 metre section). Again, while this sounds comforting, this is a hopeful prediction not an absolute fact. The absolute fact is that hydrology will not change if they do not mine. It may be true that if they extract only 50% of coal it may not affect hydrology, but if 66% of coal is mined under these areas as proposed, the likelihood of irreversible impact on permanent water sources in the SCA is much increased. The precautionary principle tells us to minimise risk, and this is highly appropriate in such a high conservation area. The EIS admits that the Airly village spring is likely to stop flowing (used by an adjacent owner via poly-pipe) but blithely asserts that there will otherwise be no impact. This claim has been made in the past however for many other mining proposals **where major change occurred to aquifers and water flow**. It is quite likely that the water flow to the Grotto will be decreased and ceases to be permanent. Other permanent water seeps (e.g. in cave at start of Genowlan Point) and pools in Genowlan Creek may also dry up. This will make it even harder for walkers to source water in the SCA. It is also likely to affect springs used by adjacent landowners. P. 42 states that there is a 'lack of water' on Genowlan Point. Having camped there many times, there ***is*** in fact seeps and drips for bushwalkers to use, just as Aboriginal people would have used them in the past (indeed one is near the boomerang art site).

p. iv states that there will be no measurable change in water quantity or quality in streams flowing to the world heritage area. It also notes however that flow to Airly creek in the WHA will increase by 14.5%. We are concerned that water quality into Airly creek will also decline. However, we remain unconvinced as to assurances of zero impact, given they have been made for every other mining proposal in the Western Coalfields, yet major changes in water quality and water pollution have resulted. For example, Centennial was fined over a million dollars by the Commonwealth for pollution of streams on Newnes plateau flowing to the World Heritage Area.

The current water management system is unsatisfactory as it mixes clean surface water with site runoff water and also combines these with mine effluent from the underground workings. This is a most unsatisfactory arrangement and contrary to any standard practice for water management for the last thirty five years. The arrangements are clearly illustrated on pages 100 and 101 of the EIS. Even the production bore water goes into the large dirty water dam, along with the water from the CPP. Centennial Coal does not explain its water management in section 3. Why are clean and dirty waters mixed with mine effluent in the largest storage on the site? Surely it is better to minimise the dirty water and the mine effluent, so that these waste waters can be first used as operational process water, as is proposed for runoff from the reject emplacement area. The REA water is proposed to go to the 109ML large storage dam.

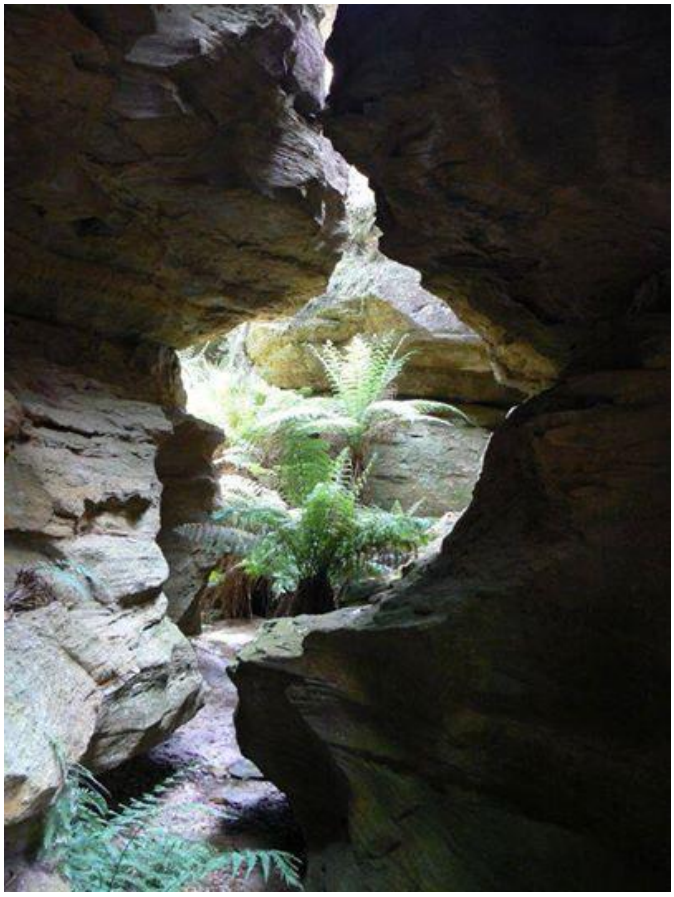
The water management plan needs to be rethought so that the dirty water is sorted SEPARATELY and used in preference for mine process water. Any overflows from these separate storages should then be diverted to the large storage dam. This would be a far better arrangement to minimise discharge of toxic water from the site, rather than risk maximising it, albeit in diluted form.

6) Failure to adequately discuss the risk of extinction to the critically endangered *Pultenaea sp.* 'Genowlan Point'

I was the co-discoverer of *Pultenaea* sp. 'Genowlan Point' (NSW 417813) and nominated it as endangered under the TSC Act and then as critically endangered under the EPBC Act. Only around 20 plants remain right on the very tip of Genowlan Point. Despite this (and the fact that the cliff below is over 120 m high), Centennial plans to extract 30% of coal under such cliffs, with some associated subsidence. Genowlan point has a fault and extensive jointing. The risk of the very end of the point collapsing is very real. Despite this, on p. 345 and 354 of the EIS it states that the proposal poses no long term risk of a decrease in the population of this EPBC listed species. This is a ***direct and blatant untruth***, as the only known population runs serious risk of being sent extinct via cliff collapse. This deception is both unprofessional and unacceptable.

7) Slot canyon misrepresentation

P. 39 states that narrow deeply incised gorges are 'quite common' throughout the Blue Mountains. This is true of gorges but quite untrue of slot canyons such as the Grotto and Valley of the kings. Slot canyons are mainly limited to the north-west edge of Wollemi NP and Gardens of Stone. The extent of slot canyons in this area is arguably of international significance (Washington and Wray 2014). The Grotto is thus not just another boring old gorge, it is a *slot canyon*, a significant landform on the national and international stage.



The Grotto – a distinctive *slot canyon* (significant on international level), not a 'common' gorge

8) Misleading greenhouse gas information

This EIS shares (with other coal EISs) a generic blindness in regard to overall greenhouse gases produced by coal mining projects – it ignores the actual burning of the coal itself! This is because it is not burnt on site. However this in effect is 'smoke and mirrors', the atmosphere and global warming does not consider such paltry distinctions. This project will produce 1.8 million tonnes of coal a year. At a carbon content of 66%, this means one tonne of coal produces 2.2 tonnes of CO_2, hence the mine will produce 4 million tonnes of CO2 a year while in production. Australia's annual emissions of CO_2 (from the March Quarterly update for 2014) are 542 million tonnes of CO_2. The Airly mine CO_2 production is thus **0.73% of total Australian emissions** – a considerable addition to global warming and climate change. This is the realistic comparison of the climate impact of the proposed mine, not the 0.002% stated on p. 432, produced by using the smoke and mirrors of the scope 1-3 methodology that ignores the burning of the coal if it is off site. The fact remains that this proposal is a significant greenhouse gas producer that will accelerate climate change, while Australia is a country that is very much at risk from climate change. To avoid runaway climate change, most of our remaining fossil fuels *need to be kept in the ground*, as noted by over 98% of climate scientists and most Academies of Sciences around the world.

Other points

Fauna

The Colo Committee has seen a breeding pair of the threatened **Peregrine Falcon** on Genowlan Point but these are not listed in the EIS.

World Heritage Area

p. 349 of the EIS downplays the impact of the proposal on the Greater Blue Mountains World Heritage Area. It fails to note however that the GBMWH Advisory Committee has identified Mugii Murum-ban SCA as an area that ***should be added*** to the WHA once mining ceases – provided that mining has not damaged the biodiversity and geodiversity of the SCA.

Missed Aboriginal art site

We question the thoroughness of the archaeological study, since if failed to identify an art site on the creek that runs up to Airly Turret from the stone cottage. This has charcoal animal drawings, which (while faint) are still visible. See below for charcoal outline of a tortoise there.

Inaccuracy re diamond mining

This was carried out on Airly Turret not Genowlan mountain. While Airly Turret is in fact on the Genowlan mesa and not the Airly mesa, nevertheless, the headwaters of Genowlan Ck separate it from the rest of Genowlan mountain, and it has a different name.

Conclusion and recommendations

This proposal is for mining under one of the most significant spots of natural heritage in NSW, an area of high biodiversity and geodiversity significance. That is why it is a State Conservation Area, that is why the Greater Blue Mountains World Heritage Area Advisory Committee would like to add the area the World Heritage Area in the future (if this mining proposal does not damage it). Let us be sure of what is at stake here – the 'jewel in the crown' of the Capertee Valley is at risk of significant degradation.

The key issue to be considered in this EIS should have been stated honestly up front – the percentage of coal to be extracted in the different mining zones. Instead, Centennial has sought to ***hide this percentage***. Why? Because if it was up front it would have to admit that it was breaking the commitment made to community groups such as the Colo Committee and the Colong Foundation for Wilderness in the past – that only 50% of coal would be mined. Instead, any reader of the EIS has to look at the mining layouts to discover that under most of this superb area 66% of coal is to be mined, leaving 61 metre voids (three times the length of a cricket pitch) below this superb area. We are expected to believe that this is *safe for all time,* not just for the 20 year life of the mine. We are asked to believe that with two thirds of the coal removed and huge voids under this special place, that a future earth tremor or small earthquake will not then bring down cliffs and pagodas and slot canyons and significantly damage the surface of the SCA. Many of us in the Colo Committee are scientists, ***we do not accept such assurances***, given the failure of similar assurances over more than three decades on the Western coalfields. This EIS proposes too great an extraction of coal in the interests of Centennial making a greater profit. The price of coal has dropped since the original promise of taking only half the coal. Accordingly, the EIS now ignores the precautionary principle and puts at risk both a critically endangered species (*Pultenaea sp.* 'Genowlan Point'), and Endangered Ecological Community, areas of internationally significant pagodas and slot canyons and high cliffs that are a *major tourist attraction* for those that visit the area. It puts the SCA itself of risk of major degradation.

Yet it doesn't have to. Centennial could return to its earlier promise to only mine half the coal under the SCA. The precautionary principle could be applied and less coal would be extracted under the area. The Colo Committee does not oppose all coal mining under the SCA, just the current escalation of coal extraction that has substantially increased the risk of subsidence and cliff collapse. Hence **our recommendations** are:

- Cliffs over 50 metres in height should have **no coal extraction under them**, even 'first workings' that remove 30% of coal. This would protect the high cliffs of Genowlan Point and the critically endangered Pultenaea and the heathland EEC, plus protect the high cliffs of Point Hatteras and Mt Airly.
- Reduce coal extraction to **50% in the pillar and panel zone** so that voids are 40 metres wide with 40 metre pillars to ensure *long term protection* of the surface of Mugii Murum-ban SCA (and its high conservation biodiversity and geodiversity)
- Reduce coal extraction on the steep **talus slopes to first workings only** – 30% extraction, not the extraction of 50-60% proposed in the EIS for the partial pillar extraction zone.

- Reduce coal extraction to **first workings (30%) in the New Hartley mine zone** to minimise further subsidence that could cause cliff collapses to damage the significant historic oil shale ruins.

These recommendations may well reduce coal extraction by 10-15% overall. However they would allow a *much safer coal project* that would not run the risk of significantly damaging this superb State Conservation Area. The Colo Committee believes that if coal mining cannot be done in a 'safe way' that ensures the long term protection of the SCA, then it should not proceed. We urge the State government to ensure that if the mine is approved it is only approved with the above safeguards to protect this 'jewel in the crown' of NSW's natural heritage. Public opinion, local opinion, and the regard of future generations of Australians requires we get it right to protect Mugii Murum-ban SCA. The current proposal fails in this by *abandoning the precautionary principle* in the interests of maximising coal extraction. However it is the responsibility of the Department of Planning to ensure under the objects of the EP&A Act that ***the precautionary principle is upheld***. The recommendations above ensure that this is the case and we urge the Department to amend the proposal accordingly.

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Review of Noise Management, Section 10.5 of Airly Mine Extension EIS.

This report reviews the SLR Noise and Vibration Impact report that is found in Appendix K of the Airly Mine Extension Project – E.I.S. Chapter 10.
The Noise and Vibration report assesses the following;
Operational Noise
Potential Sleep Disturbance

General Comment

The NSW Industrial Noise Policy mandates long term measurement of the existing background noise for industrial developments or extractive industries (NSW INP Table 3.1). Several of the noise assessment criteria are levels expressed relative to the Rating Background Level. SLR base their assessment of the existing noise environment on long-term measurements taken in 2009. They state that there have been subsequent compliance measurements, conducted on an annual basis (Appendix K, Sect. 6.1) but there is no data presented from these measurements. As such SLR's assertion that the existing noise environment may be assumed to be the same as it was five years ago is rather contestable. It is difficult to properly respond to the SLR report where all assessment is being conducted against old data. Nonetheless the following comments are made in light of that.
It should also be noted that the quiet recreation sites at the Airly Gap camp ground and the Nissen Hut on Glenowlan Mountain are not indicated in any of the noise modeling provided by SLR. It is astounding that the assessment criteria for such sites of "contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation" is set significantly higher than a school classroom (35dB(A)) or a place of worship (40dB(A)) (NSW INP, Table 2.1). Nonetheless the recommended maximum level, established by the NSW INP (p16) is 55dB(A). SLR report the maximum level as 60dB(A). This appears to be an error.

Operational Noise

SoundPlan 3D modeling software has been used to predict the noise emanating from the proposed mine. The version used is 7.1 which was released in 2011. It is unclear whether SLR are using an old version of Soundplan or the modeling, like the background noise measurements, were conducted in the past.
The modeling is conducted on three scenarios; existing mine operations without reject emplacement activity, approved mine operations with REA1 operating, approved mine operations with REA2 operating.
The SLR report states that the noise levels predicted in the models indicate that all residential locations will experience noise levels below the noise intrusion criteria (Appendix K, p43) yet reference to Figures 7 and 8 show the residence 2 will experience levels of 35 – 40dBA with REA1 or 2 operating. Reference to Table 24 shows that this is above the Project Specific Noise Criteria. Further to that there are no noise contour maps presented for temperature inversions. Temperature inversions are recognised in the NSW Industrial Noise Policy as a

significant factor in noise propagation, causing an increase in noise of up to 20dB (NSW INP Sect. 5.1). Modeling of meteorological conditions such as inversion layers is available in SoundPlan and should be included in the Acoustic Report.

Recommendation: A current assessment of the existing noise environment be conducted, modeling be conducted for all receiver sites, including the recreational sites and the modeling include meteorological conditions.

Potential Sleep Disturbance and Construction Noise

The analysis provided in section 10.4 and 12.2 of the SLR report states that the development complies with the requirements of the NSW Industrial Noise Policy yet there is little evidence to confirm that. Where modeling has been used there should be some indication of the modeling procedure. In this case it appears that SoundPlan has been used to model the noise effects. This package is capable of calculating and mapping sleep disturbance yet this information has not been provided.

Recommendation: In addition to the modeling outlined above, the modeling must include an indication of potential sleep disturbanceand effects of construction noise at all receiver sites.

John Bassett
PhD (Sydney) MAAS, MASA

AIRLY MINE EXTENSION PROJECT

REVIEW OF SURFACE WATER ASSESSMENT

prepared by Andrew Marr, October 2014

EXECUTIVE SUMMARY

The approach is considered adequate to allow assessment of the performance of the facility for a range of mine operating conditions over the proposed life of the mine and for a range of rainfall sequences, however the summary presented of the water and salt balance modelling is very limited and does not provide adequate information regarding the model outputs to allow assessment of surface water impacts over the full range of rainfall sequences and possible groundwater inflows to the mine.

The report presents in detail the water and salt balances for year 2030 assuming groundwater make into the mine based on Scenario 2 (average fracturing) in the hydrogeological model. While this represents the maximum groundwater make considered likely, and therefore the maximum discharge from LDP001, it also represents the minimum usage of the production bore and the minimum salt input into the system. The production bore will be used much more at the start of mine operation when groundwater make will be negligible. It will also be used more under Scenario 1 hydro-geological modelling. In both these cases, salt discharge from LDP001 can be expected to be much higher than presented in the report.

Other concerns with the assessment are:

As the terrain in the region is quite variable, with high plateaus, steep escarpments and broad valleys, it is likely that there are significant differences in annual rainfalls and intensity-frequency-duration rainfall characteristics over quite short distances depending on altitude and exposure. The report should have investigated the rainfall patterns in the region and demonstrated that the data sequences adopted from Ilford (Warragunyah) adequately represent both the long term rainfall averages and the shorter-duration rainfall intensities for the mine site.

The Simulation Model adapts key parameters to local conditions but there is no discussion of the effect of the changes in parameters on the stream flow characteristics so it is not possible to assess if the changes made to the parameters are appropriate. Testing of the model against data from the Turon River at Sofala demonstrates the relative inaccuracy of the model in this situation.

The statistical information presented in Figure 6-4 does not allow the water balance to be verified for the 10% and 90% excedence cases. In summary, the results presented in the report are not adequate to present the performance of the surface water facility over the full range of rainfall sequences and stages of mine development.

The water and salt balance assessment used Scenario 2 from the hydrogeological modelling for all the water and salt balance modelling. Scenario 1 case should also be modelled in Goldsim to assess the impact on salt and water balances of this reduction in groundwater make for the full range of rainfall sequences and mine development stages.

In assessing changes to the catchment hydrology and hydraulics (sub-section 6.4.1), the report provides an estimate of changes to baseflow at various locations downstream of the mine site. The studies should attempt to estimate baseflow at these locations so that changes in baseflow can also be presented as percentage change.

When commenting on impacts on stream geomorphology (sub-Section 7.7), the report states that there will be negligible impact due to the minimal subsidence from mining. The geormophological assessment should also consider changes in baseflow as these also have the potential to impact on stream morphology.

Based on the review of the GHD document, it is considered that the information on surface water and salt balances for the proposed mine extension provided in the GHD report do not adequately address the Director General's requirements in that the report does not adequately present the volume and frequency of discharges for a range of different rainfall sequences, stages of mine development and the range of possible groundwater inflows into the mine.

INTRODUCTION

The review of the documents relating to surface water issues for the proposed Airly Mine Extension is reported in this document. The review aimed to assess and comment on the following:

- The approach adopted
- The data used
- Modelling and analysis
- Presentation of results
- Validity of any conclusions included in the report
- Adequacy of the studies to address the terms of reference provided by DG.

The review did not examine all the details of the studies associated with surface water issues, and did not access the data used as inputs or seek out any other data that may be relevant.

The surface water issues are discussed at numerous locations in the various EIS documents. The key study, however, is covered by the document titled "Airly Mine Extension Project – Water and Salt Balance Assessment" (GHD July 2014) which presents a detailed assessment that is subsequently referenced elsewhere. This review does not comment on the sections of the reports that describe Existing and Approved conditions. It is considered that these sections are not directly relevant to the proposed mine extension.

The GHD 2014 document describes in detail the inputs, outputs and internal water and salt transfer rules that have been incorporated into the Goldsim model to simulate the water and salt balances of the proposed project, and summarises the outputs of the Goldsim modelling.

APPROACH

The approach adopted to the assessment of the water and salt balance is to use the GOLDSIM model to simulate the operation of the surface water facility at a daily time step over a period equal to the design life of the proposed mine extension, for a range of rainfall sequences based on historical daily rainfall records. This is considered adequate to allow assessment of the performance of the facility

for a range of mine operating conditions over the proposed life of the mine and for a range of rainfall sequences.

The reliability of the output of the simulation depends on:

- the reliability and appropriateness of the input data
- whether the operating rules incorporated into the model realistically represent the future operating procedures that will be adopted, and
- the adequacy of the representation of various processes including the conversion of rainfall to runoff, the generation of salt loads from the rainfall-runoff and mining processes, and the entrainment of water and salt in the mine products including the coal products and rejects.

INPUT DATA

Most of the input data required for the Goldsim model was provided by Airly Mining. This included physical characteristics of the components of the system as well as operating rules to be adopted. The report assumes these inputs are reliable, although it mentions that the area-capacity tables for some storages could improve in accuracy as additional terrestrial survey becomes available. It is not possible to comment on the data supplied by Airly Mining.

The key inputs that were not supplied by Airly Mining were the rainfall sequences to be used in the rainfall-runoff simulations, and the model and associated parameters to be adopted to convert daily rainfall to runoff for the various catchments.

According to the report: "Daily rainfall data was obtained as SILO Patched Point Data from the Queensland Climate Change Centre of Excellence. SILO Patched Point Data is based on historical data from a particular Bureau of Meteorology (BOM) station with missing data 'patched in' by interpolating with data from nearby stations. For this assessment, SILO data was obtained for BOM Ilford (Warrangunyah) Station (station number 62031), which is located approximately 29 km north-west of Airly Mine. This station was chosen based on the length and quality of the data record and proximity to the site."

GHD used a daily rainfall sequence from January 1901 to December 2012 for simulations. GHD performed some comparisons with data closer to the site and concluded that the record was appropriate for the simulation. As the terrain in the region is quite variable, with high plateaus, steep escarpments and broad valleys, it is likely that there are significant differences in annual rainfalls and intensity-frequency-duration rainfall characteristics over quite short distances depending on altitude and exposure. The report should have investigated the rainfall patterns in the region and demonstrated that the data sequences adopted from Ilford (Warragunyah) adequately represent both the long term rainfall averages and the shorter-duration rainfall intensities for the mine site.

SIMULATION MODEL

The Goldsim model used in the study is essentially an accounting model that simulates the operation of the water management facilities at a daily time step over the life of the mine (25 years). In order to represent variations in rainfall over time, the simulation uses as input 112 realisations of daily rainfall from the Ilford (Warragunyah) sequence. From the report it appears that the first realisation

simulated is from 01 January 1901 to 31 December 1925, the second realisation is from 01 January 1902 to 31 December 1926, etc. The record from 01 January 1901 to 31 December 1924 is added after 31 December 2012 so that 112 realisations each of 25 years duration can be obtained from the 112 years of record. This is a reasonable approach that allows any exceptionally wet or dry periods in the last 24 years of record to be included in the modelling.

