

## Advice to decision maker on coal mining project

### IESC 2014-059: Airly Mine Extension Project (EPBC 2013/7076, SSD – 5581) – Expansion

<b>Requesting agency</b>	The Australian Government Department of the Environment The New South Wales Department of Planning and Environment
<b>Date of request</b>	08 October 2014
<b>Date request accepted</b>	09 October 2014
<b>Advice stage</b>	Assessment

#### Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and the New South Wales Department of Planning and Environment to provide advice on the Airly Mine Extension Project proposed by Centennial Airly Pty Ltd in NSW.

This advice draws upon aspects of information in the Environmental Impact Statement (EIS), together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The Airly Mine Extension Project (the proposed project) is an extension to the existing underground Airly Coal Mine, located at the northern fringe of the Western Coalfields in the Sydney Basin, approximately 40 km north-northwest of Lithgow. Airly Coal Mine is currently operating under development consent (DA 162/91) dated 14 April 1993, recently extended (MOD3) to 31 October 2015.

The proposed project will produce 1.8 Million tonnes per annum run of mine (ROM) coal from the Lithgow seam beneath Mount Airly and Genowlan Mountain using a variety of underground partial extraction techniques. The project application area is 3982 ha and proposed mine life 25 years. Additional infrastructure under the proposal includes a coal preparation plant, a ROM coal stockpile, life of mine reject emplacement area and associated changes to the water management measures at the pit-top.

Water is proposed to be discharged from the site into Airly Creek, which flows through the Gardens of Stone National Park, part of the Greater Blue Mountains World Heritage Area (GBMWA), immediately south of the proposed project area. Surface waters within the proposed project area, including Airly, Gap and Genowlan creeks, and groundwater within the Sydney Basin North groundwater source are managed by water sharing plans for the Greater Metropolitan Region.

### Key potential impacts

- Potential impacts to the flow regime and water quality in Airly Creek due to the discharge of mine affected water, which flows through the Gardens of Stone National Park, part of the GBMWHA.
- While impacts to regional water resources are considered unlikely, subsidence and drawdown impacts are likely to reduce flows in Gap and Genowlan creeks and potentially impact local groundwater dependent ecosystems.

### Assessment against information guidelines

The IESC, in line with its Information Guidelines<sup>1</sup>, has considered whether the proposed project assessment has used the following:

#### *Relevant data and information: key conclusions*

While there is generally sufficient baseline surface water quality data available, there is no baseline surface water hydrology data for Airly Creek. Little information is available on the existing workings in the New Hartley Shale Mine Potential Interaction Zone and as a result, the potential subsidence effects and associated impacts on surface water and groundwater resources are uncertain. There is little aquatic ecology data available for downstream environments as sampling for macroinvertebrates and fish was restricted to the proposed project area, except for two sites on Dog Trap Creek.

#### *Application of appropriate methodologies: key conclusions*

Appropriate analytical, empirical and numerical methods have been used to estimate subsidence impacts. While fault zones are identified within the proposed project area, they are not included within the groundwater model and their potential impacts on aquifer connectivity and groundwater flow are not considered, limiting confidence in model predictions. The groundwater model is appropriate for prediction of regional-scale impacts of the proposal but finer resolution is needed to accurately predict potential impacts to the local environment, specifically including surface water–groundwater interactions.

The project assessment documentation is lacking in its identification of groundwater dependent ecosystems (GDEs). There is no estimation of the ecological water requirements of identified GDEs and no ecological conceptual model provided. This information is important for informing the appropriate resolution of future groundwater modelling.

The proponent recognises that there were limitations with the sampling methodology for stygofauna: methods used varied between bores, there were a limited number of available and suitable bores, and sampling may have been conducted too soon following purging.

Conclusions about the lack of likely impacts on the GBMWHA resulting from hydrology and water quality changes in Airly Creek are not supported by appropriate data and analysis. Identification of the relative contribution of waterways within the proposed project area to flows within the GBMWHA, and identification of potential water-dependent assets within the nearby Gardens of Stone National Park, is needed to support such conclusions.

#### *Reasonable values and parameters in calculation: key conclusions*

The groundwater impact assessment is based on the 'average' fracturing scenario for strata above the panel and pillar sections of mining within the Lithgow Seam. The risk assessment and water balance should include a sensitivity analysis.

