APPENDIX E – IESC ADVICE AND WCPL'S RESPONSE

Refer to the Department's website:
http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=5586

Independent Expert Scientific Committee
on Coal Seam Gas and Large Coal Mining Development

Advice to decision maker on South Wambo Underground Mine Modification Project

IESC 2016-077: South Wambo Underground Mine Modification Project (EPBC 2016/7636; State DA 305-7-2003 Mod 12) – Expansion

Requesting agency	The Australian Government Department of the Environment and Energy and The New South Wales Department of Planning and Environment
Date of request	22 June 2016
Date request accepted	23 June 2016
Advice stage	Final 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 Energy and the New South Wales Department of Planning and Environment (DPE) to provide advice on Wambo Coal Pty Ltd's (WCPL) Wambo Coal Mine Modification Project (the proposal) in NSW. The proposal is located in the Upper Hunter Valley region. Wollemi National Park lies to the west and south of the project.

The proposal is a modification to the existing South Wambo Underground Mine layout, approved in 2003 prior to the introduction of the Water Trigger. The proposal will include: the realignment and extension of longwall panels within the Woodlands Hill and Arrowfield seams; an increase to the surface development area; extension of the approved open cut operations by 3 years; and extension of the approved underground mine life by 7 years. A further small change was made to the proposal on 13 July 2016, in which the number of roadways in the main headings for access to Area 3 were reduced from six roadways to a minimum of three roadways to avoid extraction beneath privately owned land.

The proposal is within an area of extensive historical, current and approved open cut and underground mining operations. The assessment documentation notes that no underground mining has commenced within longwall panels of the 2003 approved mine layout and it is understood that the proposed modified underground mine layout will replace the approved underground mine layout in its entirety.

The proponent is seeking approval from NSW DPE for a modification to the existing development consent (DA 305-7-2003 Mod 12) and from the Australian Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This advice draws upon the

information in the Environment Assessment (EA) in relation to the impacts associated with the proposal only. The IESC notes that the information in the assessment documentation is limited to the difference or change in the impact of the proposal from the mine lay out that was approved in 2003. **However given the nature and scale of the proposal, the IESC's advice has** considered all potential impacts.

The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

Two critically endangered ecological communities listed under the *Environmental Protection and Biodiversity Conservation Act 1999* occur within the boundaries of the proposal. These are the Central Hunter Valley Eucalypt Forest and Woodland and the Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley. Six endangered and one vulnerable ecological community (NSW-listed) also occur within the boundaries of the proposal. These communities, including the EPBC-listed communities, are located in areas above longwalls associated with the proposal.

Key potential impacts of the proposal include:

- Altered hydrology within surface water features due to subsidence, cracking and ponding, groundwater drawdown and potential leakage from South Wambo Dam.
- Impacts to vegetation, especially groundwater-dependent ecosystems (GDEs), overlying longwalls due to subsidence, ponding and potential lowering of the shallow groundwater table.
- Impacts to surface water quality due to the discharge of mine water and increased sedimentation and erosion.
- Impacts to aquatic biota and subsurface fauna (e.g. stygofauna) due to altered groundwater tables, creek hydrology (especially low flows) and impaired water quality (e.g. fine sediments, contaminants).

Assessment against information guidelines

The IESC, in line with its Information Guidelines (IESC, 2015), has considered whether the proposal assessment has used the following:

Relevant data and information: key conclusions

The assessment documentation provides limited relevant surface water and groundwater contextual and baseline data. There is a lack of field data on GDEs (e.g. groundwater dependent vegetation, stygofauna) and aquatic biota (especially that living in remnant pools in ephemeral creeks) and this **constrains the IESC's capacity to assess potential** impacts.

Discussion and assessment of the shallow groundwater table outside of the alluvium, within the regolith, is limited. Potential impacts to the shallow water table within the regolith and associated impacts on GDEs as a result of groundwater drawdown are not discussed. The current piezometric surface for the shallow groundwater system including the regolith should be provided.

Limited groundwater and surface water quality information is provided within the assessment documentation. Water quality parameters for groundwater and surface water do not take into consideration other contaminants of concern (e.g. metals, polycyclic aromatic hydrocarbons (PAHs)). Other contaminants of concern should be discussed in the context of the existing environment in order to assess the likelihood and significance of impacts of the proposal.