Runoff from the catchments is modelled using the AWBM model. This is a widely used model for this type of application, although the model parameters need to be selected based on calibration against historical records or on the basis of the physical features of the catchments. The report provides a basis for the selection of model parameters based on work by Boughton and Chiew (2003), but then adjusts the parameters to better reproduce the "ephemeral" characteristics of the streams at the mine site. There is no discussion of the effect of the changes in parameters on the streamflow characteristics so it is not possible to assess if the changes made to the parameters are appropriate. Annexure B presents the results of sensitivity analysis of the average surface storage capacity parameter in the AWBM model, the only parameter that is normally adjusted in model calibration (other parameters are estimated from catchment characteristics). The sensitivity testing shows that the mean discharge is relatively insensitive to the value adopted. However, the model was tested on data from a gauging site on the Turon River at Sofala, a much larger catchment than those in the study. Even so, the model under-estimated runoff at this site by 60%. This illustrates the relative inaccuracy of the model in this situation.

Modelling of the salt transfers assumes that salt concentrations from catchments are constant over time and do not vary with discharge. No basis is given for this assumption. Also, it is assumed that the concentration of salt in all storages is uniform across the storage. While this a reasonable simplification for relatively small storages, there is no attempt to assess the possible impact of this assumption on system performance.

The output files from the multiple simulations must be very large and contain a huge amount of detail. It is obviously necessary to summarise the output to provide a basis for assessment of the project, however, information is lost in the process of summarising the output. It is important that the information provided in the summary is adequate for the purpose of assessing the project and provides an unbiased view of the simulation outputs. The report has presented a small amount of output from the very large quantity of simulation outputs. For the proposed mine extension, the report presents only simulation results for the year 2030 (expected to be the year with the maximum gain of groundwater from the mine):

- In Figure 6-4, the report presents for all locations only the annual average discharge and salt transfer, and the annual discharge and salt transfer that are exceeded in 10% of the realisations and in 90% of the realisations
- In Figure 6-5, the report presents daily discharges at LDP001 plotted as percentile of time exceeded
- In the text, overflow discharges from the REA facility at the Proposed LDP presented show that the mean is only 0.5 ML/y, that the discharge is zero for at least 90% of realisations and that there was one discharge of 31 ML as a result of a 5-day rainfall event that explains 0.28 ML/y of the 0.5 ML/y average discharge

- Discharges from LDP002 and LDP003 are presented as zero on the basis that pumps will be upgraded although the capacity upgrade required has not been specified.

PRESENTATION OF SIMULATION RESULTS

The statistical information presented in Figure 6-4 does not allow the water balance to be verified. The discharges and salt transfers for the 10% and 90% exceedence realisations may results from different realisations for each of the locations. For example, the 10% exceedence discharge from the 7 ML dam to the 109 ML Dirty Water Dam may be for realisation number 25, while the 10% exceedence discharge from the 109 ML Dirty Water Dam to the 35 ML Discharge Dam may be for realisation number 99. Therefore, there will not generally be a balance for each node or for the entire system, so it is not possible to check the overall water balance for the 10% and 90% exceedence cases.

The report should provide schematics similar to Figure 6-4 showing water and salt transfers within the entire facility for specific realisations, such as the realisations that give the 10% and 90% exceedence discharges at LDP001. Similar schematics should be presented showing daily water and salt transfers for the 1%, 10%, 50%, 90% and 99% exceedence daily discharges at LDP001.

The report should also present schematics similar to Figure 6-4 that show what happens at various stages of mine development. In the early years, for example, groundwater gain from the mine is small so there may be greater use of bore water, with resulting increases in salt transfers and discharges.

In summary, the results presented in the report are not adequate to present the performance of the surface water facility over a range of rainfall sequences and stages of mine development. The information is generated by the simulation model, but there is inadequate detail provided in the summaries presented.

DIRECTOR GENERAL'S REQUIREMENTS

The Director General's requirements relating to the water and salt balance assessment are presented in the GHD report as follows:

> "A detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any discharges), water supply infrastructure and water storage structures."

Based on the review of the GHD document, it is considered that the information on surface water and salt balances for the proposed mine extension provided in the GHD report do not adequately address the Director General's requirements in that the report does not adequately present the volume and frequency of discharges for a range of different rainfall sequences and stages of mine development.

REVIEW OF "WESTERN COALFIELD WATER AND SALT BALANCE" (GHD February 2014)

This document presents water and salt balance studies for numerous mines in the western coalfield (which includes the proposed Airly Mine Extension), as well as for the Wallerawang and Mount Piper Power Stations. There is no additional information in this document relating to the Proposed Airly

Mine Extension compared to the more detailed study described in "Airly Mine Extension Project – Water and Salt Balance Assessment" (GHD July 2014), which states in the Executive Summary that "there are no other developments which need to be considered contributing to the cumulative impact of the Project in relation to surface water."

REVIEW OF "SURFACE WATER IMPACT ASSESSMENT" (GHD July 2014)

This report repeats the main elements of the report "Airly Mine Extension Project – Water and Salt Balance Assessment" (GHD July 2014), then provides additional information and analysis. Comments are provided here on the additional information and analysis only.

It is noted that this report provides additional information on the hydro-geological modelling used to estimate groundwater make in the mine. The water and salt balance assessment used Scenario 2 from the hydrogeological modelling for all the water and salt balance modelling. The "Surface Water Impact Assessment Report" states in sub-section 6.3.1 (p89) that Scenario 2 (average fracturing) is considered "the most likely based on the mine design." However, it notes that considerably less inflow is predicted under Scenario 1, peaking at 23 ML/y rather than 180 ML/y for Scenario 2. This Scenario 1 case should also be modelled in Goldsim to assess the impact on salt and water balances of this reduction in groundwater make for the full range of rainfall sequences and mine development stages. A significant increase in salt inputs to the water facilities can be expected under this scenario due to increased use of the production bore which has a salinity of 4,630 microSiemens/cm compared to only 900 microSiemens/cm for the groundwater make. This is likely to increase salt discharges from the mine site.

In assessing changes to the catchment hydrology and hydraulics (sub-section 6.4.1), the report provides an estimate of changes to baseflow at various locations downstream of the mine site. The table provides estimates for three cases – Existing, Scenario 1 and Scenario 2 (where Scenario 1 and Scenario 2 apparently refer to the hydrogeological modelling). Changes in baseflow for these three cases are expressed in terms of ML/y. The last column in this table shows estimated changes in "total annual flow" at the locations expressed as percentage of flow. The table should also show the estimated percentage change in baseflow at each location. The studies should attempt to estimate baseflow at these locations as a basis for assessing the impacts of changes in baseflow. It is possible that much of the baseflow at locations further down the catchments originates in the steeper upper reaches of the stream systems rather than further down the systems, and that any change in baseflow from these upper reaches will significantly impact baseflow further downstream.

When commenting on impacts on stream geomorphology (sub-Section 7.7), the report states that there will be negligible impact due to the minimal subsidence from mining. The geormophological assessment should also consider changes in baseflow as these also have the potential to impact on stream morphology.

ABN 74 978 620 434
Phone: 02 4381 2125
Fax: 02 4381 2126
The Old Post Office
49 Lakeside Drive
MacMasters Beach NSW 2251
www.pellsconsulting.com.au

Our Ref: M2.R1

23 October 2014

EDO NSW
Level 5, 263 Clarence Street
SYDNEY NSW 2000

Attention: Megan Kessler

Dear Ms Kessler

AIRLY MINE EXTENSION - EIS

Enclosed herewith is an expert report by the undersigned in respect to subsidence and groundwater impacts set out in the EIS for the Airly Mine extension.

Yours faithfully

PHILIP PELLS
FTSE BSc(Eng) MSc(Eng) DSc DIC FIEAust MASCE

CONTENTS

EXECUTIVE SUMMARY OF FINDINGS

General

The intent of mine planning as set out in the EIS is to limit surface subsidence movements to quantities that will not cause instability of the cliff lines and pagoda structures, damage to Aboriginal and European heritage and impacts to the groundwater system that would lead to reduction in baseflows to the creeks above the mining area. In this regard, mine planning is built on the experience by Centennial Coal at the Clarence Colliery. In principle, this approach is appropriate but as set out in this report 'the devil is in the detail'.

A paper published in 2014 on Clarence Colliery records that the predicted subsidence range is 20mm to 30mm prior to flooding, with the average maximum above 31 different panels since 2003 being 24mm. These subsidence movements are significantly less than proposed for the Airly Mine in all areas other than first workings. Therefore, there appears to be an inconsistency between the Clarence Colliery model and the application at Airly.

Subsidence and Mine Planning

Centennial have planned future mining around 5 defined zones, namely:

Zone 1:

- Termed the "**Shallow Zone**", where there is low cover and only first workings using bord and pillar methods are proposed.
- Predicted maximum subsidence = **26mm**.

Zone 2:

- Termed "**Partial Pillar Extraction Zone**", located between the "Shallow Zone" and a postulated line where cliffs could be affected.
- Predicted maximum subsidence = **65mm**.

Zone 3:

- A zonal footprint beneath **cliff lines** where only first workings would be employed.
- Predicted maximum subsidence = **65mm**.

Zone 4:

- The footprint of the **old oil shale mine workings** where extraction of coal beneath the level of the oil shale workings would interact with those workings.
- Predicted maximum subsidence = **200 to 500mm**.

Zone 5:

- Beneath the **plateau areas** involving panel and pillar extraction.
- Predicted maximum subsidence = **106mm**.

However in the Executive Summary of Appendix E (Groundwater) there is a statement that "*there is no mining beneath Gap Creek and Genowlan Creek (and to a distance of 20m from the creeks) where the depth of cover is less than 40m".*

In effect this constitutes Zone 6 to the mine plan which is not dealt with elsewhere in the EIS. According to the writer's interpretation, this constraint of no mining beneath Gap and Genowlan Creeks where the cover is less than 40m, effectively breaks the mining area into a western and eastern part with a major constraint on the connection of these two parts. In addition, this constraint means that the mine plan proposed by Centennial Coal in June 2004 ("Extension of Time") is physically impossible.

In respect to the proposed mining zones, which are defined according subsidence movements, the writer concludes as follows:

- Zone 1: Acceptable as is.

- Zone 2: This mining zone constitutes a relatively small proportion of the mine area. Therefore given the uncertainty in respect to the subsidence movements, and the very adverse consequences of cliff line instability, it would appear to be wise and appropriate to eliminate this mining zone. In this case, first workings would be adopted from the low cover area through to the plateau area.

- Zone 3: The design is considered appropriate provided it is not possible that the workings in this zone can become flooded in the long term. If flooding can occur the expected subsidence and surface tilts are greater than are acceptable for safe guarding the cliff line and pagoda structures.

- Zone 4: It is predicted that new surface subsidence will be in the range 200mm to 500mm with tilts up to 17mm per metre. It is certain that such subsidence movements will cause substantial additional cracking in the surface area above the old workings and will cause cliff line instability in the escarpments around the perimeter of the old workings. In my opinion, this level of surface damage should be unacceptable to Government authorities. It is my opinion that mining beneath the old oil shale mine should be limited to first workings.

- Zone 5: Given that the experience at Clarence Colliery is the basis for the Airly Extension mine design, it is my opinion that the panel and pillar design should target the same surface subsidence as at Clarence, namely 20mm to 30mm.

- Zone 6: I have drawn attention to the fact that Appendix E of the EIS states there would be no mining beneath Gap Creek and Genowlan Creek where cover is less than 40m. In my opinion, failure to incorporate Zone 6 in the mine planning presented in the EIS is a fundamental issue that warrants re-submission of the EIS.

Hydrogeology and Groundwater

As set out in Section 2.2 of this report, there are significant omissions in respect to factual data relevant to assessing likely impacts on the groundwater system, and associated impacts on springs and baseflows to the creek system above the mining area. These relate particularly to details of existing piezometer monitoring and details of permeability measurements which are the key part of the predictive groundwater modelling.

A greater concern is that the results of the groundwater modelling using the software MODFLOW 2005 are counterintuitive in terms of groundwater physics. In an attempt to check the predictions made by the groundwater model using alternative software we have concluded that there may be errors in the application of the MODFLOW 2005 software in this particular mining situation. Given that we cannot access the full details of the 3D model described in Appendix E. We have been unable to resolve the conflict. However, it is a conflict of such significance that the likely impacts of the mine on the groundwater system cannot properly be assessed on the available information.

Heritage

The whole assessment of impacts on Aboriginal and European heritage is premised on the statement that subsidence will be limited to between 0 and 10 millimetres. This statement is given nowhere else in the EIS and appears not to be true. This must call into question the conclusions in regard to impacts on Aboriginal and European heritage.

INTRODUCTION

In accordance with a letter from the EDO NSW of 8 October 2014, this report by Dr Philip Pells presents an assessment of subsidence and hydrogeological impacts presented in the Environmental Impact Statement (the **EIS**) for the Airly Mine Extension Project.

I have read the documentation termed Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 (NSW), have prepared this report in accordance with those rules, and agree to be bound by those rules in this matter. My curriculum vitae is given in Appendix A.

The documentation I have relied upon in preparing this report is listed in Appendix B.

I note that the mine operates under DA 162/91 granted on 14 April 1993. That DA allowed for a mine layout and associated subsidence different to that proposed in the EIS. I note that in many places in the EIS reference is made to the 'Approved Conditions' as opposed to the 'Proposed Conditions' (see for example, the Executive Summary in Appendix E of the EIS). I make no comment in this report on the so-called 'Approved Conditions'. I only provide comment on the 'Proposed Conditions'.

This report is in two parts. Part 1 is a summary of the main facts, calculations and designs within the EIS germane to subsidence and hydrogeology. Part 2 presents my assessment and opinions in relation to those matters.

PART 1 – SUMMARY OF RELEVANT PARTS OF THE EIS GERMANE TO SUBSIDENCE AND HYDROGEOLOGY

1.1 LOCATION AND LAYOUT

The area of the mine is succinctly described by Joseph Carne (1903) in Memoir 3 of the Geology Survey of NSW, viz:

> *"Airly and Genowlan, or Morindurey, Mountains consist of an isolated mass of productive Permo-Carboniferous strata, surmounted by exceedingly bold and fantastic sandstone escarpments of the Hawkesbury Series*[1]*. The main branch of Genowlan Creek divides the latter into the irregular summits known collectively as Airly and Genowlan Mountains."*

Figure 1-1 gives an overview of the topography and shows the major creek systems and existing mine workings. Figure 1-2 gives contours of depth to the coal seam which is to be worked in the Airly Mine Extension Project[2].

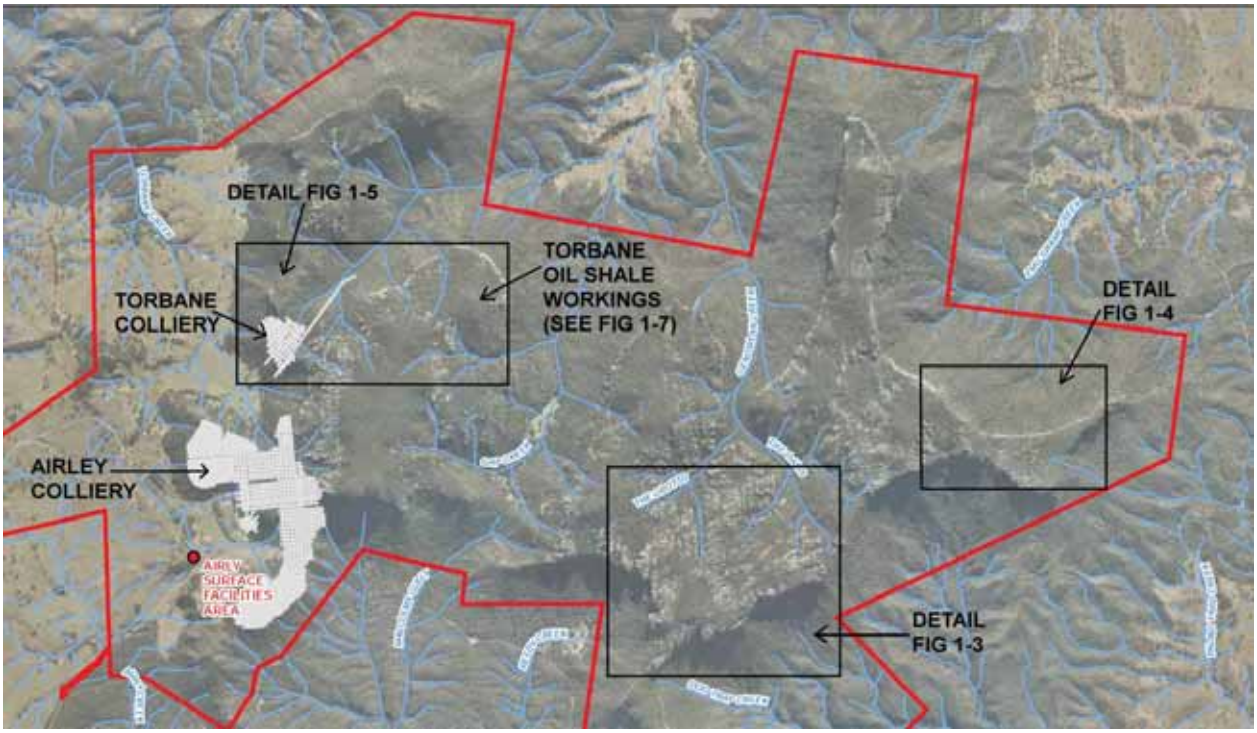

Figure 1-1: Aerial photograph showing topography and existing mines.

[1] We now know that the sandstone escarpments are Burra-Moko Sandstone that forms the cliffs at Govetts Leap near Blackheath.

[2] According to the EIS this is the Lithgow Seam. However, work by Bayly (38th Symposium on Advances in the Study of the Sydney Basin, 2012) indicates the seam is more properly described as the Lidsdale Seam.

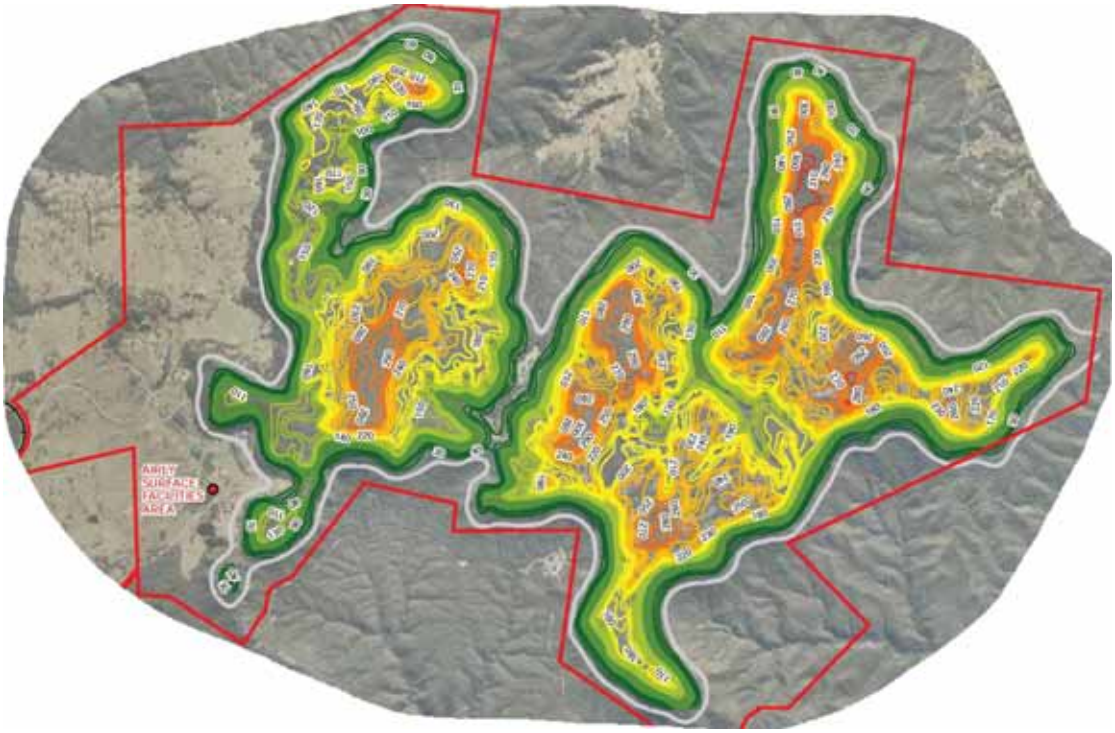

Figure 1-2: Contours of depth to the Lithgow Seam, which is the seam worked in Airly Colliery.

The “fantastic sandstone escarpments’ of Joseph Carne are shown in more detail in Figures 1-3 to 1-5.