## Advice

The IESC's advice, in response to the requesting agencies' specific questions is provided below.

Question 1: In respect to the baseline data utilised in the EIS: Has the baseline climate, groundwater and surface water data been collected to a satisfactory standard over an appropriate timeframe?

### Response

1. Climate, surface water quality and groundwater data has largely been collected to a satisfactory standard and over an appropriate timeframe, but surface water hydrology data is lacking for Airly Creek.

### Explanation

2. Climate data is generally sufficient, however rainfall data used in the surface water model predictions, and in groundwater recharge predictions, should be validated to confirm its representativeness (discussed further in response to Question 2).
3. A reasonable number of surface water quality samples are provided covering a sufficient period. However water quality data was not related to flow volume, therefore variations in water quality associated with flow variability were not represented.
4. There is generally sufficient hydraulic and hydrochemical data to establish existing conditions for groundwater. Aquifer physical parameters are based on 14 falling head and packer tests in shallow units and one pumping test in the production bore in the Shoalhaven Group.
5. There is no hydrology data presented for Airly Creek or downstream environments within the GBMWA. The baseline hydrology of Airly Creek needs to be established to demonstrate that changes to flow from mine water discharges will not have adverse effects on the downstream environment.

Question 2: In respect to the baseline data utilised in the EIS: Are the rainfall records relied upon in the EIS sufficiently representative of the Airly site for water modelling and prediction purposes? Are better rainfall records available?

### Response

6. It is not possible to answer whether there are better rainfall records available based on the information provided.
7. To determine the representativeness of rainfall data used in the EIS for modelling and predictive purposes, an event-based comparison of the rainfall-runoff model against the limited rainfall and stream-gauge data from the site should have been undertaken.
8. Rainfall records, if they exist, should be examined to determine whether there are spatial variations in respect to geomorphic differences such as elevation, slope, and aspect. This variability could impact on the surface water model for the site.

### Explanation

9. The water and salt balance assessments within the EIS and recharge component of the numerical groundwater model used daily rainfall records as SILO Patched Point Data from the Queensland Climate Change Centre of Excellence. The data was based on historical data from Bureau of Meteorology (BoM) station Ilford (Warrangunyah; 62031), located approximately 29 km northwest of Airly Mine at an elevation of 750 m, with missing data 'patched in' by interpolating

data from nearby stations. The proponent considered this data to be appropriate due to the length (January 1901–December 2012), quality of the data record, and proximity to the mine site.

10. The Ilford rainfall station lies within a separate rainfall district to the Airly mine site<sup>2</sup>. Without any analysis it is not possible to tell how representative the data may be. In flatter terrain the rain gauge chosen for the assessment would be suitable. However in the mountainous terrain of the proposed project area the representativeness of the data may be affected by the comparative elevation, aspect and slope of the gauging site relative to relevant features at the mine site.
11. Site-specific rainfall data was also available for the period April 2010 onwards. No metadata or statistical summary are presented in the EIS for the site-specific rainfall data. The site-specific rainfall data was used for comparison against gauged flows in Village Spring, Gap Creek and Genowlan Creek as shown on Figures 5-6 to 5-8 on pages 56–57 of the EIS Surface Water Impact Assessment.

Question 3: In respect to the baseline data utilised in the EIS: Are there significant geological features present that have the potential to act as preferential pathways between the different hydrogeological units and have these been adequately investigated for inclusion/omission within the groundwater model?

Response

12. There are significant structural features (faults) present in the proposed project area that have the potential to act as preferential pathways for water flow within and between different hydrogeological units. These structural features have not been considered in the hydrogeological modelling and groundwater impact assessment.
13. A sensitivity analysis of the potential impacts of faults on the groundwater system and mine inflows would improve confidence in the groundwater risk assessment. Further evidence of the hydraulic characteristics of these structural features should be gathered through continued monitoring of groundwater levels and inflows to the underground workings. Resultant risks to groundwater resources should be assessed and the groundwater model adjusted as needed to ensure that the effects of structural features are captured in updated model predictions.