Flow characterisation of streams within the project area was modelled using a 2009 model developed from flow records of streams in a different catchment and was not calibrated and validated against existing flow data in the catchment.

Subsidence impacts in Area 4 were reportedly reduced in magnitude compared to the 2003 approved mine layout and as such were not considered further in the assessment documentation. Further assessment of subsidence related impacts with Area 4 should be considered as part of the full impact assessment for the proposal in order to determine the extent and magnitude of potential impacts to water resources and water dependent ecosystems.

While the nature and scale of groundwater and surface water impacts from the proposal are largely similar to that of the current 2003 approved mine layout, the existing monitoring and management plans should be updated taking into account likely changes in impacts and ongoing assessment and management of impacts to water dependent ecosystems.

Application of appropriate methods and interpretation of model outputs: key conclusions

For the purposes of impact assessment, the alluvium should be separated from the regolith within layer 1 of the groundwater model. Drawdown impacts to the regolith should be considered, particularly in areas associated with GDEs and listed vegetation. The southern boundary of the numerical groundwater model should be extended beyond the zone of predicted drawdown. Further consideration of the Hunter Valley Cross Fault and Redmanvale Fault and their influence on groundwater flow and drawdown should be given, particularly where the Hunter Valley Cross fault intersects the alluvium.

The rationale, frequency, objectives and performance indicators for surface water and groundwater monitoring programs were not described. The assessment of flooding impacts did not consider predicted subsidence and ponding. Significant increases in sediment loads were not considered likely, with mobilised sediment expected to be captured in downstream ponds. Given the significant predicted subsidence impacts to the creeks and landscape, a suitable water quality monitoring program including appropriate performance indicators, triggers and required management actions should be developed and clearly described.

A geochemical assessment to characterise coal reject, waste rock and tailings materials was not provided.

The qualitative risk assessment is limited and did not consider all hazards, such as those associated with mine water discharges and waste management. Planned controls were not detailed; rather reference was made to relevant plans, which were not included in the assessment material.

Advice

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

Question 1: Do the subsidence, groundwater and surface water assessments, including numerical modelling therein, provide reasonable estimations of the likely impacts to water resources and water dependent ecosystems? Consideration should include but not necessarily be limited to potential changes to water quality, water quantity, aquifer connectivity, flow regimes and cumulative impacts?

<u>Response</u>

1. No. Further consideration is required regarding:

   a. Improved characterisation of water requirements of GDEs associated with impacted alluvial systems and areas of regolith affected by drawdown and ponding.

b. Groundwater assessment and modelling:

   i. Improved characterisation of drawdown impacts to the shallow water table within the regolith in the vicinity of listed communities and GDEs.

   ii. Further consideration of potential impacts to alluvial groundwater systems, particularly in relation to identified GDEs.

   iii. Further discussion on the adequacy of the numerical groundwater model construction, boundary conditions, parameterisation, calibration, sensitivity and uncertainty analyses.

   iv. Further consideration of the influence of the Hunter Valley Cross Faults to the north and the Redmanvale Fault to the west on groundwater flow and drawdown.

c. Surface water assessment and modelling:

   i. The stream flow modelling is based on stream data in a separate catchment. Further information is required to assess the adequacy of surface water modelling for the affected catchment(s).

   ii. The surface water assessment does not estimate combined impacts to hydrology and water quality from subsidence, cracking and ponding.

   iii. Existing and planned water extraction and/or discharge was not described within the surface water assessment.

   iv. Details on monitoring frequency, location of the monitoring sites, derivation of site-specific water quality guidelines are required. The limited parameters measured and lack of proposed actions when parameters are exceeded, confound the ability to determine potential impacts on surface water quality.

d. Impact of altered flow regimes associated with stream bed cracking and reduction in groundwater inflow, particularly during low flows, and the ecological implications for aquatic biota and, if present, stygofauna of ephemeral streams and other water dependent ecosystems is required.

Groundwater

2. Layer 1 in the numerical groundwater model combines the alluvium and regolith. Given the significance of the alluvium in the region, these units should be separated for the purposes of assessing impacts to the alluvium and shallow water table within the regolith. It is unclear from the assessment documentation whether there is a water table within the regolith, thus further characterisation and discussion is needed.