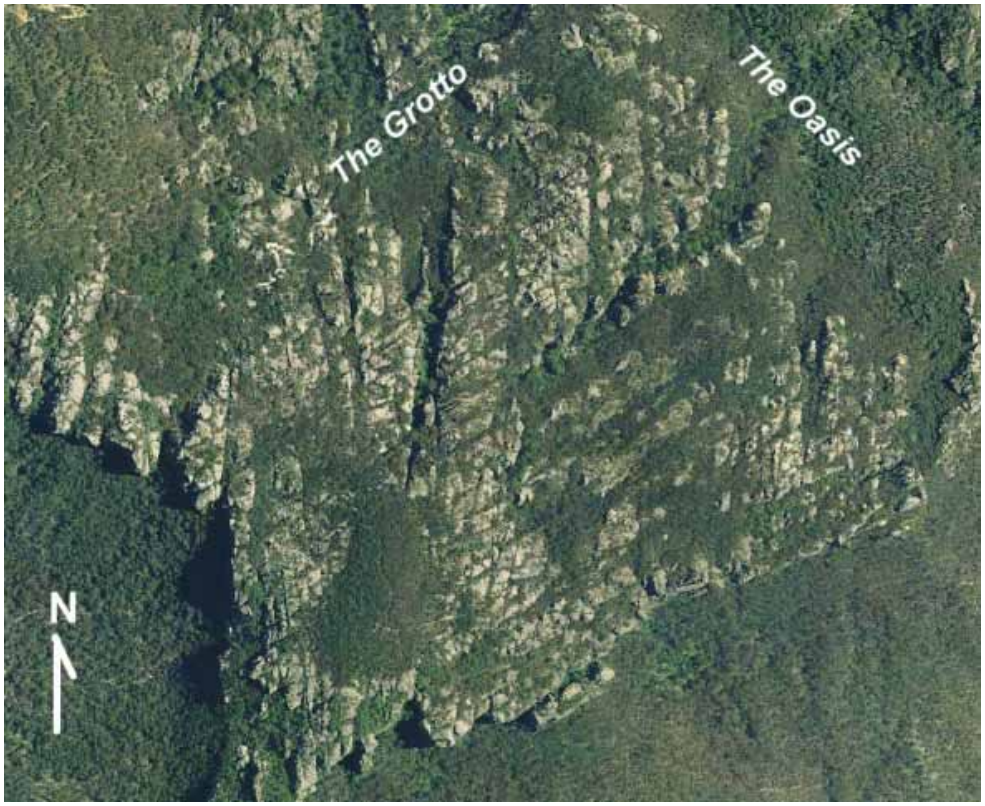

Figure 1-3: Southern area of plateau, showing well developed jointing in sandstone, and two important environmental locations.

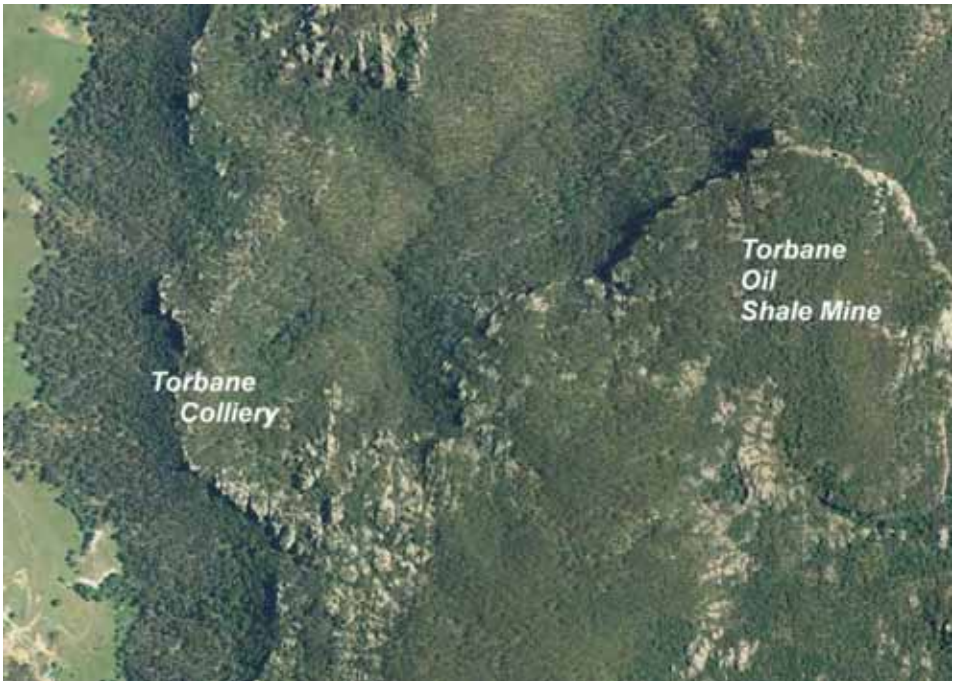

Figure 1-4: Area above the old Torbane workings. The Torbane Colliery was in the Lithgow Seam. The oil shale mine was higher in the stratigraphic sequence.

Figure 1-5: Airly Turret view NE. Note overhanging cliffs and numerous pagoda structures (photo: Brian Fox).

Figure 1-6 is Carne's map of the torbanite mines as of 1903. The mine plan of the old Torbane and Genowlan oil shale (torbanite) workings is given in Figure 1-7.

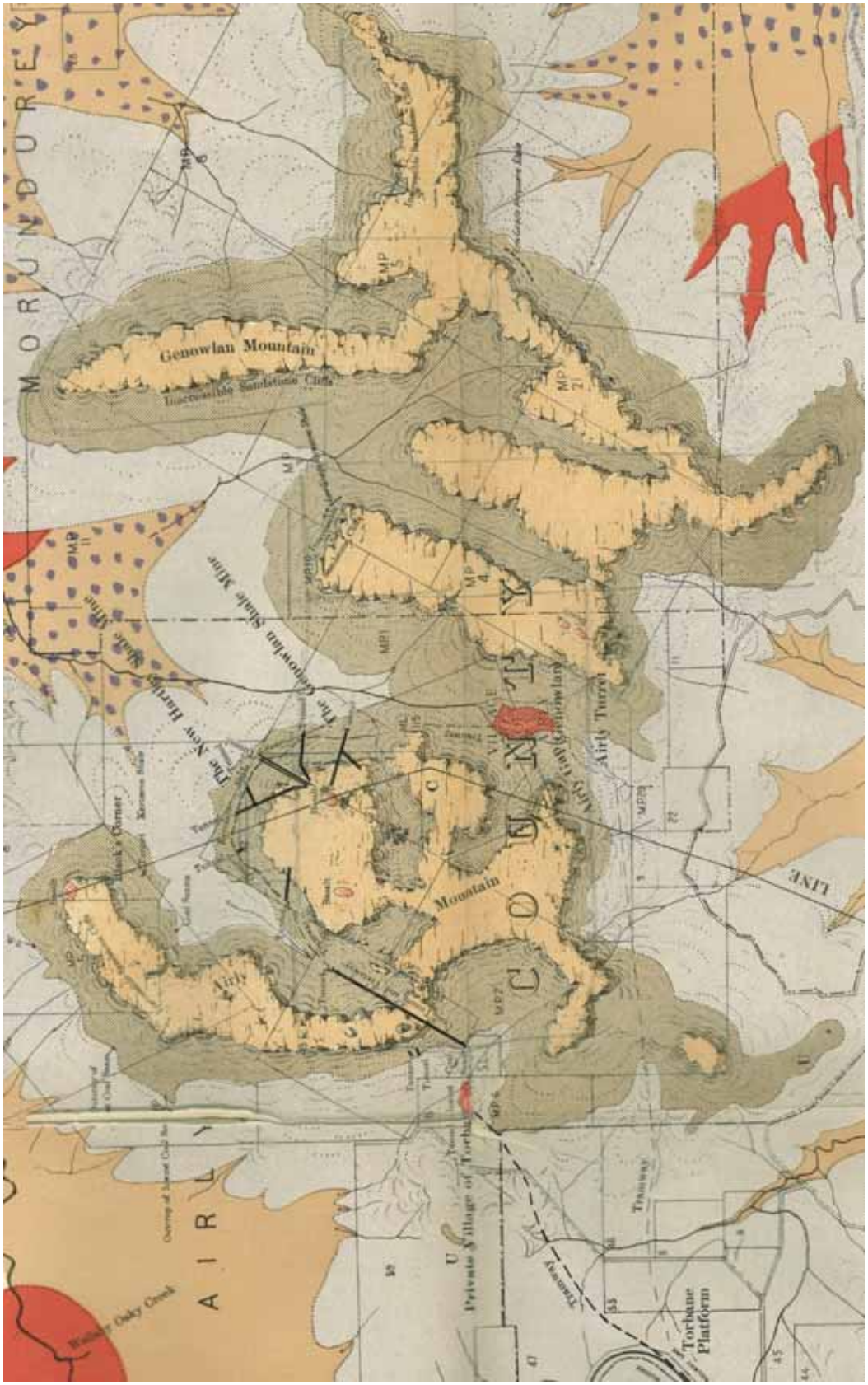

Figure 1-6: Map by Joseph Carne, 1903.

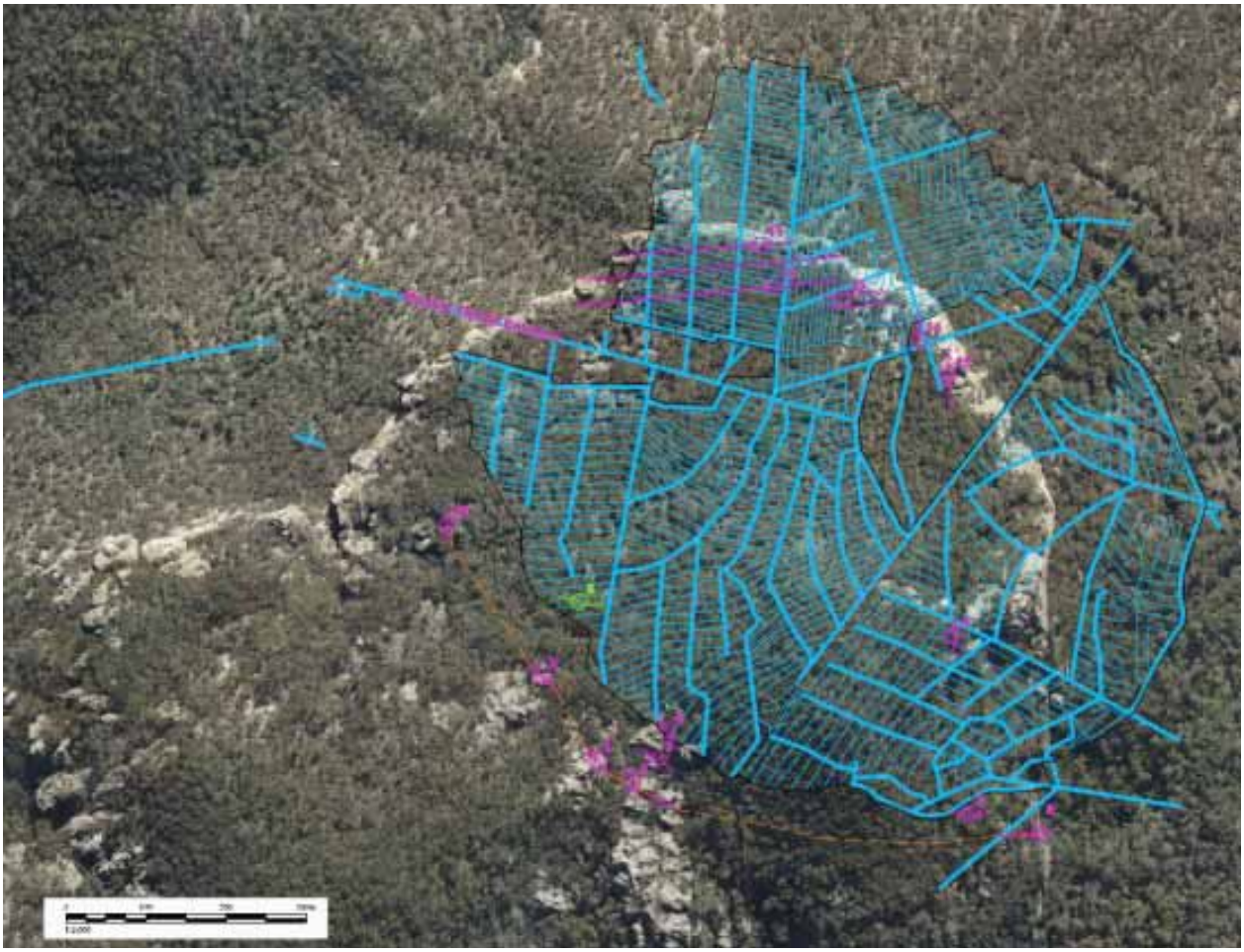

Figure 1-7: Detail of Torbane oil shale workings – 1893 to 1913.

Figure 1-8 is a detail from Carne's map of 1903. It shows the entries into what were then two separate shale mines, New Hartley and Genowlan. It also shows the tramway and tunnel through Airly Mountain, at coal seam level, that was used to transport the torbanite to the retorts at Torbane Village.

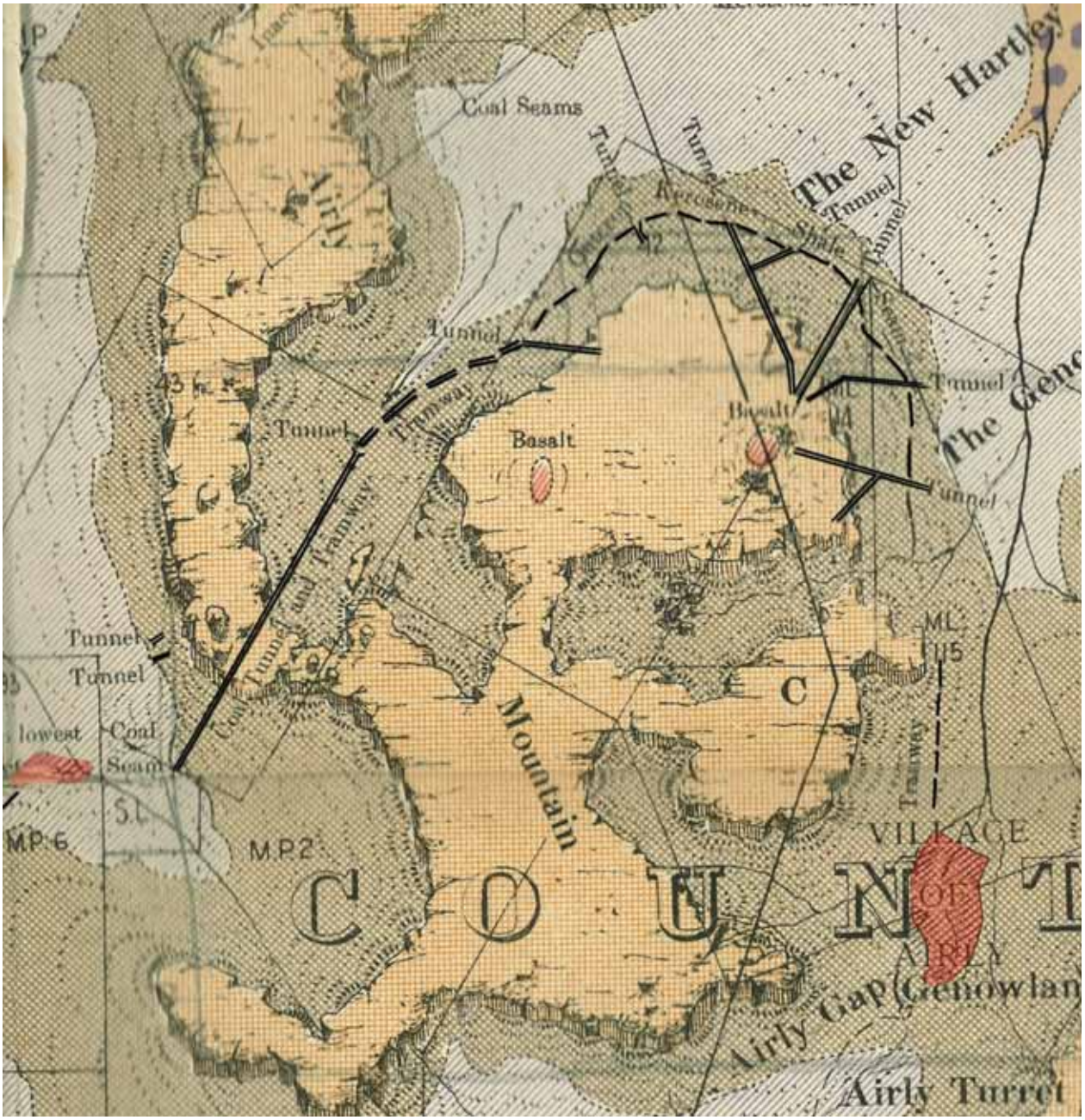

Figure 1-8: Detail from Carne's map of 1903 showing tunnels and tramways servicing the New Hartley and Genowlan oil shale mines.

Figure 1-9 shows Carne's map overlain on the Google Earth photograph of 24 October 2013. The agreement is remarkably good given that Carne produced his map by compass survey. Figure 1-9 shows that in 1903 there was an Airly Village, on Gap Creek, between Airly Mountain and Genowlan Mountain. The location is shown in more detail in Figure 1-10, superimposed in the Google Earth photograph of 23 May 2006. The village is discussed in Appendix J to the EIS which dismisses all heritage associated with the quite extraordinary Torbane-Airly-Genowlan engineering works and the Airly society as being only of "local interest".

Figure 1-9: Carne's map overlain on Google Earth.

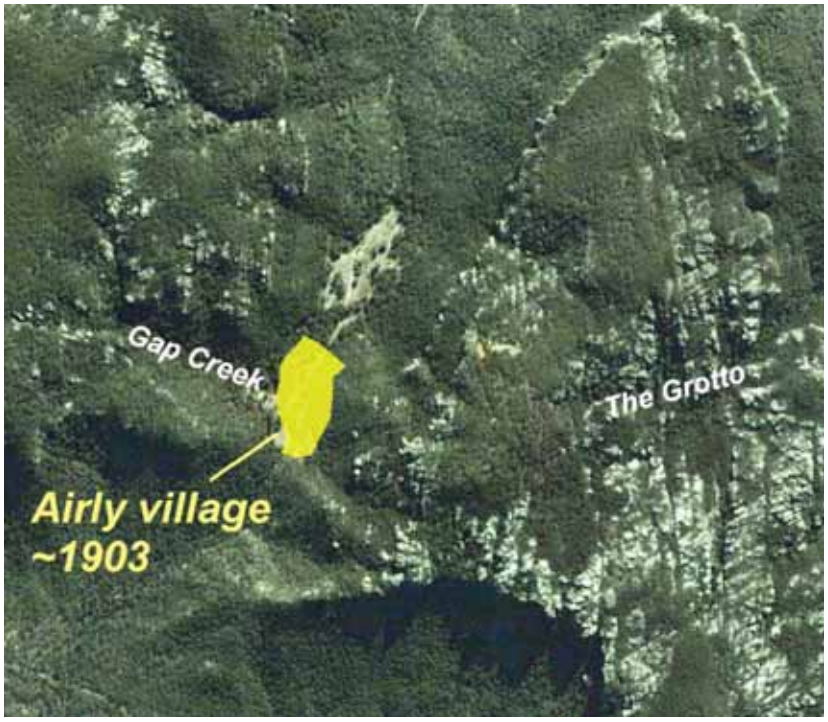

Figure 1-10: Location of Airly Village according to Carne (1903).

A submission by Centennial Coal of June 2014 indicated that the initial extensions to the present mine layout would be as per Figure 1-11. Details of this initial mining given by Golder Associates (June 2014) show that the mining would be beneath Airly Village (see Figure 1-12). This is discussed further in Section 1.3, below.

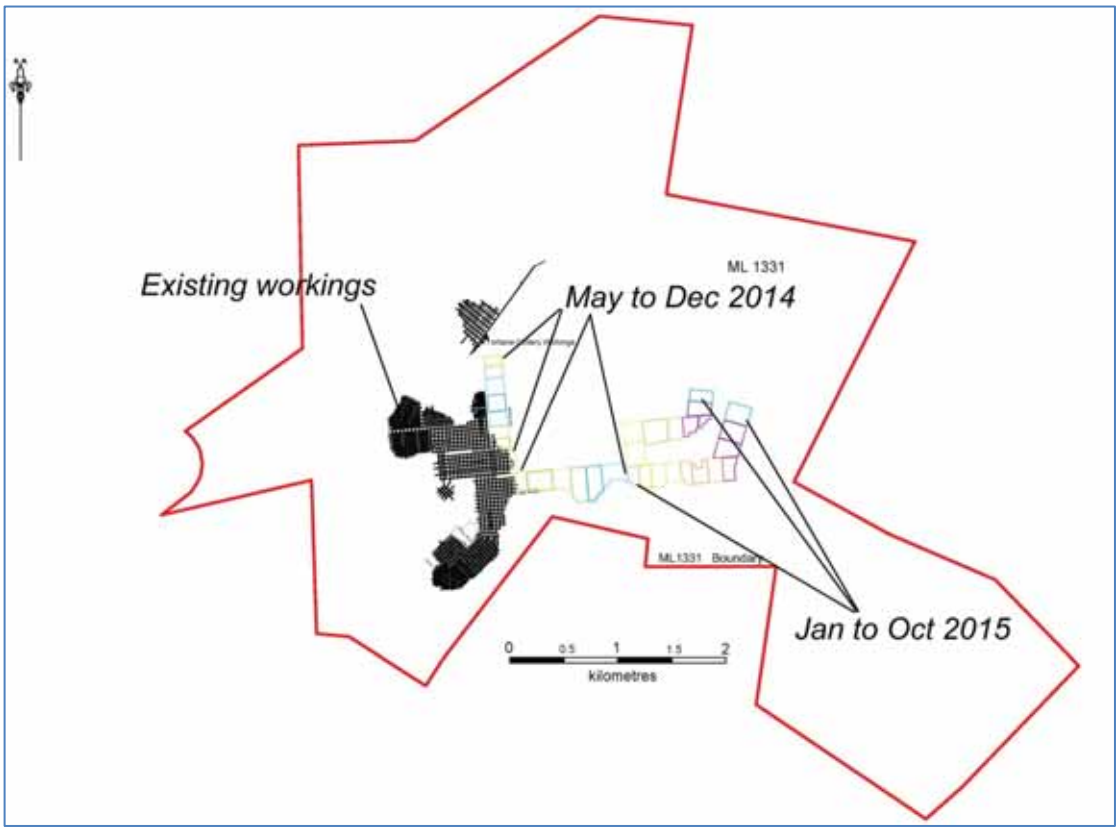

Figure 1-11: Proposed initial extensions to Airly Mine (Centennial Coal, June 2014).