Explanation

14. A structural risk assessment<sup>3</sup> identified a number of prominent intersecting NW, NE and NS trending structures, which are interpreted to extend from basement strata to the surface. There are also significant structural features noted in the EIS (Chapter 8). The Groundwater Impact Assessment (s 5.1.5) assumes that the natural vertical structural features are discontinuous and does not include them in the groundwater modelling or impact assessment.
15. Aquifer testing of the production bore<sup>4</sup>, originally installed to target several sub-vertical geological structures suggests intersection of a high conductivity zone which may be a fault or a more permeable layer in the strata. This means that the hydrogeological conceptual model needs refinement.
16. The influence of these identified features within basement and shallow geology on groundwater systems and flow is not adequately addressed in the groundwater modelling and impact assessment. Increased groundwater flow along structural features could result in mine inflows greater than currently predicted and variable impacts to groundwater levels.

Question 4: In respect of the EIS's groundwater modelling and its assessment of the impacts of potential water discharges to surface waters: Does the groundwater model use reasonable and suitable characterisations of the groundwater resources for the Project?

### Response

17. The groundwater model is based on a reasonable conceptualisation of groundwater resources. However predictions of mine inflows and baseflow losses are sensitive to hydraulic properties of fracture zones overlying mined areas, which are yet to be verified. A description of the likelihood of each fracturing scenario and an explanation as to why the chosen scenario was adopted for impact assessment and water balance modelling would be beneficial. Ongoing assessment and verification of hydraulic properties of fracture zones induced by mining would improve confidence in model predictions.
18. Finer discretisation within the model in areas of potential groundwater-surface water interaction would improve confidence in predictions of baseflow and alluvial groundwater levels.

### Explanation

19. The Hydrogeological Model Report identifies the potential mining-induced changes to baseflow conditions under Scenario 1 (no induced fracturing above the mine) and Scenario 2 ('average' induced fracturing and increased hydraulic conductivity values above the mine). Predictions of baseflow losses associated with hydraulic properties calculated for the highest predicted ('active') fracturing scenario are likely to be greater, but are not reported. An explanation has not been provided for the fracturing scenario chosen.
20. The model has a relatively large mesh size (50 m by 50 m) in the vicinity of streams, considering the relative size of streams and associated alluvium. The scale and discretisation of the model is suitable for general drawdown estimates, but finer discretisation combined with additional baseflow monitoring points in creek and alluvium areas to use as model calibration targets, would improve confidence in predictions of drawdown in alluvium and baseflow reductions. Improved identification of local GDEs and their water requirements would inform future modelling, including appropriate model resolution.

Question 5: In respect of the EIS's groundwater modelling and its assessment of the impacts of potential water discharges to surface waters: Are the anticipated quantitative groundwater and surface water impacts accurately and reasonably described?

### Response

21. No. The predictions of baseflow and mine inflows do not quantify potential impacts of structural features present on the site or the full range of potential subsidence impacts, i.e. the 'active' fracturing scenario. Consideration of the full range of likely induced hydraulic properties above mined areas and the potential effects of geological structures would improve assessment of the potential impacts of the proposed project on groundwater and surface water resources.
22. Further, potential impacts associated with springs and seepages highlighted in the aquatic ecology and stygofauna assessment are not adequately considered in the groundwater impact assessment.

Question 6: In respect of the EIS's groundwater modelling and its assessment of the impacts of potential water discharges to surface waters: Are the predictions of loss flows in local streams reasonable? (Tables 10.5 and 10.6 on pages 290 and 291 of the EIS main text)

### Response

23. There is limited confidence in the predictions of baseflow losses from the current groundwater model due to inadequate consideration of structural features, lack of verification of sensitive fracture zone hydraulic properties and the relatively large mesh size within the model in the

vicinity of streams. There is also a lack of baseflow measurements to utilise as model calibration targets. As mining progresses, calibration to actual mine inflows and stream baseflows would improve confidence in predictions.