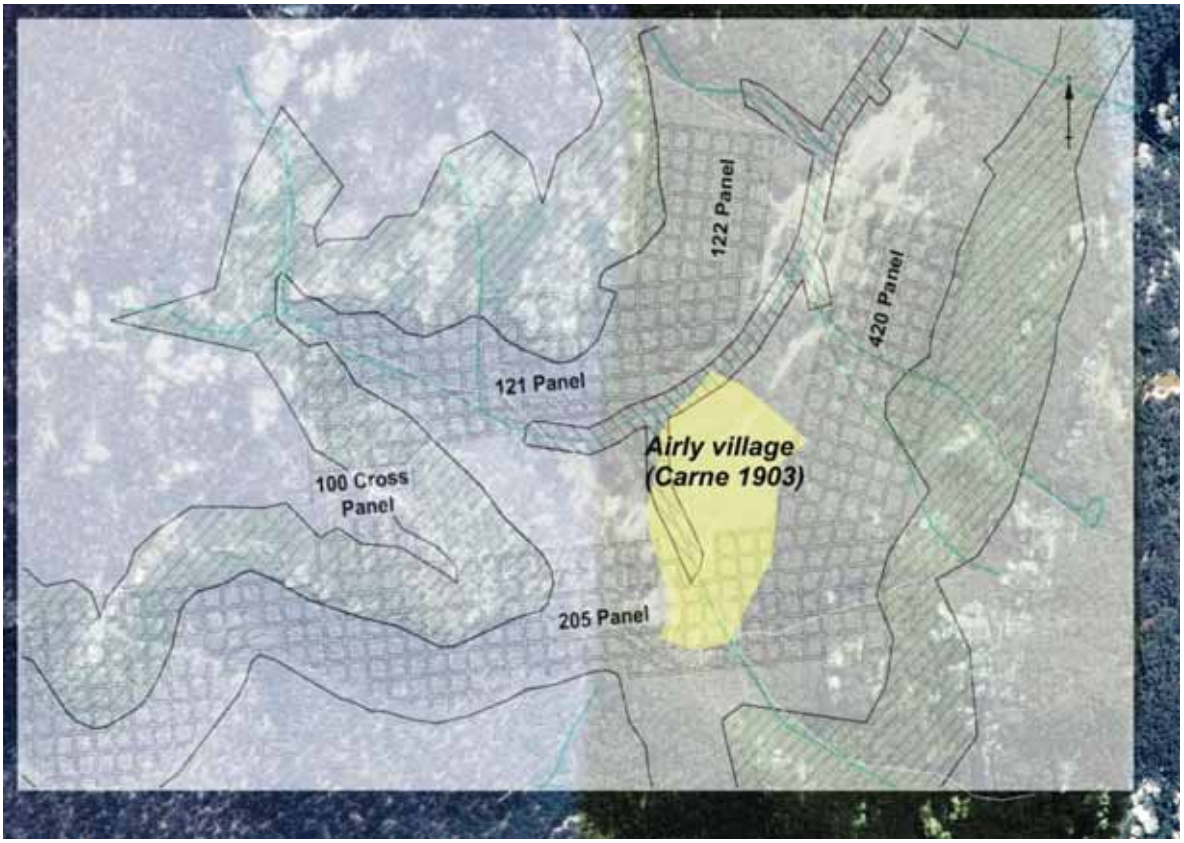

Figure 1-12: Details of proposed initial extensions.

1.2 GEOLOGY

Figure 1-13 is a geological plan of the relevant area. Figure 1-14 is a west-east cross section at an exaggerated vertical scale.

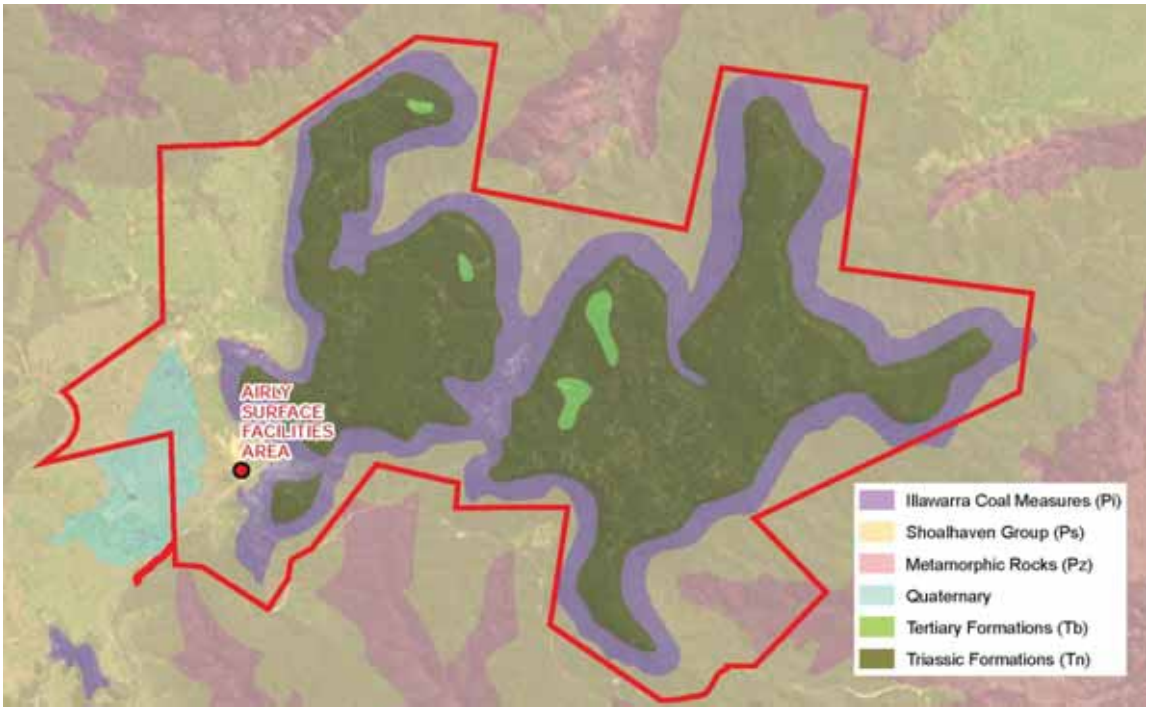

Figure 1-13: Geological map.

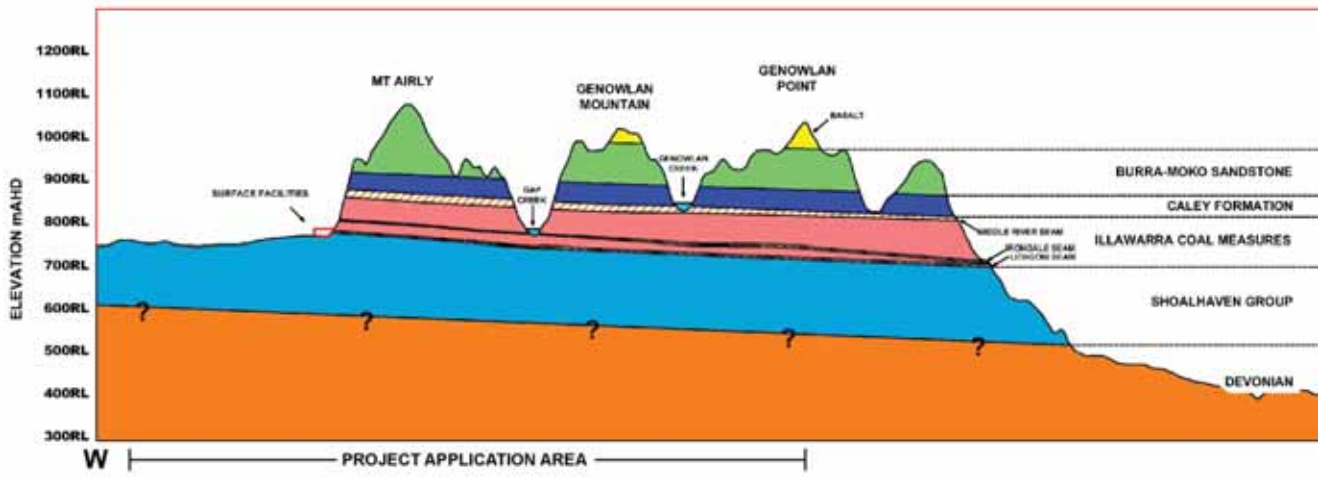

Figure 1-14: Geology section.

An important point is that the coal seam which is to be mined (the Lithgow Seam) outcrops around the perimeter of the Airly-Genowlan Mountain complex. This has particular implications in respect to the groundwater systems in the area, as is discussed in Section 1.4.

Figure 1-15 is a cartoon showing the major stratigraphic layers, which are tabulated in Table 1.

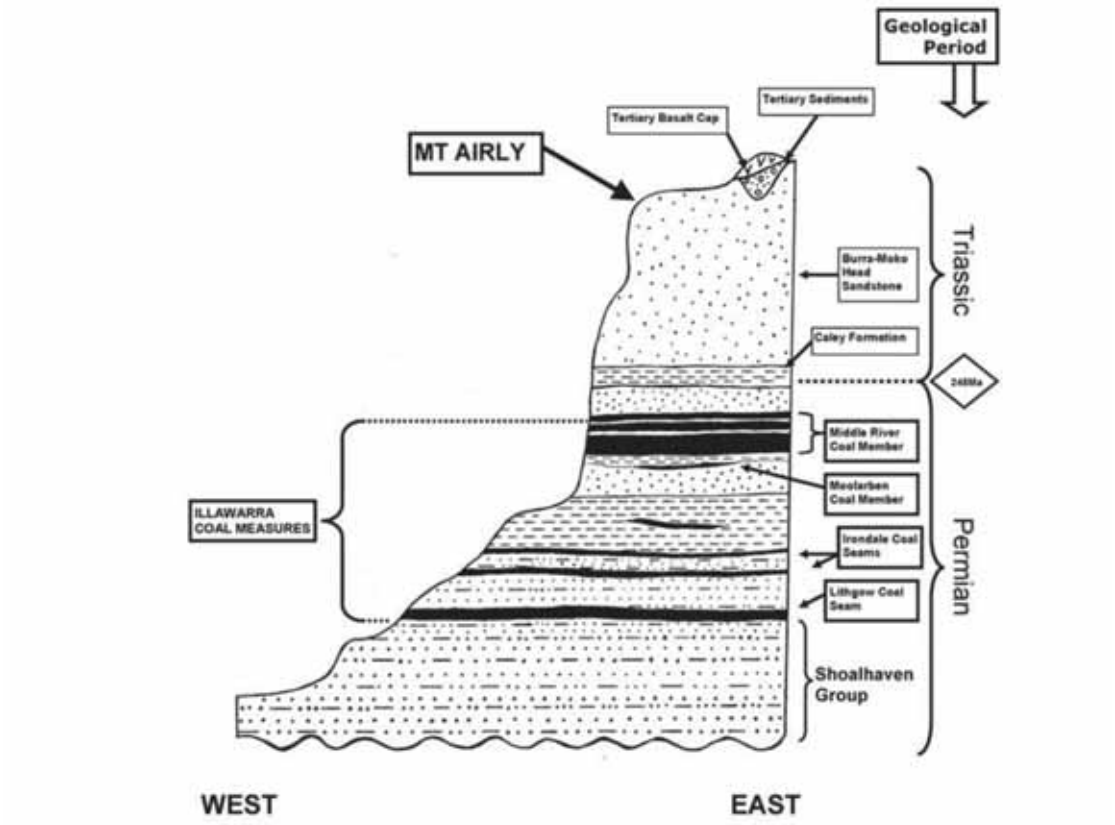

Figure 1-15: Stratigraphy.

Table 1
Stratigraphic Sequence – Airly Mine

Period	Stratigraphy			Lithology
	Group	Subgroup	Formation	
Quaternary	Alluvium			Silt, clay, sand, gravel
Tertiary				Basalt, dolerite
Triassic	Narrabeen	Grose	Burra-Moko Head Sandstone	Quartz sandstone, red-brown claystone
			Caley Formation	Claystone, shale, quartz sandstone
Permian	Illawarra Coal Measures	Wallerawang	Middle River Coal Gap Sandstone	Coal, lithic sandstone, claystone
		Charbon	Glen Davis Formation Irondale Coal Long Swamp Formation	Sandstone, claystone, coal, mudstone
		Cullen Bullen	Lidsdale Seam Blackmans Flat Conglomerate Lithgow Seam Marrangaroo Formation	Coal, claystone, siltstone, mudstone, conglomerate
	Shoalhaven Group		Berry Siltstone	Siltstone, lithic sandstone conglomerate
Devonian	Metamorphic rocks			Quartzite, shale, sandstone, limestone, tuff

As mentioned earlier, the cliff lines around Airly and Genowlan Mountains are formed in the Burra Moko Sandstone, named after Burra Moko Head near Blackheath, where the well-known ‘Hanging Rock’ is composed of this sandstone (see Figure 1-16).

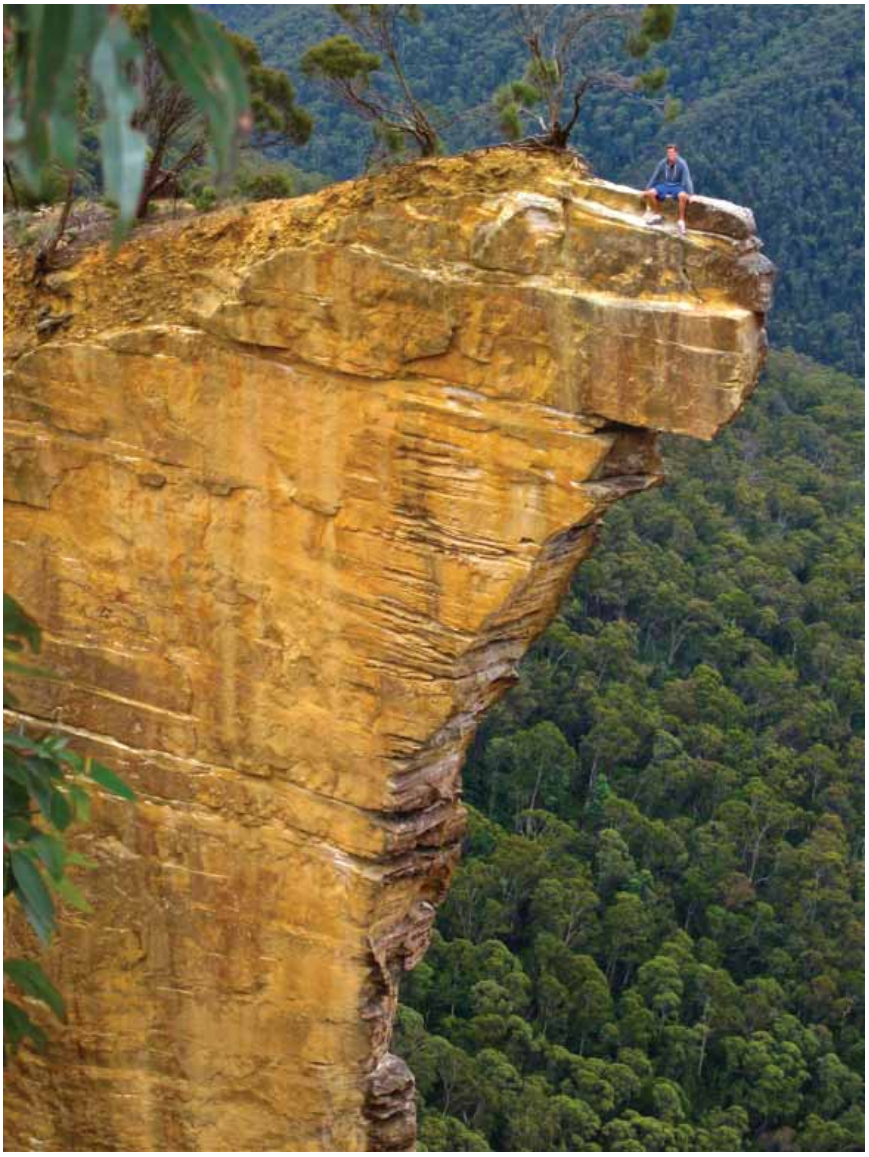

Figure 1-16: Hanging Rock near Blackheath – Burra Moko Sandstone.

1.3 Subsidence and Mine Plan

Centennial have planned future mining so as to limit subsidence, and associated ground strains, according to zones defined by surface features, being primarily the sensitive cliff lines. There are five zones, namely:

Zone 1:

- Termed the "**Shallow Zone**", where there is low cover and only first workings using bord and pillar methods are proposed.
- Predicted maximum subsidence = **26mm**.

Zone 2:

- Termed "**Partial Pillar Extraction Zone**", located between the "Shallow Zone" and a postulated line where cliffs could be affected.
- Predicted maximum subsidence = **65mm**.

Zone 3:

- A zonal footprint beneath **cliff lines** where only first workings would be employed.
- Predicted maximum subsidence = **65mm**.

Zone 4:

- The footprint of the **old oil shale mine workings** where extraction of coal beneath the level of the oil shale workings would interact with those workings.
- Predicted maximum subsidence = **200 to 500mm**.

Zone 5:

- Beneath the **plateau areas** involving panel and pillar extraction.
- Predicted maximum subsidence = **106mm**.

The zones are shown in plan in Figures 1-17, taken from Appendix E of the EIS, and Figure 1-18 taken from Golder Associates (Appendix D of EIS).

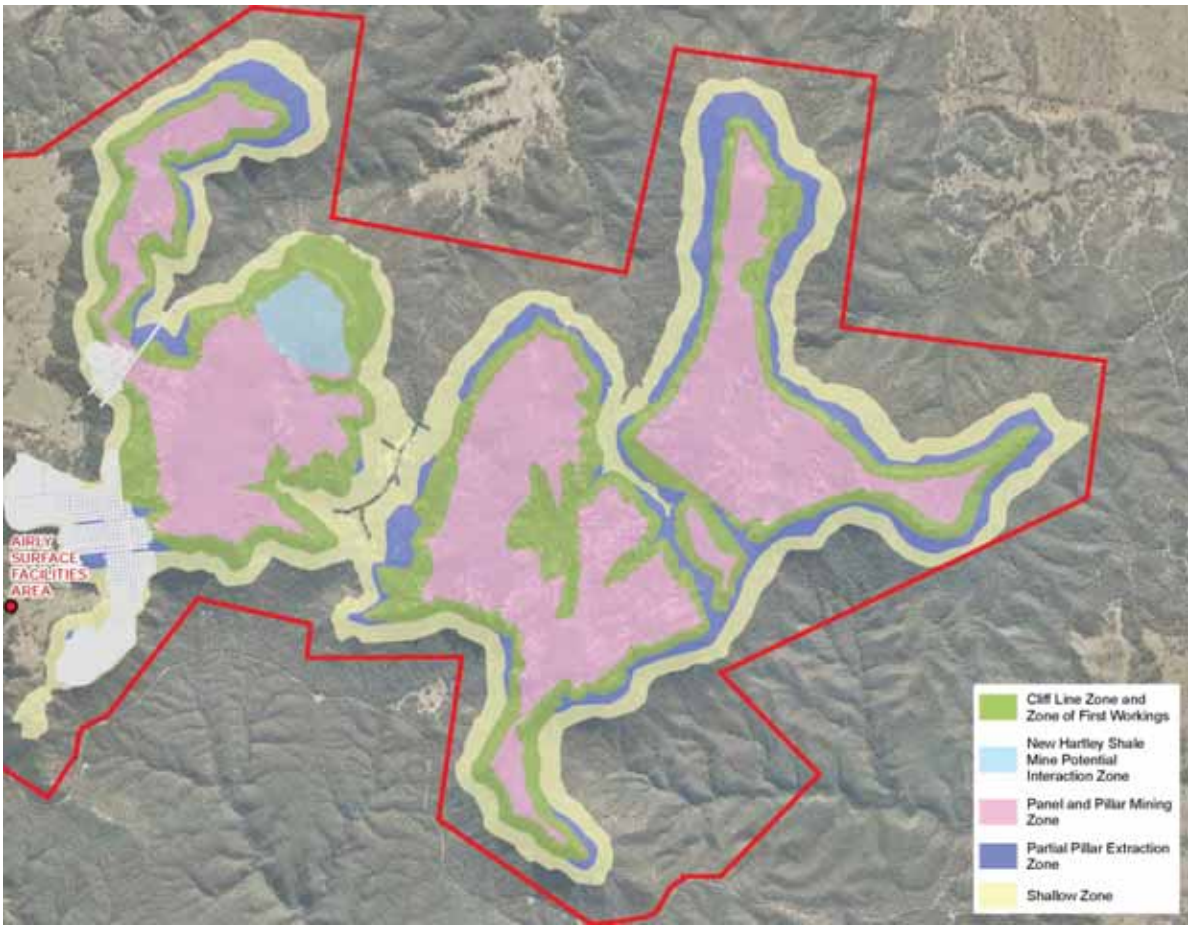

Figure 1-17: Proposed Mining Zones above the Lithgow Seam. Note that the pink zones are beneath the plateau areas where panel and pillar mining is proposed.

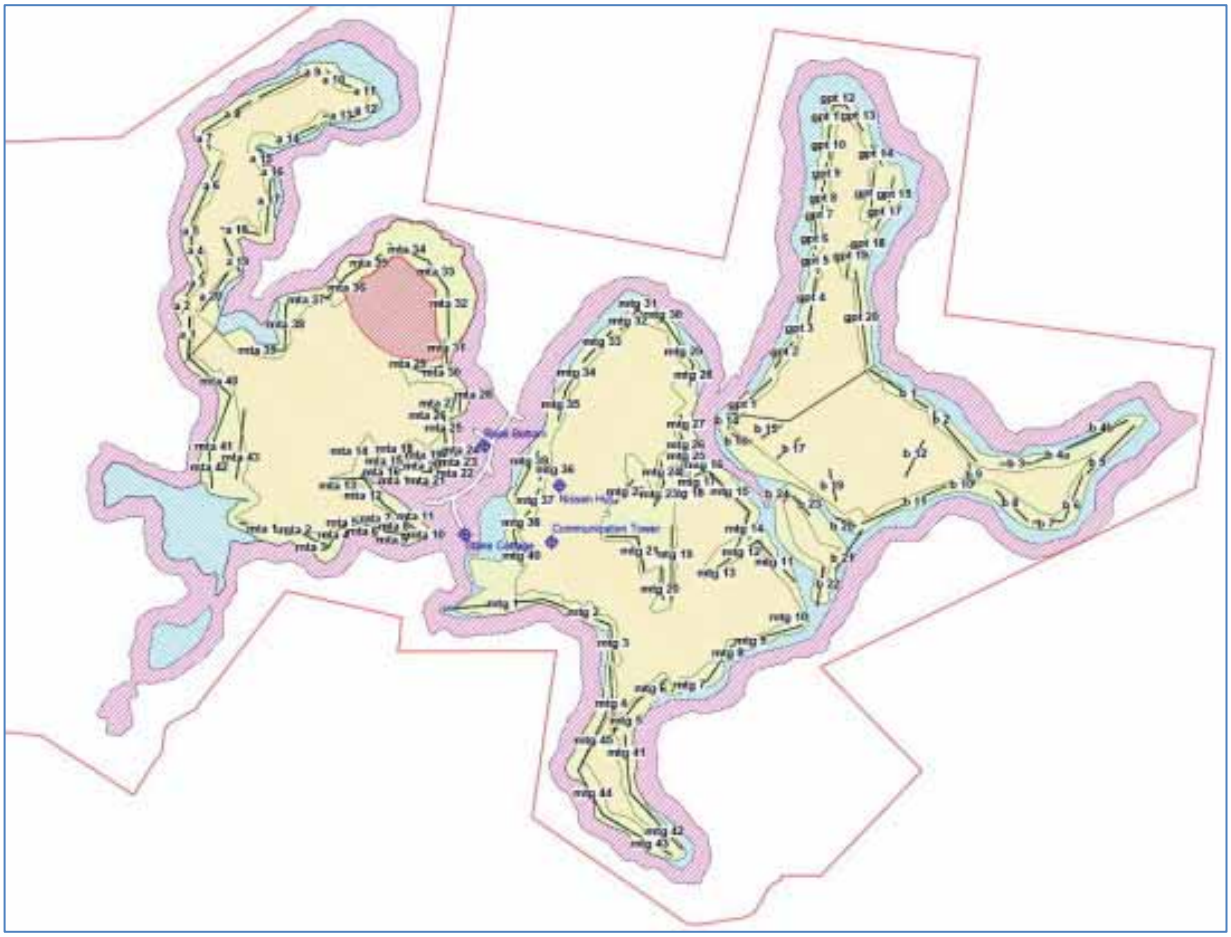

Figure 1-18: Proposed Mining Zones showing Golder's cliff line numbering.

It should be noted that the zones in Figure 1-17 and 1-18 partly overlap with the Environmental Protection Zone shown in Centennial Coal Drg No. 5 of 28 May 2014 (reproduced in Figure 1-19). This is shown in Figure 1-20 where the outline from Figure 1-19 is superimposed on the Mining Zones as given in Figure 1-18. The important point to note is that the Environmental Protection Zone extends well beyond the cliff line zone (Zone 3) described above, which is the zone given particular consideration in the mine plan, designed to limit subsidence so as not to cause cliff line collapses. That is to say that the whole Environmental Protection Zone is not given the level of protection proposed for the 'cliff zone'.

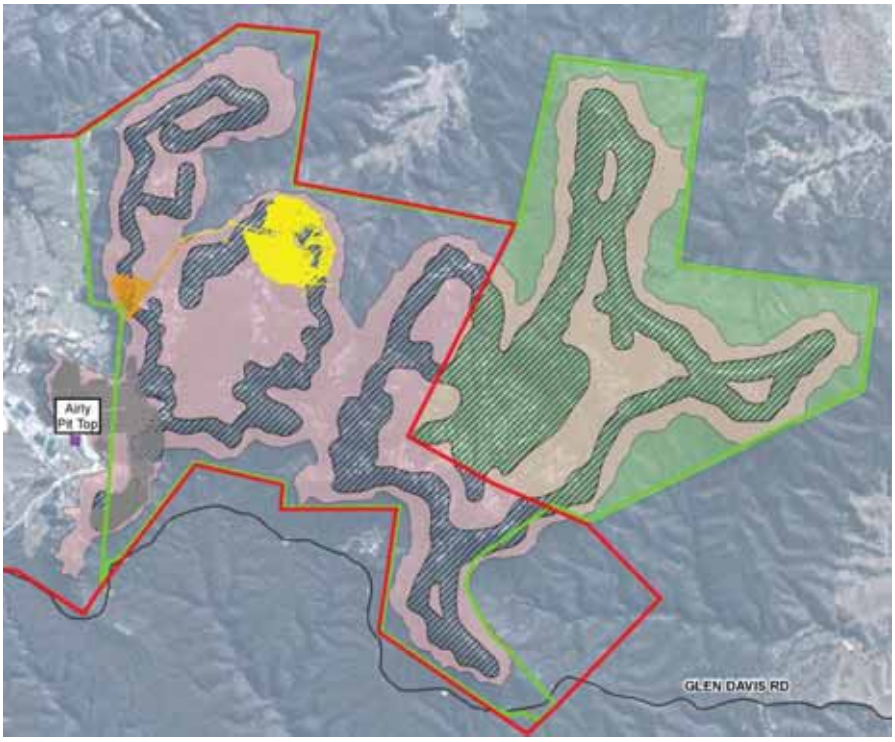

Figure 1-19: Environmental Protection Zone from Centennial Coal, June 2014.

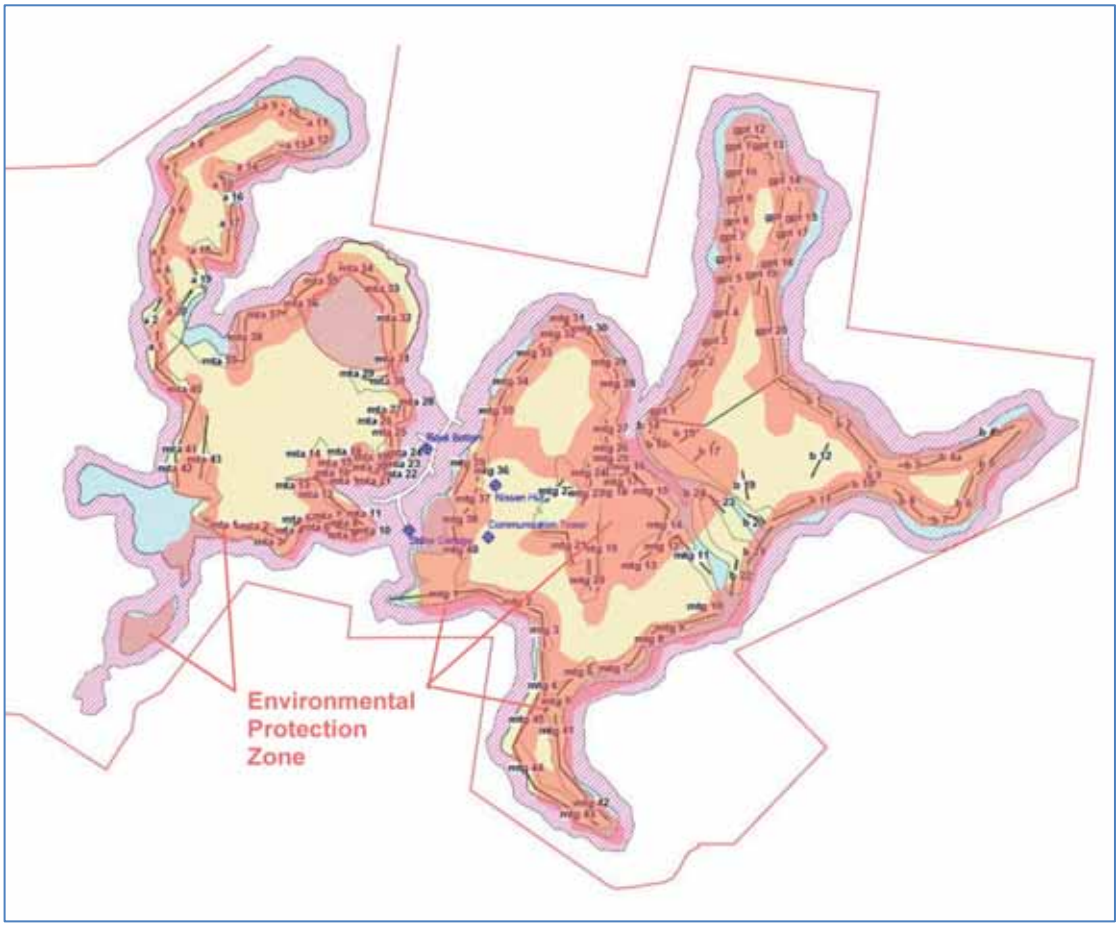

Figure 1-20: Environmental Protection Zone superimposed on Mining Zones.

Figure 1-21 is a cartoon from Chapter 8 of the EIS that shows how the Mining Zones are related to topography. There could be geometric confusion as per Figure 1-21 where the boundary between Zones 2 and 3 is defined both by a distance of 30m from the toe of a cliff line, and an angle of >8°, particularly as the cliff line bases are not shown on contour maps and are difficult to determine. What this means is that the 30m distance and the 8° angle may be in conflict. If as I recommend in Part 2 of this report mining in Zone 2 is restricted to first workings as per Zone 1, then this issue of conflict is irrelevant however with the proposal as set out in the EIS it would be appropriate that the following sentence is included:

> The upslope boundary of Zone 2 shall be no closer than 30m from the intersection of the scree slope with the base of the cliff line or no closer than defined by an 8° vertical angle from the intersection of the scree slope with the base of the cliff line, whichever is the greater.

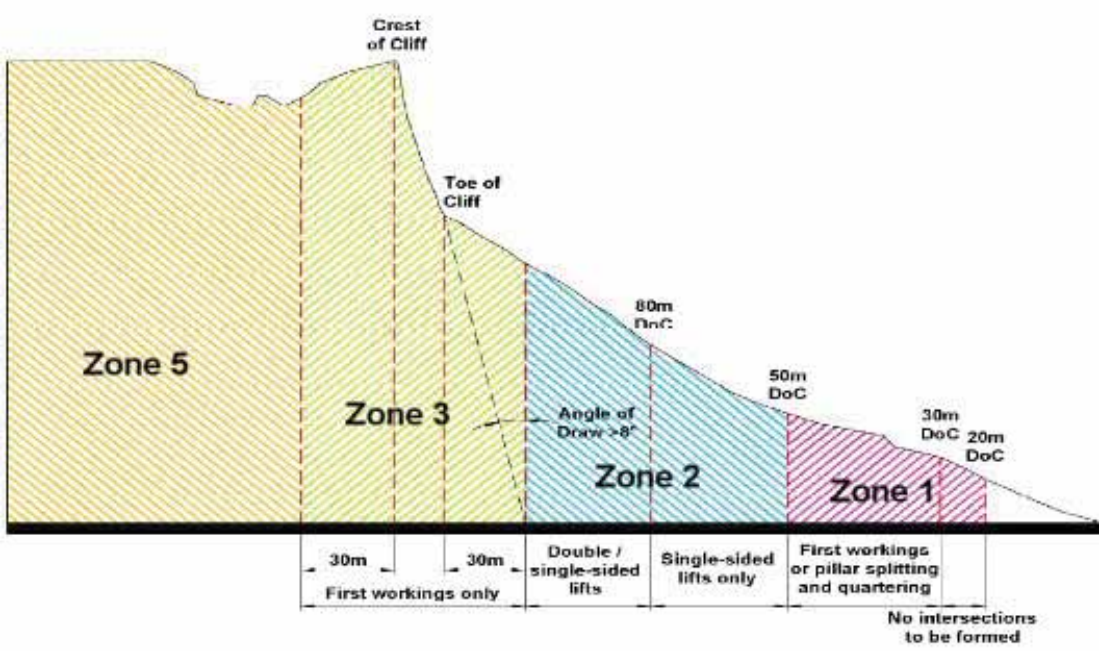

Figure 1-21: Cartoon showing Mining Zones.

There is a key statement in the Executive Summary of Appendix E (Groundwater) that appears not have been incorporated in planning of the mine. The statement is as follows:

> *"Where groundwater impacts have been predicted for proposed conditions, a mitigation measure incorporated into the proposed mining system is the restriction of mining in the Shallow Zone so that there is no mining beneath Gap Creek and Genowlan Creek (and to a distance of 20m from the creeks) where the depth of cover is less than 40m."*

Appendix E does not show the extent of the area covered by the above statement. Therefore, I have used the contour information given in Figure 1-2 to designate these areas, as is shown in Figure 1-21A.

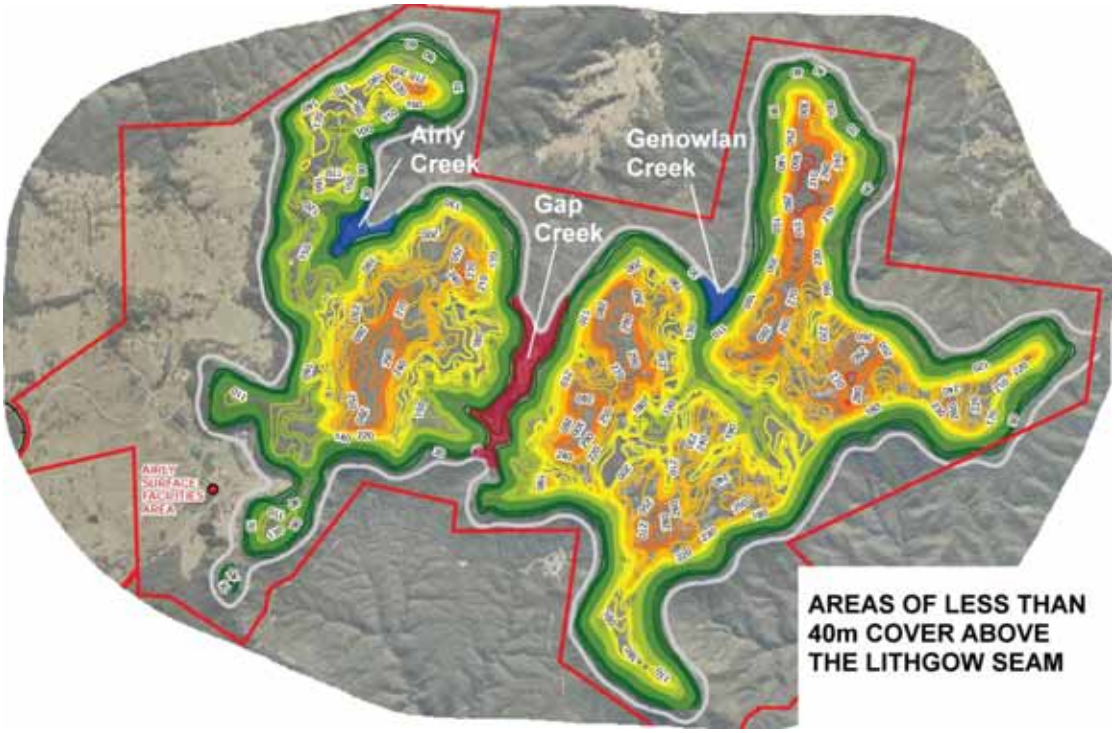

Figure 1-21A: Areas with cover less than 40m in Gap Creek and Genowlan Creek. Note there is a similar area in Airly Creek.

The statement that there will be no mining in the areas shown in Figure 1-21A should constitute a sixth zone to the mine plan. The significance of this is apparent when one considers the mine plan proposed by Centennial Coal in their report of June 2014 (Reference 8). In Figure 1-21B, I have superimposed the "no mining zone" beneath Gap Creek over the mine plan proposed in June 2014. It can be seen that the mine plan of June 2014 is in conflict with the statement quoted above from Appendix E.

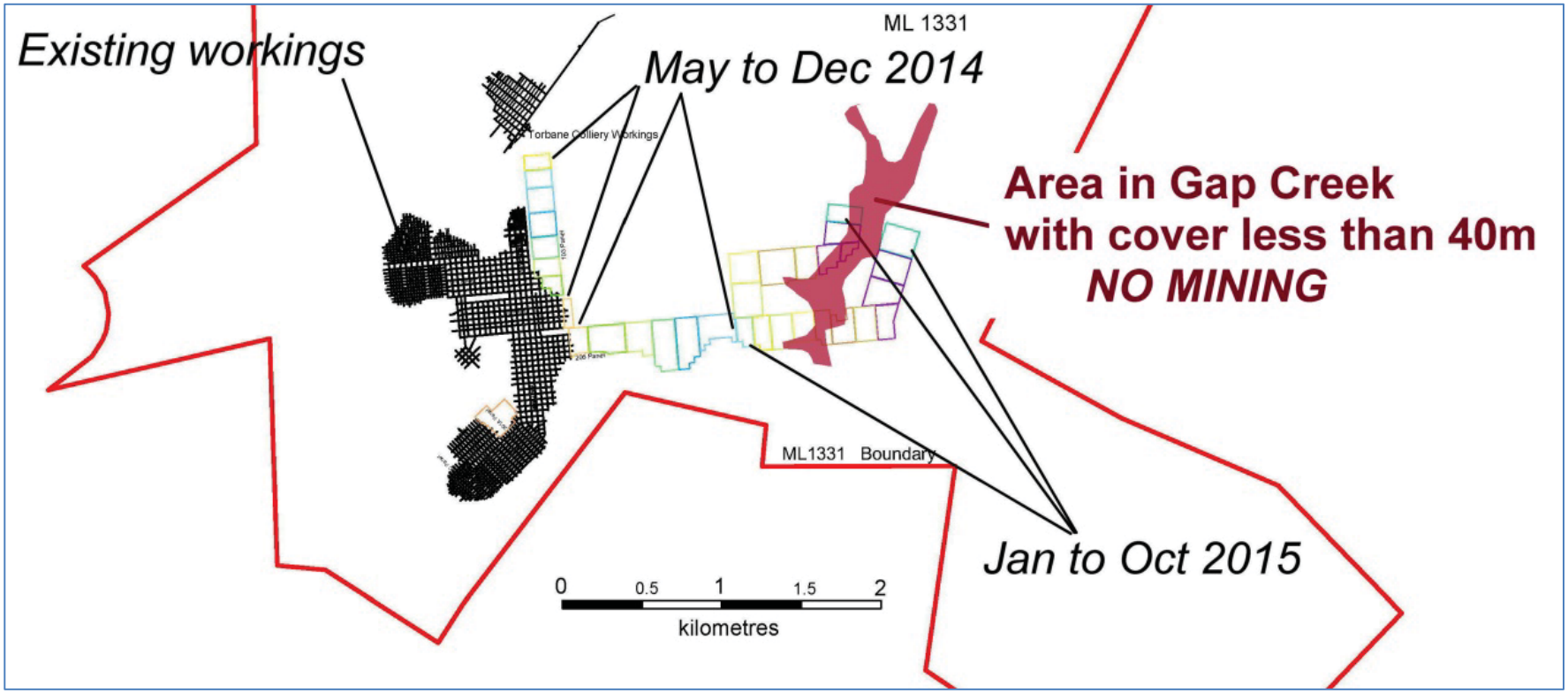

Figure 1-21B: Zone of "no mining" as per Appendix E of the EIS superimposed on mine plan submitted by Centennial Coal in June 2014 (Reference 8).

The following information in respect to subsidence is taken from Chapter 8 and Appendix D of the EIS.

ZONE 1 – LOW COVER

SHALLOW ZONE

Mining Method

To avoid any surface cracking or sinkhole formation due to caving of the overburden to the surface, it is proposed that only first workings be practiced in the shallow zone.

Subsidence Predictions and Impact

Subsidence effects in the Shallow Zone are:

- *subsidence: 3.5 to 25.5mm*
- *tilt: 0.6 to 1.1mm/m*
- *tensile Strain: 0.1 to 0.4mm/m*
- *compressive strain: 0.2 to 0.6mm/m*
- *fractured zone height: <10m above the seam*
- *surface cracking: not expected*

ZONE 2 – BETWEEN LOW COVER AND CLIFFS

PARTIAL PILLAR EXTRACTION ZONE

Mining Method

Mining in the Partial Pillar Extraction Zone will consist of the initial formation of a layout of large pillars followed by the systematic removal of 'lifting" of the edges of some of the pillars in the system during retreat. This lifting process would either be on one side of a roadway (single sided lifting) for areas where depth ranges between 80 and 120m, or on both sides of the roadway (double sided lifting) for areas where depth ranges from 120 to a maximum of 160m. Typical single and double sided lifting layouts are shown in Figure 8.10.

Single sided lifting will generate voids up to 15.5m wide, whilst double sided lift would generate voids up to 25.5m wide with long term stable pillars between.

Subsidence Predictions and Impacts

Predicted subsidence effects in the Partial Pillar Extraction Zone are:

- *subsidence: 25 to 65mm*
- *tilt: 0.5 to 2.6mm/m*
- *tensile strain: 0.2 to 1.1mm/m*
- *compressive strain: 0.2 to 1.9mm/m*
- *fractured zone height: 20 to 35m above the seam*
- *surface cracking: not expected.*

ZONE 3 – CLIFFS

CLIFF LINE ZONE AND ZONE OF FIRST WORKINGS

Mining Method

This would consist of first workings only with pillars designed to be long term stable. The pillars used in this area would be typically large with an appropriately high FOS equivalent to that used for protection of key surface features (typically FOS>2.11). Apart from the major cliff lines, this zone also covers other key areas where subsidence impact would be significant, such as the talus slope below the cliffs adjacent to the New Hartley Oil Shale Mine; or where depth of cover is too shallow for panel and pillar mining but also too great for partial pillar extraction, such as around The Grotto as shown on Figure 8.2. A typical pillar layout for the cliff zone is shown in Figure 8.6.