Question 7: In respect of the EIS's groundwater modelling and its assessment of the impacts of potential water discharges to surface waters: Is it reasonable for the EIS to rely on the conclusion that "There is minimal hydraulic connection between the local and regional groundwater sources"? (Page 277 of the EIS main text)

Response

24. From the information provided it is considered likely that there is minimal hydraulic connection between the local and regional groundwater systems. However structural features (faults) are present on the mine site, which potentially contribute substantial quantities of water to the production well, as indicated by the high conductivity zone intersected during aquifer testing of the bore<sup>4</sup>. The contribution of these structural features to aquifer connectivity has not been determined nor reflected in the groundwater model. There is the potential that these features may intersect both local and regional groundwater systems.
25. Monitoring of groundwater levels within the Shoalhaven Group strata in the vicinity of the production well and to the east of the proposed project area, ongoing monitoring and verification of model parameters and associated incorporation of identified structural features in the groundwater model as needed would provide early warning of any potential impacts to regional groundwater resources.

Explanation

26. The proponent has identified a series of N-S and NW-SE trending faults, of which, the N-S faults were associated with the greatest displacement. The potential influence of faults on hydrogeological unit connectivity, groundwater flow, and mine water inflows has not been sufficiently assessed.
27. Groundwater level drawdown during testing of the production bore potentially intersected a high conductivity zone, which raises the possibility that faults act as groundwater flow conduits between different strata. It is unlikely that faults would act as connective groundwater flow conduits between the deeper regional Devonian hydrogeological unit and mine workings. However faults and depressurisation of the Lithgow Seam may encourage groundwater flow between the mine workings and both overlying and underlying strata, including the upper regional groundwater source (Shoalhaven Group), which could result in greater than predicted mine water inflows.
28. Ongoing monitoring of groundwater levels and inflows to the underground workings should be used to assess hydraulic properties of faults. The hydraulic nature of the identified structural features should be incorporated into future versions of the groundwater model as needed to allow an accurate assessment of mine water inflows. Changes to predicted mine water inflows due to groundwater barriers or conduits would then need to be represented in water balance modelling.

Question 8: In respect to how the EIS relates to matters of national environmental significance: Do the subsidence, groundwater and surface water assessments provide reasonable estimations of the risk, likelihood, extent and significance of impacts to water-related assets?

## Response

29. No. The assessment does not provide reasonable estimates of the risk, likelihood, extent and significance of impacts to water related assets. Although impacts to streams in the vicinity of the project area have been considered, the assessment of impacts to downstream water-related assets arising from proposed discharges to Airly Creek has not been justified and supported by data. Confidence in the prediction of impacts to GDEs is limited as no assessment of the ecological water requirements of GDEs in the proposed project area has been undertaken. Furthermore, potential impacts to some springs across the escarpment are not considered.

## Explanation

### *Surface water*

30. Local impacts to streamflow have been considered and the proponent identifies impacts on aquatic ecosystems as being limited to potential impacts on Airly Creek, relating to discharges from the licensed discharge point. However the impacts of proposed discharges on downstream water related assets, particularly to Airly Creek within the Gardens of Stone National Park, have not been justified and supported with data.
31. The potential impacts to instream and riparian ecological communities associated with third order streams in the shallow zone have not been adequately assessed. In particular, the risk to Gap Creek could be significant. Subsidence-induced cracking in the New Hartley Shale Mine Potential Interaction Zone is predicted to reduce flows in Gap Creek at the confluence with Genowlan Creek by 13.4 ML/year (or 5% when combined with predicted baseflow reductions). The proponent argues that any loss of flow will re-appear further downstream, but this is not supported by hydrogeological evidence or relevant examples. Subsidence estimates for the New Hartley Shale Mine Potential Interaction Zone are uncertain due to lack of information regarding the existing shale mine and do not consider a 'worst-case scenario', including the potential that multi-seam subsidence is greater than the additive effects of the individual subsidence patterns.