Subsidence Prediction

Predicted subsidence effects in the cliff line zone and zone of first workings are:

- *subsidence: 10 to 65mm*
- *tilt: 0.6 to 1.1mm/m*
- *tensile strain: 0.2 to 0.3mm/m*
- *compressive strain: 0.2 to 0.5mm/m*
- *fractured zone height: <10m above the seam*
- *surface cracking: not expected.*

ZONE 4 – OLD OIL SHALE MINING AREA

NEW HARTLEY SHALE MINE POTENTIAL INTERACTION ZONE

The New Hartley Shale Mine Potential Interaction Zone represents the part of the deposit overlain by the abandoned New Hartley Shale Mine. The shale mine interaction zone represents a total recoverable coal resource of approximately 1 million tonnes which is around 3% of the total recoverable resource in the most productive part of the deposit, namely the Panel and Pillar Zone.

In summary, the following mining constraints will apply to the New Hartley Shale Mine Potential Interaction Zone:

- *panel and pillar mining in the majority of the area*
- *cliff zone first workings only under the cliffs and extending to limit of the oil shale mine workings down slope of the cliffs*
- *increased set back from the cliffs to half the mining depth.*

In the case of sub-critical old voids, the subsidence predictions are[3]:

- *new subsidence: 500mm*
- *tilt: 6.2 to 16.7mm/m*
- *tensile strain: 2.4 to 5mm/m*
- *compressive strain: 1.8 to 8.3mm/m*
- *new surface cracking: expected.*

Where the old workings had super-critical voids, the new subsidence predictions are less, essentially because much of the cumulative subsidence has already occurred.

- *new subsidence: 200mm*
- *tilt: 2.5 to 6.7mm/m*

[3] Note that the predicted subsidences are substantially greater than for the remainder of the plateau area as per Zone 5.

- *tensile strain: 1.0 to 2mm/m*
- *compressive strain: 0.7 to 3.3mm/m*
- *new surface cracking: expected.*

ZONE 5 – PLATEAU

PANEL AND PILLAR MINING ZONE

It was decided that provided the upper bound of subsidence at 160m (the typical depth at the top of the cliffs) remained <125mm (the value not to be exceeded), the design was worth pursuing. The results of the analysis are summarised below.

Void Width Sensitivity Analysis

Width (W) of Void (m)		*50.5*	*55.5*	*60.5*	*65.5*	*70.5*
Depth (H) of cover (m)		*160*	*160*	*160*	*160*	*160*
Final maximum subsidence (mm)	*Expected*	*45*	*48*	*51*	*81*	*84*
	Upper Bound	*99*	*106*	*113*	*145*	*151*

An important feature of the panel and pillar style of mining is the limitation of the height of fracturing above the Lithgow seam. Golder Associates (2014) indicates that the likely height of fracturing above the Lithgow seam in the panel and pillar zone to be 60-70mm. Given the average thickness of the Permian strata above the Lithgow seam is 105m, the fractured zone would remain well within that stratum. This coupled with the lack of surface fracturing predicted due to the low levels of subsidence means that the overlying Triassic sandstone unit is left intact. It is this Triassic unit and associated alluvium and colluvium that provide much of the groundwater baseflows to the creek systems such as Genowlan Creek. The only exception to this scenario is in the limited area of the oil shale interaction zone.

Key features of this type of mining include:

- *mining height: <3.0m*
- *maximum roadway width: 5.5m*
- *maximum void width: 61m*

Subsidence Predictions

The predicted subsidence effects for the Panel and Pillar Mining Zone are:

- *subsidence: typically less than 100mm but ranging from 40 to 106mm*
- *tilt: typically 1 to 2mm/m (lower bound 0mm/m and upper bound 3mm/m)*
- *tensile strain: 0 to 1mm/m*
- *compressive strain: 0 to 2mm/m*
- *fractured zone height: 60 to 70m above the seam*
- *surface cracking: not expected.*

No impact is predicted[4] on the following features within the Panel and Pillar Mining Zone:

- *pagodas*
- *aquifers in alluvium and colluvium material*
- *aquifers in the Triassic sandstone*
- *aquifers in the Devonian strata underlying the Shoalhaven formation.*

[4] I do not agree with these findings as is discussed in Part 2.

1.4 Groundwater Impacts

1.4.1 Existing Groundwater Regime

Appendix E of the EIS summarises the existing groundwater regime as follows:

> *"The local groundwater sources within the Project Application Area are those within strata that outcrop around Airly and Genowlan Mountains, namely: within the Quaternary alluvium, weathered and/or fractured sandstone and coal seams. Yields are typically less than 5L/s and the local groundwater sources are part of the Sydney Basin North groundwater source. The porous and fractured rock groundwater sources include the Narrabeen Sandstone and coal seams of the Illawarra Coal Measures. The Narrabeen Sandstone is an unconfined aquifer that outcrops across the plateaus of Mount Airly and Genowlan Mountain. The outcrop areas are recharged by net rainfall and catchment runoff. Groundwater discharges to the ground surface as seepage along the slopes. Genowlan Creek is assumed to receive seepage from the Narrabeen Sandstone in the upper catchment. These sources are recharged by rainfall via fractures within overlaying strata, and seep out of the side of the mountains or directly into watercourses. With the majority of discharge from these sources being to seepage areas, there is minimal inter-aquifer flow to underlying regional groundwater sources* (see Figure 1-22)*. There is a downward vertical hydraulic gradient across the strata from the Narrabeen Sandstone to the Illawarra Coal Measures. The regional groundwater sources occur within the Shoalhaven Group below the Lithgow seam, as well as within the underlying metamorphic rocks.*
>
> *Genowlan Creek and Gap Creek* (see Figure 1-23) *are fed consistently by flows which emerge from the Quaternary colluvium and alluvium. Flows in the Grotto and Gap Creek vary with rainfall seasonality whereas the flows through the Oasis are persistent, varying from approximately 2.2L/s in average conditions to 1L/s during drought.*
>
> *A search of the NSW Groundwater Bore Database identified 35 private bores and one test bore within 5km of the Project Application Area* (see Figure 1-24)*."*

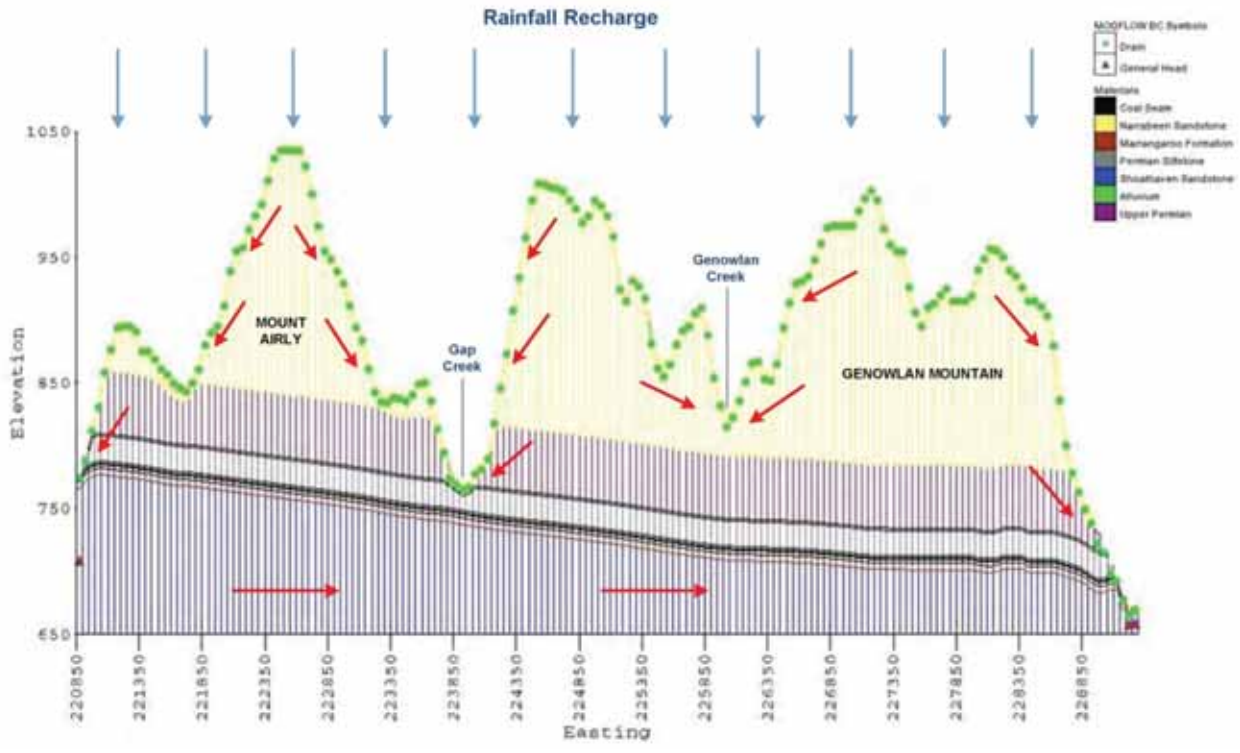

Figure 1-22: Cartoon from EIS indicating existing groundwater regime.

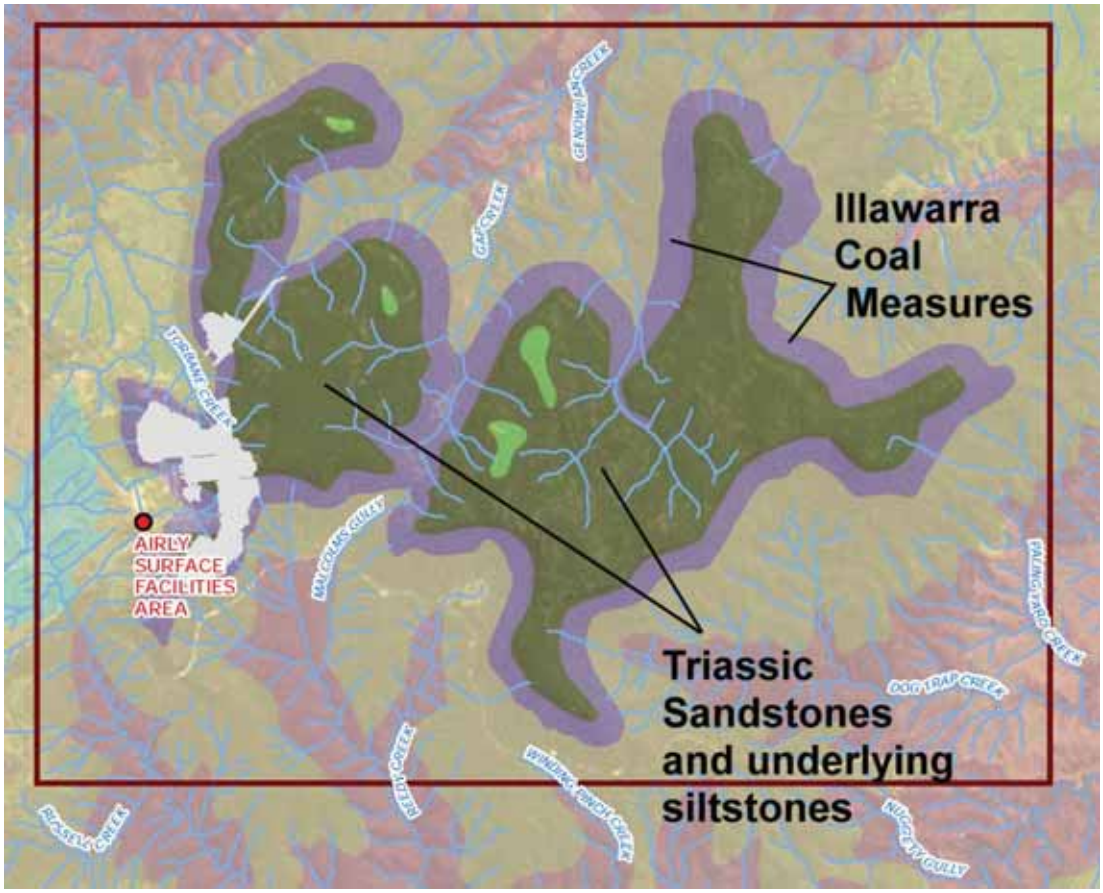

Figure 1-23: Creek systems.

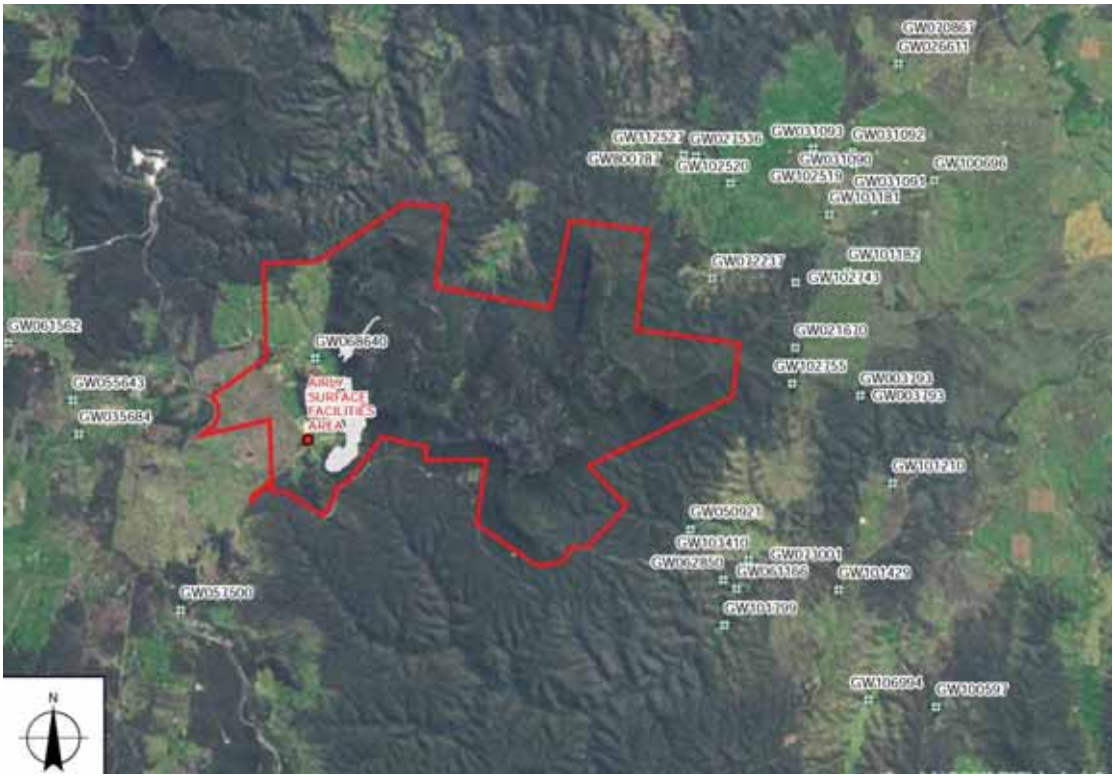

Figure 1-24: Existing bores within 5km of Project Application Area according to EIS.

1.4.2 Factual Information

The report includes important information from piezometers that have been installed in the vicinity of the existing Airly Mine Workings. In particular, piezometer numbers:

- ARP01
- ARP02A
- ARP03A
- ARP04
- ARP06
- ARP07
- ARP08.

Unfortunately the report does not give the reduced levels for the collars (tops) of these piezometers meaning that it is impossible for me to properly analysis the data. A request was made for this information but it had not been furnished by 21 October 2014.

Page 27 of the Groundwater Impact Assessment refers to "Packer testing" as follows:

> *"Packer testing reported by GHD (2014b) indicates the following hydraulic conductivities:*
> *-Narrabeen Sandstone: 0.00015 m/day (ARP06).*
> *-Lithgow Seam: 0.07 m/day (ARP06).*
> *-Marrangaroo Formation: 0.00016 m/day (ARP06)".*

The report states that GHD (2014b) is the Surface Water Assessment (viz: GHD (2014b). Airly Mine Extension Project – Surface Water Impact Assessment). There does not appear to be a reference to the Packer testing in this report. I have searched all the documentation and cannot find details of the field tests. I need access to the processed field test data in order to evaluate the validity of the testing and the generalisations made by GHD as summarised above. Again this information was requested but had not been furnished by 21 October 2014.

1.4.3 Predictive Groundwater Modelling

Assessment of probable impacts of mining beneath the whole area defined by the Mining Zones is presented in the EIS using the 3D software MODFLOW 2005. The particular version used was MODFLOW-NWT. The following is extracted form Appendix E of the EIS.

> *"The model domain covers approximately 75km^2, as shown in Figure 1-25.*
>
> *The area has been divided into a grid consisting of 200 columns and 150 rows, generating equally sized cells with dimensions 50m x 50m. It was considered that this degree of discretisation of the model domain would provide adequate refinement throughout the main areas of interest without leading to excessive model run times.*
>
> *The horizontal domain of the hydrogeological model includes the outcrop boundary of the Illawarra Coal Measures and extends into the Shoalhaven Group outcrop area as shown by the boundary in Figure 1-25. The vertical domain of the local scale hydrogeological model extends from the ground surface to a depth of 450m AHD.*
>
> *The model has been divided into ten layers and seven different hydrogeological units as follows:*

- *Layer 1: Alluvium and Shallow Zone*
- *Layer 2: Narrabeen Sandstone*
- *Layer 3: Permian Siltstone interburden*
- *Layer 4: Coal seam (Irondale)*
- *Layer 5: Permian Siltstone interburden*
- *Layer 6: Coal seam (Lidsdale)*
- *Layer 7: Permian Siltstone interburden*
- *Layer 8: Coal seam (Lithgow)*
- *Layer 9: Marrangaroo Formation*
- *Layer 10: Basement rock (Shoalhaven Group).*

Calibration of the hydrogeological model was undertaken under steady state conditions, followed by some transient validation over the period 2012 to 2014 comparing modelled groundwater levels to observed levels at ARP05.

Horizontal and vertical hydraulic conductivities and the net recharge coefficient were adjusted during steady state calibration in order to minimise the residual errors between modelled and observed steady state head (groundwater levels) and to achieve the other calibration targets (see Figure 1-26). The calibrated steady state heads (levels) were used to define initial head conditions for the transient predictive simulations.

The steady state model was converted into a transient model and was initially run from 2009 to 2014 using annual stress periods."

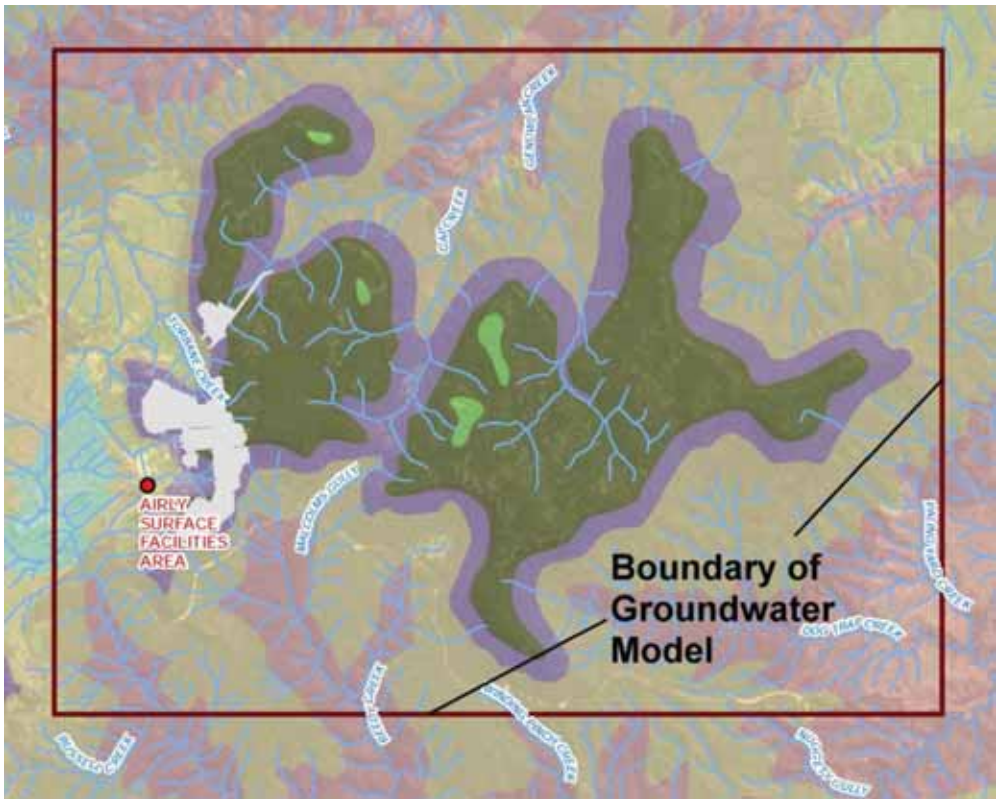

Figure 1-25: Boundary of MODFLOW groundwater model.

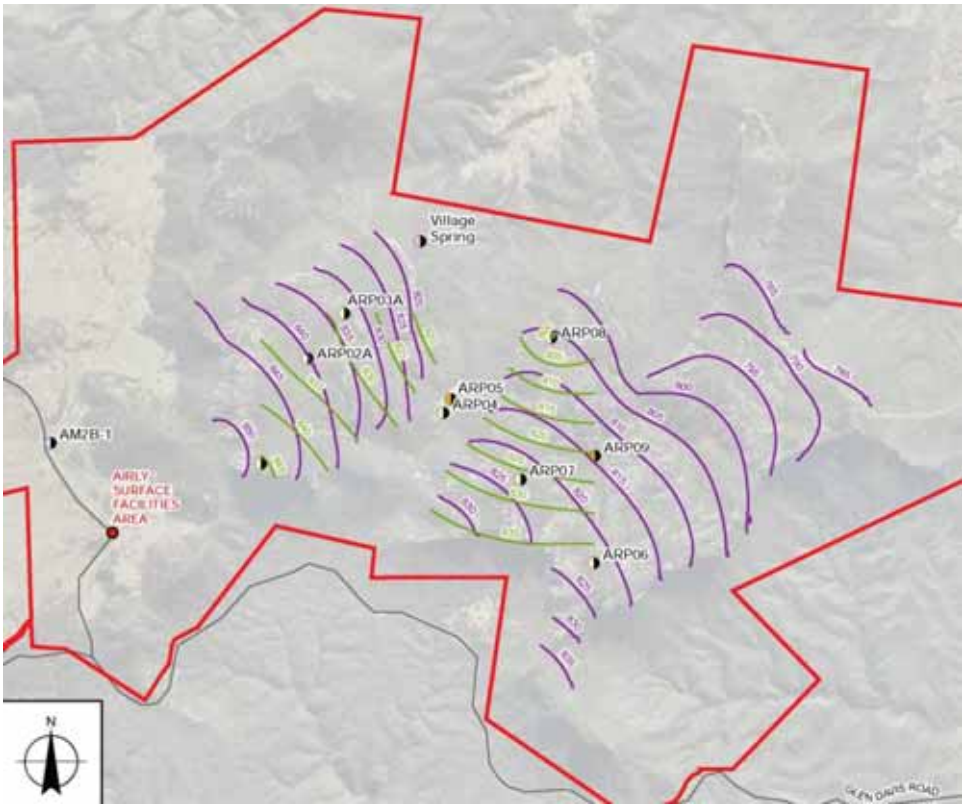

Figure 1-26: Comparison of measured and computed pre-mining groundwater contours in Burra Moko Sandstone.