### *Groundwater*

32. Inadequate baseline groundwater data not allowing accurate modelling and assessment of impacts on groundwater dependent ecosystems (GDEs) was rated as an extreme risk in the risk register at Section 9.4 of the EIS. The project assessment documentation does not adequately identify potential groundwater related assets, compounding this risk. For example:
- a. There is no assessment of ecological water requirements of GDEs in the proposed project area, including the many vegetation communities which are identified as being potentially groundwater dependent. The proponent states that the limited drawdown predicted is not expected to significantly reduce the functioning or extent of these GDEs (EIS, Ch. 10, p. 354). There is no evidence provided to support this statement.
  - b. Potential impacts to springs across the Mount Airly and Genowlan Mountain escarpment which are sourced from Narrabeen Group aquifers (EIS, App. G, p. 60) are not considered, except for the Grotto, which is not predicted to experience drawdown or reduction in baseflow.
  - c. The EPBC Act-listed Mount Vincent Mintbush (*Prostanthera stricta*) is recorded at multiple locations in the proposed project area; however water related impacts have not been adequately considered. The EPBC conservation advice for this species<sup>5</sup> includes information that suggests that its occurrence is related to groundwater. For example:
    - i. it is found in riparian zones and at the basalt/sandstone interface

- ii. a priority action for the species is to “manage changes to hydrology that may result in changes to water table levels, increased runoff, sedimentation or pollution”.
33. To identify GDEs, a systematic approach is recommended in which the hydrogeological conceptualisation identifies areas of shallow groundwater (up to 20 metres below ground level) and groundwater discharge. Vegetation overlying areas of shallow groundwater should be investigated to determine potential groundwater dependence. Techniques from the Australian GDE Toolbox<sup>6</sup> may then be applied to confirm groundwater use by vegetation and groundwater discharge to surface water bodies.

Question 9: In respect to how the EIS relates to matters of national environmental significance: Is the Project likely to cause any impacts to the downstream streams and rivers, and through to the Colo River, and within the Gardens of Stone and Wollemi National Parks and Greater Blue Mountains World Heritage Area? If so, what is the likely nature and extent of these impacts?

Response

34. Changes to the flow regime and water quality in Airly Creek are likely as a result of the proposed project. In order to determine the nature and extent of potential impacts to downstream watercourses additional baseline hydrological and ecological information is needed, particularly within the Gardens of Stone National Park.

Explanation

35. Airly Creek is the receiving waterway for Airly pit top facility discharges. Water quality samples collected downstream of the Airly Mine Surface Facilities Area were used to derive site-specific trigger values. The proponent considers that this location represents background water quality for the Airly Creek catchment as discharges from the Airly Mine Surface Facilities Area to date have been minimal. Further information relating to the water quality of discharges to date is needed to support the assertion that the water quality monitoring data at Airly Creek was not affected by mine water discharged during the monitoring period. It is noted that there were several discharge events from LDP001 (up to 16 ML/day in April 2012) during the period of water quality monitoring at Airly Creek (EIS, App. B of App. F, p. 34).
36. The proponent predicts that the proposed project will not have a significant impact on waterways within the Gardens of Stone National Park given the indicated scale of flow and quality impacts within Airly Creek and the diluting influence of water flows from additional catchments both upstream of, and within, the Gardens of Stone National Park. However this conclusion is not supported by baseline data for flow and water quality within the Gardens of Stone National Park, and does not consider the consequences of extreme events and onsite accidents. As such the likely nature and extent of potential impacts is uncertain. Confirmation of flow regimes, water quality and aquatic ecology in Airly Creek within or adjacent to the park, and ongoing monitoring are needed to support the conclusion that the proposed project will not have significant impact on waterways within the Gardens of Stone National Park.
37. The proponent states that there are likely to be no significant impacts to the Wollemi National Park given its distance downstream and the diluting influence of additional water flows from contributing catchments. Confirmation of the relative contribution of flows from the proposed project area to flows within the Capertee River at or near its entry to the park is needed to support this assessment.
38. The EIS provides no advice on potential impacts to the Colo River. However it is reasonable to assume no significant impacts to the Colo River as a result of the proposed project given its distance downstream and the diluting influence of additional flows from contributing catchments.



Question 10: In respect to how the EIS relates to matters of national environmental significance: What are the risks of impact to the critically endangered species *Pultenaea* sp. *Genowlan Point* from hydrological and hydrogeological changes resulting from the project? Are these adequately addressed in the EIS?

Response

39. Hydrological or hydrogeological impacts to the Genowlan Point *Pultenaea* (*Pultenaea* sp. Genowlan Point) are not anticipated as a result of the proposed project. The EIS would benefit from maps detailing the location of the population relative to the proposed mining zones, and development of an adaptive monitoring and management approach to prevent potential diversion of water as a result of subsidence.