The adopted hydraulic conductivity values for the predictive analyses are given in Table 2. The report does not present adopted compressibility and volumetric water content parameters.

Table 2
Hydrogeological Properties after Steady State Calibration

Hydrogeological Unit	Model Layers	Horizontal Hydraulic Conductivity 'K_h' (m/day)	Vertical Hydraulic Conductivity 'K_v' (m/day)
Shallow Zone / Alluvium	Layer 1	0.05	0.005
Narrabeen Sandstone	Layer 2	0.05	0.005
Coal seams	Layers 4, 6 and 8	0.05	0.005
Permian Siltstone	Layer 3, 5 and 7	1.9×10^{-4}	1.9×10^{-5}
Marrangaroo Formation	Layer 9	0.001	0.0001
Shoalhaven Group	Layer 10	0.003	0.0003

1.4.4 Groundwater System Impacts Predicted in the EIS

The following is extracted from Appendices E and F of the EIS:

> *"The peak groundwater inflow into the mining void is predicted to range from 24ML/year to 184ML/year under proposed conditions. Approximately 80% of this groundwater is expected to come from the overlying Permian strata and the remaining 20% from the underlying Marrangaroo Formation.*
>
> *One of the largest sources of water into the Airly Mine water management system under proposed and approved conditions is expected to be the inflow of groundwater into the underground workings. Under existing conditions there is negligible groundwater make. The greatest change to the system is the predicted increase in groundwater make into the proposed mining areas, which is estimated to peak under proposed conditions at approximately 180ML/year in 2030. The predicted quantities are very sensitive to the assumed extent of fracturing above the workings as shown in* Figure 1-27*.*
>
> - *Scenario 1 assumes that there will be no change in hydraulic conductivity in the caving and fracturing zones above the panel and pillar mining zone. This scenario was modelled to provide a lower bound estimate for groundwater inflows and drawdown.*
> - *Scenario 2 assumes that the vertical and horizontal hydraulic conductivity will increase up to a height of 75m above the panel and pillar mining zone, which is the maximum height of the fracture zone predicted by Golder Associates (2013)."*

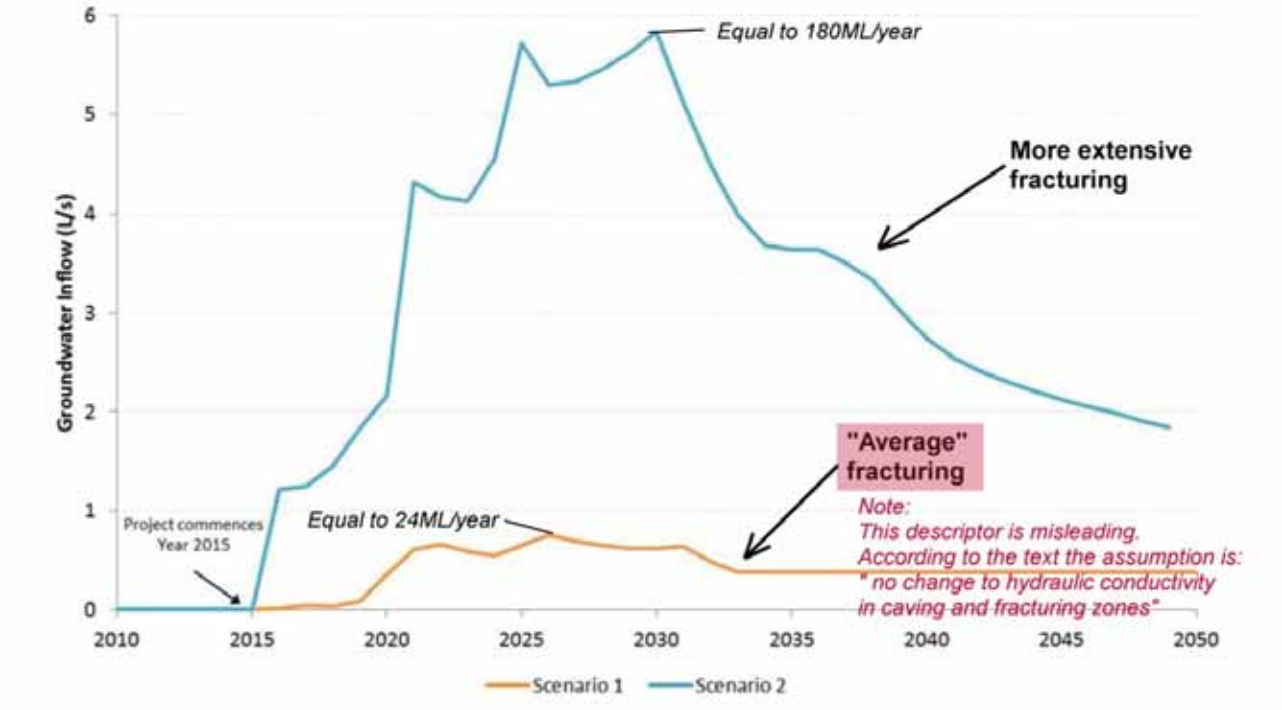

Figure 1-27: Predicted groundwater inflows into underground workings under proposed conditions.

The comment on Figure 1-27 made by myself should be noted. This is to effect that the wording "average fracturing" which is one the figure in the EIS is somewhat misleading. According to the text of the EIS the assumption is:

"no change to hydraulic conductivity in caving and fracturing zones".

In other words, the computed flows for average fracturing take no account of the fracturing that is stated to be expected for each of the mining zones within the EIS.

Predicted impacts[5] on the groundwater regime are taken from the EIS as follows:

> "*Depressurisation of the Narrabeen Sandstone is expected to be negligible (not measurable) under proposed conditions throughout most of the strata, although there may be some localised drawdown at the interface with the underlying Permian strata.*
>
> *Depressurisation of the Permian strata of the Illawarra Coal Measures overlying the Lithgow Seam is expected to range from 4.6m to 7.5m and depressurisation of up to 6m within the underlying Marrangaroo Formation.*
>
> *As a result of depressurisation of the Permian strata within the New Hartley Shale Mine potential interaction zone, there is potential for the flow at Village Spring to reduce or cease."*

The modelled changes to groundwater sources are said to be summarised in Table 7-1 from which Table 3 is extracted.)

Table 3
Summary of Hydrogeological Model Predictions

Impact Type	Proposed Conditions
Groundwater Flow to Mining Void	24-184ML/year (peaks for Scenario 1 and Scenario 2 (average fracturing))
Groundwater Drawdown	*Gap Creek alluvium:* drawdown 2.5-3.5m *Genowlan Creek alluvium:* drawdown up to 1.1m. No impact at the Grotto or Oasis areas *Narrabeen Sandstone:* minor drawdown anticipated at interface with Permian strata *Permian Siltstone:* drawdown 4.6-7.5m *Marrangaroo Formation:* drawdown up to 6m *Shoalhaven Group:* drawdown up to 0.1m
Drawdown Recovery	<5-60 years
Baseflow Reduction	1.3-27.1ML/year at confluence of Gap and Genowlan Creeks

[5] My assessments of these findings are given in Part 2 of this report.

PART 2 – ASSESSMENT AND OPINIONS IN RESPECT TO SUBSIDENCE AND HYDROGEOLOGY

2.1 Subsidence and Mine Plan

The proposed mine plan is linked directly to calculations of probable subsidence.

In principle, I agree with the intent of limiting surface impacts by limiting subsidence movement using appropriate extraction methods, all based on the experience at Clarence Colliery.

The EIS documentation (see Appendix D of EIS) does not set out in detail how the predictions of subsidence are made; the reader being referred to Strata Engineering (2011a) and (2012a) which documents are not given on the NSW Planning and Environment website for the Airly Mine Extension Project. Therefore, I have relied on information given in Section 6.2 of Appendix D of the EIS. From this Section I draw the following conclusions:

- The estimates of subsidence above the panel (50m wide) and pillar workings (Zone 5 in Figure 1-21) are empirical estimates based on a very limited NSW database[6], and a numerical model from the USA, and there is substantial uncertainty in respect to subsidence magnitudes (settlement, strain and tilt). There is a significant probability that these magnitudes could be greater than the predicted ranges (settlement 40 to 106mm, tensile strain 0 to 1mm/m). The conclusion documented in Section 1.3, above, that there would be no impacts on the pagoda structures and smaller cliff lines above the panel and pillar mining is based entirely on the assumptions that behaviour will mimic that at Clarence Colliery. However, a paper published in 2014[7] on Clarence Colliery records that the predicted subsidence range is 20mm to 30mm prior to flooding, with the average maximum above 31 different panels since 2003 being 24mm. Given that the experience at Clarence Colliery is the basis for the Airly Extension mine design, it is my opinion that the panel and pillar design should target the same surface subsidence as at Clarence, namely 20mm to 30mm, and therefore warrants redesign.

- The estimation of subsidence for first workings beneath the cliff lines (Zone 3 in Figure 1-21) are based on elastic theory for stable pillars. I consider this to be appropriate and accept that maximum settlement should be less than about 20mm. However, I am concerned with the conclusion given in Section 6.2.2 of Appendix D that where the workings may fill with water in the long term, settlements could reach about 65mm, with tilts in the range 0.6 to 1mm/m. These tilts mean that a 150m high cliff line could tilt up to 150mm, which is likely to cause joint opening and possible instability. Therefore, in my opinion, the reality is that some cliff line instability must be expected if the areas of first workings fill with water. Therefore, if the intent of the mine plan is to be achieved, namely no mine-induced cliff line instability it will be necessary to ensure that the first

[6] Figure 10 of Appendix C shows that the proposed Airly design covers a mining geometry for which there is no data in the Holla (1991) guidelines for the Western Coalfields.
[7] White, E. *Clarence Colliery – Partial Extraction to Protect Surface Features*. 9th Triennial Conference, Mine Subsidence Technological Society, Institution of Engineers, Australia, 2014.

workings can never fill with water. If this is not possible then, it is my opinion, that the intent of the mine plan may not be achieved.

- The estimates for the partial pillar extraction areas (Zone 2 in Figure 121) have been made using the same methodology as adopted for Zone 5, as discussed in Part 1 above. As shown by Pells (1991)[8], subsidence in the vicinity of the toe-lines of cliffs is critical to cliff line stability.

  It can be seen from Figure 1-18 that this mining zone constitutes a relatively small proportion of the mine area. Therefore given the uncertainty in respect to the subsidence movements, and the very adverse consequences of cliff line instability, it would appear to be wise and appropriate to eliminate this mining zone. In this case first workings would be adopted from the low cover area through to the plateau area.

- Panel and pillar mining is proposed beneath the old oil shale mine workings and it is predicted that new surface subsidence will be in the range 200mm to 500mm with tilts up to 17mm per metre. It is certain that such subsidence movements will cause substantial additional cracking in the surface area above the old workings and will cause cliff line instability in the escarpments around the perimeter of the old workings. In my opinion this level of surface damage should be unacceptable to Government authorities. It is my opinion that mining beneath the old oil shale mine should be limited to first workings.

- In Section 1.3, above, I have drawn attention to the fact that Appendix E of the EIS states there would be no mining beneath Gap Creek and Genowlan Creek where cover is less than 40m. This in effect constitutes Zone 6 for mine planning purposes. I have shown by Figures 1-21A and 1-21B that this statement has a significant impact on mine planning which is not addressed in Chapters 8 and 10 of the EIS. In my opinion, failure to incorporate Zone 6 in the mine planning presented in the EIS is a fundamental issue that warrants re-submission of the EIS.

2.2 Hydrogeology

I accept, as reasonable, the interpretation of the existing groundwater regime in the EIS, as summarised in Section 1.4.1, above. I also accept, as reasonable, the conceptual groundwater model for assessing groundwater impact, as summarised in Section 1.4.2.

The predicted impacts are based entirely on the computer calculations made using the software MODFLOW-2005. It is acknowledged that this is established software, but it is also noted that the software is known, in some cases, to incorrectly computer the impacts of downward seepage[9]. The situation in the plateau area at Airly involve substantial components of vertical downwards flow to the mine workings.

[8] Pells, P.J. N., *A note on escarpment instability associated with mining subsidence.* 2nd Triennial Conference, Mine Subsidence Technological Society, 1991.
[9] MODFLOW was developed by the USGR for large 3D problems involving dominantly horizontal flow. Pells and Pells (2013) have demonstrated some of the issues with vertical flow.

I was surprised that the MODFLOW analyses showed that "depressurisation of the Narrabeen Sandstone is expected to be negligible (not measurable) under proposed conditions throughout most of the strata". Because the details of the complex modelling are not given in the EIS, it was not possible to check the full 3D analyses. However, a check was made for the central part of the model, beneath the plateau area, where downward seepage gradients should be significant. Hydraulic conductivity values were adopted as per the EIS, as summarised in Table 3. Specific storage parameters were estimated.

Layer	Description	Thickness	From	To	kh	kv	Specific storage
		m	m		m/sec	m/sec	1/m
1	Soil	5	0	5	5.80E-07	5.80E-08	5.69E-06
2	Burra-Moko Head Sandstone	150	5	155	5.80E-07	5.80E-08	5.69E-06
3	Siltstone and Middle River Seam	40	155	195	2.20E-09	2.20E-10	2.16E-08
4	Irondale	4	195	199	5.80E-07	5.80E-08	5.69E-06
5	Siltstone	15	199	214	2.20E-09	2.20E-10	2.16E-08
6	Lidsdale	4	214	218	5.80E-07	5.80E-08	5.69E-06
7	Siltstone	3	218	221	2.20E-09	2.20E-10	2.16E-08
8	Lithgow seam	6	221	227	5.80E-07	5.80E-08	5.69E-06
9	Marangaroo	13	227	240	1.20E-08	1.20E-09	1.18E-07
10	Shoalhaven	100	240	340	3.50E-08	3.50E-09	3.43E-07

Two dimensional analyses were undertaken using the geometry and parameters as per Table 3 using four different versions of MODFLOW[10], and a finite element program SEEP/W[11].

The results of these analyses are given in Figure 2-1 and 2-2.

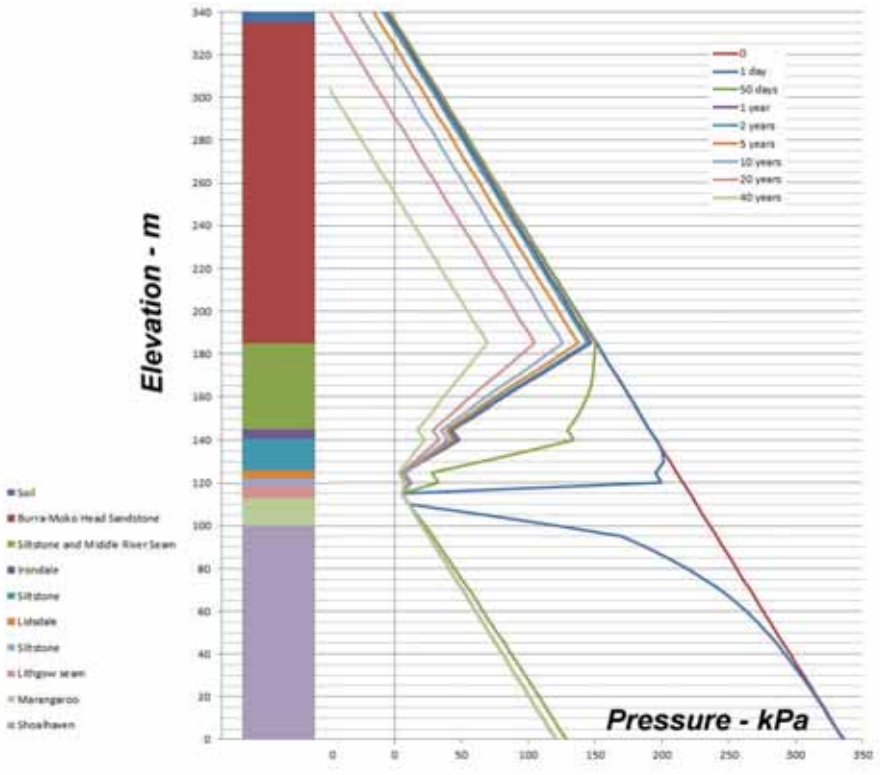

Figure 2-1: Results from SEEP/W analyses.

[10] MODFLOW 2000, MODFLOW 2005, MODFLOW-NWT, MODFLOW SURFACT.
[11] SEEP/W is very well established software from Canada with more than two decades of international testing.

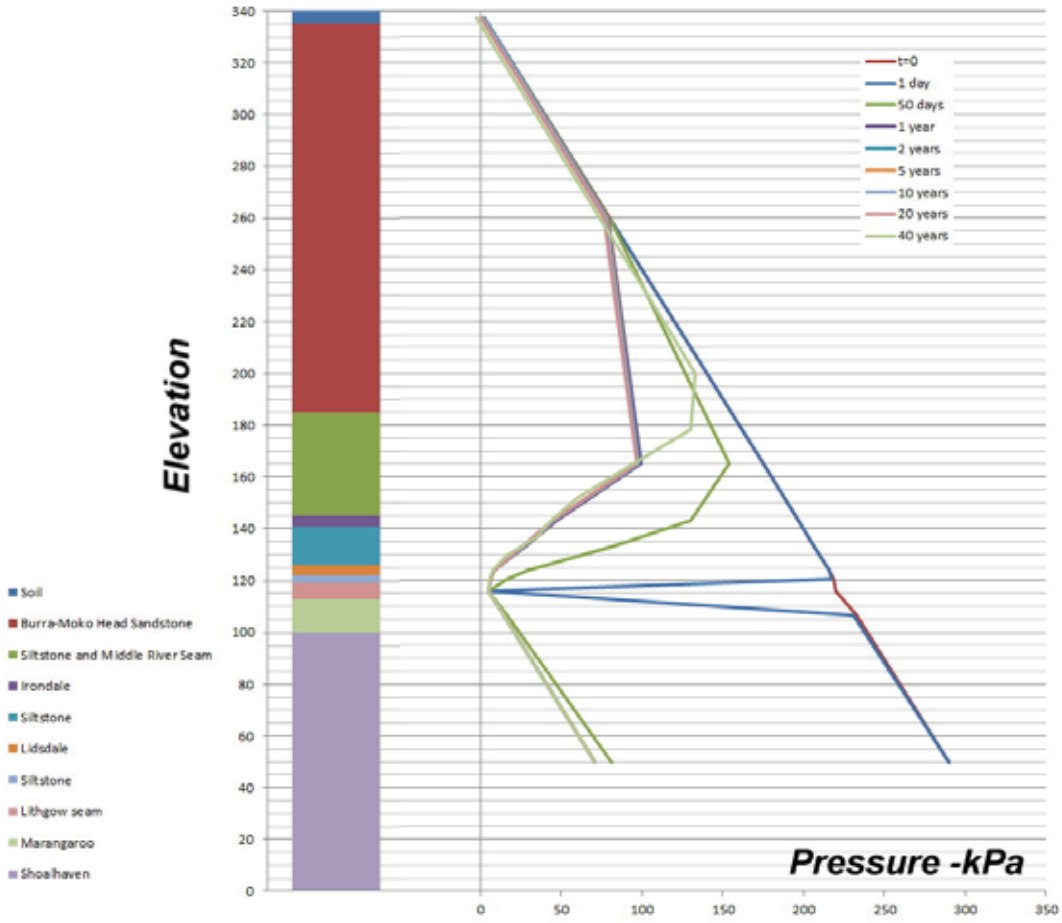

Figure 2-2: Results from MODFLOW-NWT analyses.

Figure 2-1 shows how the vertical groundwater pressure profile changes with time, in association with dewatering at mine level, using the SEEP/W software. It can be seen that the SEEP/W software shows that depressurisation within the Narrabeen Sandstone (Burra Moko Sandstone) continues with the passage of time. This is the behaviour I expect from first principal of physics.

Figure 2-2 shows the same plot but from the MODFLOW-NWT software. The results are similar to the SEEP/W for the initial few months, but after about 1 year computed depressurisation ceases within the Narrabeen Sandstone. This behaviour is inconsistent with fundamental principles, and appears to relate to the software. I have not determined the cause of this unexpected behaviour but it leads me to question a fundamental conclusion of the EIS, namely that there will be no depressurisation in the Burra Moko Sandstone and therefore no impact on springs and seeps that constitute baseflows to the creeks. It is my opinion that this matter warrants resolution by the consultants to Centennial Coal.

2.3 Heritage

While matters pertaining to Aboriginal heritage are outside my expertise, I do have substantial knowledge related to the history of oil shale mining in New South Wales as documented in a book by Pells and Hammon (2009)[12].