Explanation

40. The Genowlan Point *Pultenaea* is a critically endangered species (under the Threatened Species Conservation and EPBC Acts) that occurs in a single population occupying an area of 250 m<sup>2</sup> and comprising approximately 50 individuals on well drained stony soils near a cliff edge on Genowlan Point. The species is not considered to be groundwater dependent.

41. Within 30 metres of the cliff line, the population is proposed to be undermined by first workings only and as such the risk of subsidence-induced surface cracking or ponding, leading to diversion of water is low. However, there is the potential for subsidence-induced changes to surface water drainage above the panel and pillar zone. As such, buffer distances between the panel and pillar zone and the location of the Genowlan Point *Pultenaea* population should be specified.

42. Subsidence effects in the first workings (cliff) zone should be closely monitored. As mining beneath Genowlan Point is proposed to occur toward the end of the mine life, if actual subsidence is greater than predicted in the vicinity of cliffs, management responses, such as changing the mine plan, should be employed to limit water related impacts to the Genowlan Point *Pultenaea*.

Question 11: In respect to how the EIS relates to matters of national environmental significance: Are the proposed mitigation measures likely to be effective in managing impacts to water-related assets of the project (including downstream assets)? Are additional measures and commitments required to mitigate and manage impacts to water-related assets?

Response

43. There is limited confidence in the accuracy of predicted impacts to groundwater, surface water and water related assets. As such, the effectiveness of proposed mitigation measures is difficult to assess and additional mitigation may be required following further identification and assessment of impacts to water related assets. Consideration should be given to broadening the mining exclusion zone around Gap Creek and the development of further adaptive management procedures for subsidence.

Explanation

*Groundwater*

44. The proposed mitigation measure for groundwater impacts is to restrict mining in the Shallow Zone so that there is no mining beneath Gap Creek and Genowlan Creek (and to a distance of 20 m from the creeks) where the depth of cover is less than 40 m.

- a. Measurements of the spatial extent and induced hydraulic properties of fracture zones as mining progresses combined with ongoing groundwater and baseflow monitoring would

enable improved parameterisation, calibration and predictive capability of future versions of the groundwater model.

- b. As proposed in the project assessment documentation (EIS, Ch. 9, Table 9.5, p. 263), broader exclusion zones based on updated modelling could then be established to further mitigate impacts to alluvial groundwater and baseflow reductions.
- 45. Geological faults identified in the structural risk assessment have not been represented in the groundwater model or included in the assessment of risks and uncertainties regarding mine inflows and potential impacts to stream baseflow. Consideration should be given to the potential effects these faults may have on mining operations.
- 46. Mitigation measures may need to be determined for GDEs once they have been systematically identified and their ecological water requirements assessed (as described in paragraph 33).

*Surface water*

- 47. Water quality at the best available reference site in the region needs to be used for deriving local water quality objectives and site specific trigger values, such as upstream of existing mine water discharge points within the proposed project area or other appropriate reference sites where upstream sites are not available. For example, if Torbane Creek is similar to Airly Creek but is not affected by mine water discharges, it may be an appropriate reference site to validate site specific trigger values derived from Airly Creek data. It is noted that the proponent has attempted additional monitoring further upstream in the Airly Creek catchment but the dataset was inconsistent due to the ephemeral nature of the stream.
- 48. Additional measures may be needed to manage impacts to the Gap Creek catchment as a result of mining in the New Hartley Shale Mine Potential Interaction Zone. Given the likelihood of impacts to Gap Creek (see paragraph 31); consideration should be given to broadening the exclusion zone around this creek. Given the uncertainty in subsidence predictions, a conservative approach would be to exclude this zone from the proposed mine design.
- 49. As identified by the proponent (EIS, Ch. 9, Table 9.5, p. 263), an adaptive management process for subsidence impacts on second and third order watercourses should be developed. This plan needs to identify effective monitoring, mitigation and adaptive management measures that could be implemented despite access difficulties and with minimal surface disturbance.

Question 12: In respect to how the EIS relates to matters of national environmental significance: What are the key features of a monitoring and management framework that would address the key uncertainties and risks of the project identified by the Committee?
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Response

- 50. Key uncertainties and risks of the proposed project include: the nature and extent of downstream impacts on Airly Creek; identifying potential water related assets within the Gardens of Stone National Park; and groundwater drawdown and subsidence, with associated effects on mine inflows, baseflow reductions to Gap and Genowlan Creeks and potential GDEs within the proposed project area. In order to address these risks and uncertainties a robust groundwater, surface water, aquatic ecology and subsidence monitoring and management framework is needed, as described below.

## Explanation

### *Groundwater*

51. Clearly defined monitoring objectives and performance indicators should be developed in the proposed Groundwater Monitoring and Management Plan.
52. Additional hydraulic testing above mined zones in early stages of the proposed project would provide improved confidence in model parameterisation and subsequent mine inflow, drawdown and baseflow loss predictions.
53. Additional monitoring bores around the production well, within Genowlan Mountain, and to the east of the proposed project area in the regional Shoalhaven Group aquifer would increase robustness of the groundwater monitoring system and provide early warning of potential impacts to other water users.

### *Surface water*

54. The proponent's surface water monitoring program should continue as proposed, in particular:
  - a. Volumetric monitoring at LDP001 on a daily basis when discharging.
  - b. Continuous flow monitoring at the Grotto, Gap Creek, Genowlan Creek and Village Spring throughout the life of the proposed project.
  - c. Installation of an additional flow gauge on Genowlan Creek.
55. In addition, flow monitoring should also be undertaken at locations corresponding to current water quality monitoring locations on Airly Creek and Airly Tributary. Water quality data should be related to flow volume.
56. Additional monitoring is recommended for valley closure and upsidence effects in upper reaches of incised valleys in the panel and pillar extraction zone. Ground-survey methods may be the only option as remote sensing is not capable of accurately monitoring horizontal movement<sup>7</sup>.
57. Commitments for surface and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy.

### *Aquatic ecology*

58. Once GDEs have been systematically identified and their ecological water requirements assessed, an appropriate monitoring and management program should be developed.
59. Proposed monitoring for stygofauna is to sample twice annually, with wider spatial replication, for a further two years prior to commencement of mining. It is recommended that survey design and sampling follow the method outlined in *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia*<sup>8</sup>.

### *Other considerations*

60. The Sydney Basin has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible to this Bioregional Assessment and other research to assist the knowledge base for regional scale assessments.

<b>Date of advice</b>	13 November 2014
<b>Source documentation available to the IESC in the formulation of this advice</b>	Centennial Airly Pty Ltd. 2014. Airly Mine Extension Project Environmental Impact Statement. Merrick, N. 2014. Airly Groundwater Review.
<b>References cited within the IESC's advice</b>	<p><sup>1</sup> Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals available at: <a href="http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf">http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf</a></p> <p><sup>2</sup> Bureau of Meteorology. 2014. Climate Data Online. Available at <a href="http://www.bom.gov.au/climate/data/">http://www.bom.gov.au/climate/data/</a> [Accessed 29 October 2014]</p> <p><sup>3</sup> SRK Consulting. 2012. <i>Airly 2011 HRAM Data Radiometric Data Acquisition and Interpretation</i>.</p> <p><sup>4</sup> Larry Cook &amp; Associates Pty Ltd. 2009. <i>Test Drilling and Aquifer Testing: Test Production Bore AM2B-1</i>.</p> <p><sup>5</sup> Threatened Species Scientific Committee. 2008. Approved Conservation Advice for <i>Prostanthera stricta</i> (Mount Vincent Mintbush).</p> <p><sup>6</sup> Richardson, S. et al. 2011. <i>Australian groundwater-dependent ecosystem toolbox</i>. Waterlines report, National Water Commission, Canberra.</p> <p><sup>7</sup> Commonwealth of Australia 2014. Background review: subsidence from coal mining activities. Review prepared by Sinclair Knight Merz Pty Ltd. June 2014.</p> <p><sup>8</sup> Western Australia Environmental Protection Authority 2007. Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. No. 54a. Available at <a href="http://epa.wa.gov.au/EPADocLib/2543_GS54a30708.pdf">http://epa.wa.gov.au/EPADocLib/2543_GS54a30708.pdf</a></p>