I note that Appendix J (Cultural Heritage) contains the following statement:

> *"The Airly shale mining complex sits between Mount Airly and Genowlan Mountain in a dramatic and highly scenic landscape characterised by sweeping topography, dense vegetation and large sandstone mesas rising from the Capertee Valley floor. As such, the Airly site and its visual setting have high aesthetic value. Some of the more intact dwelling remains such as the so called Manager's House and the Bakery are considered to be picturesque ruins with visually impressive backdrops (refer to Plates in Section 4). In many cases, therefore, it is the combination of the site components and their setting that creates attractive views/vistas. The introduction of access generally including a transport system in the form of the haulage skipway/tramway, the mine workings themselves and the associated dwellings to this remote location was undoubtedly a feat of technical ingenuity. It is understood that the introduction of tramways in particular, initially a narrow gauge tramway on a self-activating inclined way followed by a double line cable tramway which passed through the mountain, were considerable technical achievements."*

It then states:

> *"The principle element ensuring negligible impact to the Airly shale mining complex is the Centennial Airly Mine Plan. Whilst the Airly shale mining complex will be undermined using partial extraction mining methods, the mining occurs at depth resulting in a predicted level of between 0 and 10 millimetres of subsidence. As such, there will be no impact on the remnant structures."*

The statement that subsidence will be limited to between 0 and 10 millimetres is given nowhere else in the EIS and is not true. This must call into question the conclusions in regard to impacts on Aboriginal and European heritage.

Yours faithfully

PHILIP PELLS

[12] Pells, P.J. and Hammon, P.J. (2009), "*The Burning Mists of Time. A Technological and Social History of Mining at Katoomba".* Philsquare Publishing.

APPENDIX A

CURRICULUM VITAE OF DR PHILIP PELLS

PHILIP J. N. PELLS

FTSE BSc(Eng) MSc DSc(Eng) DIC CPEng MASCE FIEAust

Educational Qualifications:

BSc (Eng), Cape Town, 1966
MSc (Eng), London, 1968
DIC (Soil Mechanics), London, 1968
DSc(Eng), Cape Town, 1993

Professional Associations:

Fellow, Engineers Australia
Fellow Australian Academy of Technological Sciences and Engineering
Member ASCE

Awards:

1972 SA Inst of Civil Engs – Best Paper in Transactions
1993 EH Davies Memorial Lecture, Australian Geomechanics Society
2003 Australian Centenary Medal for Services to Civil Engineering
2008 Allen Neyland Award, AusIMM

FIELDS OF SPECIALISATION:

- tunnels and mining rock mechanics,
- earth and rockfill dams, and tailings dams,
- hydrogeology,
- foundations, slope stability and design of stabilisation works
- haul road and heavy duty pavements

EMPLOYMENT:

2009
Principal, Pells Consulting

1993 - 2009
Principal, Pells Sullivan Meynink Pty Ltd
Adjunct Professor of Civil Engineering, University of NSW

1981 - 1993
Director, Coffey Partners Pty Ltd, Sydney
Manager, New South Wales

1975 - 1980
Senior Lecturer in Rock Mechanics, University of Sydney

1971 - 1974
Senior Research Officer, Rock Mechanics Division, CSIR
Senior Research Officer, National Institute for Road Research, CSIR

1967 - 1970
Design Engineer, Ninham Shand & Partners, Cape Town - Assistant Resident Engineer, Xonxa Dam

MAJOR PROJECTS:

Dr Pells' contributions to projects he has worked on since 1970 are summarised in a separate document titled Project Summaries and Publications given on the website www.pellsconsulting.com.au.

The following projects are highlighted to give an idea of the range of work undertaken.

Sydney Harbour Tunnel	Sydney	Geotechnical investigations and geotechnical design studies for the tunnel beneath Sydney Harbour.
Bennelong Car Park	Sydney	Site investigation for 17.5m span underground cavern, rock mechanics analyses, primary and permanent support design, instrumentation installation and monitoring, construction control.
Eastern Distributor	Sydney	Development of concept of piggyback tunnel including upper carriageway carried on prestressed concrete planks supported by narrow ledges of rock. Design of permanent support for tunnels in project. Provision of technical advice during construction.
MK1 Transfer Station Chuquicamata	Chile	Independent investigation and reporting in regard to the collapse of the MK1 Cavern that stopped production from the in-pit crushers. Work done together with SRK Chile.
Gateway Bridge	Brisbane	Investigation, design recommendations and construction advice and inspections for rock socketed foundations for Pier 7.
Selangor Turf club	Kuala Lumpur	Site selection for proposed new race course at Sungei Besi, evaluation of settlements and earthworks requirements for construction on an abandoned tin mine site.
Yandicoogina Bridge, Area C, Pilbara	WA	Specialist advice in regard to stability against toppling and sliding of pier foundation on edge of gorge, including recommendations for rock mass reinforcement.
Rio Tinto Technical Services	International	Preparation of pavement design part of Rio Tinto's design and construction guidelines for haul roads within Rio Tinto's international operations.
De Beers Open Pit Diamond Mine	Kimberley, NSW	Analysis of movements in side slopes of old open pit diamond pipe.
Bengalon Coal Prospect, East Kalimantan	Indonesia	Terrain evaluation and preparation of detailed designs for out-of-pits waste dumps including catchment diversion requirements and control of acid generation.
Thredbo	NSW	Member of PSM team acting as advisors to the NSW Coroner on the causes of the 1997 landslide at Thredbo. Responsible for all testing and stability analyses.

Melawan Open Pit and Satui Open Pit, Thiess Indonesia	Kalimantan	Investigation analysis and reporting on causes of failure of in-pit dumps of December 2010 and September 2011.
Xonxa Dam	South Africa	Design of 60m high rockfill dam including reinforcement layout for downstream face. Assistant Resident Engineer during construction.
Kelian Gold Mine, East Kalimantan	Indonesia	Site investigation, design and construction advice for a 120m high sloping clay core rock fill dam completed in October 1996. This project includes three saddle dams, one 70m high with a vertical core, the other two 12m and 20m high.
Ballarat Goldfield, NL	Victoria	Formulation of geotechnical model and design of primary and permanent support for 250m deep 1 in 8 decline in squeezing ground comprising extremely weathered siltstone of unconfined compressive strength ranging from 0.5 MPa to 2.5 MPa.

PUBLICATIONS:

Dr Pells has published four books, 54 refereed papers and 38 conference papers. Details are given in the separate document cited above.

APPENDIX B

DOCUMENTATION

APPENDIX B
DOCUMENTATION

1. Golder Associates (September 2014). EIS Airly Mine Extension, Chapter 8, Mine Design and Subsidence.

2. Golder Associates (September 2014). EIS Airly Mine Extension, Chapter 10, Assessment and Management of Key Environmental Issues.

3. Golder Associates (undated) Report No. 127621105-003-R Rev 2, Subsidence Predictions and Impact Assessment for Airly Mine, being Appendix D of EIS.

4. GHD and Centennial Coal (July 2014). Groundwater Impact Assessment, Airly Mine Extension Project, being Appendix E of the EIS.

5. GHD and Centennial Coal (July 2014) Surface Water Impact Assessment, being Appendix F of the EIS.

6. Centennial Coal (September 2014) Environmental Impact Statement, Volume 1, Report, which is actually only an Executive Summary and Table of Contents.

7. Golder Associates (June 2014). Pillar Stability and Subsidence Assessments for the 205 Panel Extension, 100 Cross Panel, 420 Panel, 121 Panel and 122 Panel. Report No. 127621105-109-Rev 1.

8. Centennial Coal, Airly (June 2014). Airly Mine Extension of Time. Section 75W Modification to Development Consent DA 162/91.

9. Carne, J. E. (1903). The Kerosene Shale Deposits of New South Wales. Geological Survey of NSW, Memoir No. 3.

10. RPS Australia East Pty Ltd (August 2014). Airly Mine Extension Project, Cultural Heritage Impact Assessment.

The Australia Institute

Research that matters.

Airly Mine Extension Proposal

Submission
October 2014

Rod Campbell

TAI

Submission

The Australia Institute

Research that matters.

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Level 5, City Walk Centre
131 City Walk
Canberra City, ACT 2601
Tel +61 2 6130 0530
Email: mail@tai.org.au
Website: www.tai.org.au

Introduction

The Australia Institute welcomes the opportunity to make a submission on the Airly Mine Extension Proposal. Our submission relates to the Economic Impact Assessment of the proposal by consultants AIGIS Group, included as Appendix N to the Environmental Impact Statement (EIS). The results of this appendix are the basis for economic claims in EIS Chapter 6 – Socio-economic analysis, Chapter 12 – Justification and Conclusion and the Executive Summary.

The Economic Impact Assessment of the Airly project does not comply with Australian and NSW government guidelines for economic assessment and makes basic technical errors in its application of cost benefit analysis and environmental economic techniques.

The assessment fails to discuss the major costs and benefits of the project, giving decision makers no insight into the financial strength or otherwise of the project and the reliability of the estimates of economic benefit.

One major technical error is the inclusion of wages in the benefit calculations of the project. This assumes that all employees would otherwise be unemployed for the duration of the project, an assumption that is not realistic at any time other than during a deep economic depression, which is clearly not the case in NSW.

Attempts have been made to evaluate the environmental impacts of the project. While these attempts are welcome and some of the references used are important studies, the application of environmental economic techniques does not meet standards expected in the economics profession.

Approach to economic assessment

The economic assessment written by AIGIS Group is not based on standard economic assessment techniques and does not comply with NSW Treasury or Federal Government guidelines. This is acknowledged by AIGIS group:

> *The approach taken in this report may be considered as being unorthodox in the context of the use of cost-benefit analysis techniques. However, the intent is to produce material which facilitates 'lay' stakeholders to better comprehend the analysis presented, as it relates to project impacts likely to be of greater significance to such stakeholder groups.*[1]

It is surprising that research submitted to a formal planning process would be based on 'lay' economics rather than standard approaches supported by government departments. This approach has not been adopted in other parts of the EIS – sections relating mine design are not based on 'lay' engineering and seem to employ very 'orthodox' approaches to geology. While we support any attempt to make economics more accessible to the public, this should not be at the expense of the quality of the analysis, as is the case here. It is convenient for the proponents that AIGIS Group's approach to 'lay' economics happens to overstate the value of their project to NSW by at least $100 million, as will be discussed below.

Furthermore, the main audience for EIS technical appendices is not the general public, but NSW decision makers, government departments and members of the public with a strong interest in planning. All of these groups have members and staff with training in 'orthodox' economics and are not assisted by distortions ostensibly aimed at making results more

[1] (AIGIS Group, 2014a) p9

accessible. Centennial Coal can, and does, promote its economic claims on its website and other public relations material.[2] The EIS process is not the place for such promotion.

Employment and wages in cost benefit analysis

Wages and opportunity cost of labour

The most significant technical error in the Economic Assessment is the treatment of employment. Decision makers should certainly consider the jobs of the 135 people who would work on the project. However, the value of employment is fundamentally overstated in the Economic Assessment.

The Economic Assessment treats wages earned by workers as a benefit of the project. While wages are beneficial to workers, they are a cost to the mine, so the treatment of wages in cost benefit analysis needs to be carefully considered.

The standard assumption for cost benefit analysis is that workers would work in other jobs if this project did not go ahead, as is made clear in the federal guidelines for cost benefit analysis:

> *As a general rule, it is recommended that analysts assume that labour, as with other resources, is fully employed. Moreover, unless the project is specifically targeted towards the goal of reducing unemployment, it can be expected that many of the jobs will be filled by individuals who are currently employed but who are attracted either by the pay or by other attributes of the new positions.*[3]

Cost benefit analysis only includes wages as a benefit if it can be shown clearly that workers on the project would not otherwise have a job, or be engaged in any productive activity. In times of very high unemployment this may be a possibility, but with NSW unemployment at around 5.8 per cent, this is not an appropriate assumption. To include wages as a partial benefit, it has to be shown that some degree of the labour on the project would otherwise be unused, as is emphasised by NSW Treasury:

> *It can be argued that in times of unemployment the opportunity cost of labour employed on a project is less than the wage costs, and project costs and benefits should be adjusted accordingly. However, in practice such adjustments are not generally made and are not recommended.*[4]

AIGIS Group make no attempt to estimate what portion of workers on the project might otherwise be unemployed and therefore assume that all workers would be otherwise unemployed for the duration of the project. In a highly skilled industry like mining this is clearly incorrect, as these skills would be used in other mining, construction and engineering projects. This is stressed in discussion of cost benefit analysis commissioned by the proponents of the Maules Creek Coal Project:

> *BCA involves the comparison of the 'with and without' project circumstances. The use of resources with and without the mine must therefore be considered. Without the mine, the resources to be allocated to the mining operation would be engaged in other uses in the economy. These are the opportunity costs of the proposed mine. Given that markets for these resources (land, machinery, labour etc.) in the Australian*

[2] See for example http://www.centennialcoal.com.au/Operations/Projects/Airly-Extension.aspx
[3] (Department of Finance and Administration, 2006) p40
[4] (NSW Treasury, 2007) p48

> *economy are relatively competitive and not highly distorted by subsidies and regulations, market prices reflect these resources opportunity costs.*[5]

The correct treatment of the wages related to the project is to treat them as a cost to the proponents, one that will be covered by revenue from sales. If it can be shown that some portion of this employment would otherwise not exist, some small amount can be included in the cost benefit analysis, however this is not standard practice in NSW or more widely.

The result of including wages as a benefit is that the AIGIS Group cost benefit analysis overstates benefits by present value $102.6 million.[6] Under standard assumptions, none of this amount would be included in a cost benefit analysis.

Main costs and benefits

Proper cost benefit analysis gives readers some idea of the financial strength of the project. By presenting estimates of likely revenues and costs, readers can assess the degree to which the project will be able to operate through market fluctuations and other difficulties. Readers gain some understanding of the likelihood of benefits such as royalties and employment being maintained at the claimed levels.

Given the importance of this information to stakeholders, it is surprising that this EIS says:

> *This material is unsuitable for presentation in a document which is intended for public exhibition and is excluded from this Economic Assessment on that basis.*[7]

Proposals by Centennial, assessed by the AIGIS Group, are the only projects to make this claim. Every other recent coal project in NSW has included broad estimates of capital and operating costs as well as likely revenues. Companies such as Rio Tinto, BHP Billiton, Whitehaven Coal, Glencore, Yancoal, Shenhua and many others do not consider such estimates to be unsuitable for the public and provide it in their economic assessments.

Centennial and AIGIS Group adopted the same approach in their assessment of the Angus Place extension proposal. Showing no cost or revenue estimates, they claimed the project would operate for 25 years, bringing 225 jobs and $770 million in benefits, including $203 million in royalties.

None of these benefits are likely to occur, however, as Centennial recently announced the suspension of operations at Angus Place and probable cancellation of the extension:

> *In this current market that additional investment that we'd need to get [for the Angus Place Extension] is extremely difficult to justify on the back of both the domestic and international market.*[8]

No indication is provided in the AIGIS Group assessment of the Angus Place project that such an outcome was possible.

The economic strength of the Airly project is also impossible to gauge from the EIS submitted based on non-transparency and 'lay' economics. Airly's viability should be questioned as since beginning operation in 2009-10, the project has already been closed and put in care

[5] (Bennett, 2011) p2
[6] See (AIGIS Group, 2014b) p19, the sum of construction and mine operation employment benefits.
[7] (AIGIS Group, 2014b) p14-15
[8] Centennial's Managing Director, David Moult, quoted on ABC website, http://www.abc.net.au/news/2014-10-29/another-coal-mining-blow-for-lithgow3a-angus-place-mothballed/5850380

and maintenance for over a year between 2012 and 2014, a fact not mentioned in AIGIS Group's otherwise comprehensive history of the mine on page12.

This shows that the Airly mine is a marginal operation and that future interruptions should be expected. This is confirmed by company statements. While AIGIS Group considers that discussion of Airly's costs and revenues is too sensitive for the NSW public, Centennial's parent company, Thailand's Banpu, shows no such reservations:

> *Centennial's run-of-mine output in 2013 decreased … The decrease was due to the higher cost Airly and Mannering operations being placed under 'care and maintenance' throughout the year.*[9]
>
> *Airly is a high cost operation and a decision has been made recently to put it onto care and maintenance and to transfer equipment to Clarence.*[10]
>
> *In 4Q12 the operations of Airly and Mannering, both regarded as small and high-cost mines, were put in Care and Maintenance phase in order to improve efficiency for the group.*[11]

Discussion of project economics, including costs and benefits, is important for decision makers. This is emphasised in the NSW Treasury *Guidelines for use of Cost Benefit Analysis in mining and coal seam gas proposals*:

> *Benefits and costs should be estimated where possible as those that accrue for New South Wales. In the first instance, it will generally be most practical to assess all major costs and benefits to whoever they accrue and then adjust to estimate the proportion of these attributable to residents of the State.*

Clearly, the financial strength of the project is important to the NSW community. The community and decision makers should have an understanding of the project's economics to ensure that the claimed benefits – such as jobs and royalty revenues – actually do materialise. Where projects are financially weak, they fail to provide these benefits but still impose costs on the community. From publically available information the Airly project appears financially marginal.

Environmental impacts

Environmental costs associated with the project have been estimated through "benefits transfer". Benefits transfer involves taking the results of environmental valuation studies in one area and applying them to the area in question. Benefits transfer is not ideal – ideally detailed studies would be done relating to the project area. However this is not always practical or possible, so using benefits transfer can be an acceptable way of estimating environmental impacts in monetary terms.

Great care must be taken, however, to ensure that appropriate studies have been used and that their results have been carefully adapted to the relevant impacts. Analysts must outline why they have chosen particular studies and what they have done to "transfer" these results. Unfortunately no such analysis is provided in the Angus Place economic assessment. Studies used in the assessment and some comments are provided in Table 1 below:

[9] (Banpu, 2014) p11
[10] (Banpu, 2013) p11
[11] (Banpu, 2013) p106

Table 1: Environmental valuation in the Airly EIS

Impact	Study used	Comment
Noise	Day B, Bateman I & Lake I (2010): "Estimating the Demand for Peace and Quiet Using Property Market Data" - Hedonic pricing (impact on dwelling values)	This study is based on property sales data from 1997 in Birmingham in the UK. It is unclear why this study has been used, when similar studies have been conducted in Australia.
Subsidence, soil and water	Streever WJ, Callaghan-Perry M, Searles A, Stevens T & Svoboda P (1998): "Public Attitudes and Values for Wetland Conservation in New South Wales, Australia"	There have been many environmental valuation studies done in NSW since 1998, including in relation to coal projects and subsidence. Why this one is used and how its values have been applied is unclear. Of greater significance, however, a willingness to pay value has been calculated only for households in Lithgow. As the project's subsidence impacts will affect significant areas, the willingness to pay of households in the rest of NSW or Australia may be relevant. This is emphasised in evaluation of similar impacts in the Warkworth case in the Hunter Valley, see (Preston, 2013). The approach taken is therefore likely to heavily undervalue the potential impacts of the project. Why this same study has been applied to estimate impacts on soil, surface water, groundwater and natural heritage impacts is unclear and seems inappropriate.
Air	DEC NSW (2005): "Health Costs of Air Pollution in the Greater Sydney Metropolitan Region"	This is a well-known study and an obvious choice to assist in evaluating this impact. More detail needs to be provided on how values calculated for the entire greater Sydney area have been applied to 17 individuals and whether this is the appropriate approach to take in valuing this impact.
Heritage	Allen Consulting Group (2005): "Valuing the Priceless: The Value of Heritage Protection in Australia"	This study relates to a nation-wide survey of attitudes towards heritage protection. Why this study was chosen when studies relating specifically to aboriginal heritage sites exist is unclear. Minimal detail is provided on how the results of this study have been adapted to the Airly situation.
Biodiversity	Land & Water Australia (2005): "Making Economic Valuation Work for Diversity Conservation":	This reference is not an economic evaluation of biodiversity impacts, but a basic review of environmental economic techniques. The economic assessment seems to base its evaluation from a text box in this report relating to a separate study, Jakobsson K. &

		Dragun A. (2001) *The worth of a possum: valuing species with the contingent valuation method.* Environmental and Resource Economics 19, 211-227. AIGIS Group make no comment as to whether this study's context in Victoria is applicable to the Capertee area or how its results were adapted.
Visual	Curtis I.A. (2004): "Valuing Ecosystem Goods and Services: A New Approach Using a Surrogate Market and the Combination of Multiple Criteria Analysis and a Delphi Panel to Assign Weights to Attributes"	Curtis's ecosystems valuation approach is an interesting and important development in ecological economics. However, this study is based on ratable land values and evaluation of all aspects of ecosystems services in the Queensland Wet Tropics World Heritage Area. It is completely unsuitable for evaluation of visual impacts of the Airly project. This is the opinion not just of The Australia Institute, but of the author of the study, who we contacted for comment. AIGIS Group have either not read or not understood Curtis' study.

Decision makers should give little weight to the evaluation of environmental costs in the Economic Assessment. An identical approach was adopted in AIGIS Group's assessment of the Angus Place project. In their response to submissions their main defence of their choice of benefits transfer studies is that they appear in the Environment and Heritage Department's Environmental Valuation Reference Inventory. Their appearance in this inventory does not justify their use and shows AIGIS Group's limited knowledge of wider environmental valuation literature. While some of the studies used to evaluate these impacts are important pieces of research, the level of rigour applied to adapting these results to the Airly project falls far short of standards expected within the economics profession.

Conclusion

The economic assessment of the Airly coal project makes fundamental errors in economic theory and fails to comply with state and federal guidelines. The authors justify their departure from standard economic practice by claiming to write for a 'lay' audience. This not only serves to overstate the value of the project by over $100 million, but insults their primary audience – NSW planning officials.

Wages are incorrectly counted as a benefit of the project. This is inappropriate as it assumes workers would otherwise be unemployed for the duration of the project – a situation highly unlikely in NSW.

By not including any discussion of the major costs and benefits of the project, such as capital costs, operating costs and coal sales revenue, the Economic Assessment provides decision makers with no understanding of the project's economics. It is impossible to assess whether, and under what circumstances, the project will be able to provide the jobs and royalties claimed by the proponents. This is especially surprising for a project which has been in and out of care-and-maintenance in its short life and is openly acknowledged as high-cost by its owners.

References

AIGIS Group. (2014a). *Airly Mine Extension Project Economic Impact Assessment*.

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