3. The Redmanvale Fault and Hunter Valley Cross Faults are stated to be major geological structures within the Wambo area. The southern Hunter Valley Cross Fault appears to be present within the northern boundary of the mine lease and intersecting the alluvium in this region (EA, App B, Figure 6). It is stated that the influence of these geological structures on groundwater flow is not known with certainty (EA, App B, pg 20), however the proponent also states that faults are likely to act as barriers to local groundwater flow rather than conduits. This assumption needs to be justified and validated with assessment data and strategically positioned monitoring bores so that the influence of faults on groundwater head and flow can be determined.

4. To provide confidence in the numerical groundwater model predictions, further consideration and discussion is required on:

a. Model assumptions and limitations.

b. The hydraulic parameters used for all model layers. While laboratory core testing has been performed on Permian horizons to determine hydraulic conductivity, these results should be supported with direct field measurements.

c. The derivation of recharge and evapotranspiration rates, including the justification for the 3m extinction depth.

d. The influence of the southern boundary condition on predicted drawdown.

e. Inclusion of sensitivity and uncertainty analyses to enable determination of parameters that are most important in controlling model predictions, including an assessment of how uncertainties in those parameters affect model predictions. This should also include a sensitivity analysis of faults and their influence on groundwater drawdown predictions and groundwater flow patterns.

5. There is limited discussion on groundwater quality and potential impacts to GDEs including stygofauna if present. Improved understanding of existing groundwater quality conditions, including greater understanding of water quality requirements of all potentially affected GDEs would assist in developing suitable management triggers.

Surface Water

6. Limited flow data was available for creeks in the area of the proposal. Creek flow was modelled based on a Gilbert & Associates (2009) AWBM model developed for Doyles and Appletree creeks, which are located in a separate catchment to the west of North Wambo Creek and **adjusted "to take account of" North Wambo creek flow data (EA, App.** C, pp. 15–19). The following limitations with the surface water model were identified within the EA:

a. Doyles and Appletree creeks were not mapped or described.

b. The surface water model was not described in detail, however the assessment documentation stated that the model was adjusted to take account of flow data at only one monitoring site (FM3) at North Wambo Creek. While this site was considered by the proponent to be the longest, most representative flow record, additional monitoring points would be beneficial to calibrate the model.

c. Only one year of data (Feb 2014 to Jan 2015) from FM3 appears to have been used to calibrate the model (EA, App. C, p. 17, para 1). However, the data summary in the assessment documentation (EA, App. C, p. B-3, Table B1) does not include the entire time period, and does not clearly indicate that it is the most representative available flow record.

d. Model representativeness was not demonstrated by comparison with available flow data. On-site flow monitoring sites were established in late 2008. The model should be updated with current and recent measured data.

7. Predicted impacts to Wollombi Brook were only discussed in the context of mean annual flow (EA, App. C, p. 45). Impacts are likely to be greater in periods of low flow as relative losses in creeks on-site due to cracking and ponding will be greater in low-flow periods. Impacts to Wollombi Brook should be compared across a range of flow conditions including low flows.

8. The diverted North Wambo Creek has elevated pH, salinity and total suspended solids (TSS). Potential sources and reasons for the observed water quality were not discussed, nor were the consequences of exceedences. Management actions associated with exceedence of water quality guideline levels, if determined, are not clearly described.

Flooding

9. The 2016 flood study prepared for the proposal was not provided, only referenced and summarised. Information in relation to flood volume, depth, duration, extent and velocity were not provided. These details as well as details of the flood assessment itself, are required to assess adequacy of the flood assessment.

10. Potential impacts to flood behaviour in the area of the proposal were only considered in the context of a levee to be constructed near the surface infrastructure area (EA, App. C, p. 45). Potential changes to flood extent due to subsidence and ponding impacts should be considered.

Subsidence

11. Fracturing is predicted to reach the surface in some areas. The proponent's statement that mining induced fracturing does not have long-term adverse effects on ephemeral streams with natural soil beds (EA, App. A, p. 52) requires justification. Some of the ephemeral streams (e.g. Stony Creek) in the potential subsidence zones have large areas of bedrock or coarse rocky streambeds.

12. The proponent indicates it will be necessary to remediate some sections of creeks, using regrading and infilling methods, and expects no long-term adverse impacts on the creeks after remediation. The success or otherwise of these techniques will need to be assessed and exceedence triggers developed to inform ongoing management options.

13. Potential subsidence impacts on South Wambo Dam, including fracturing and buckling of the uppermost bedrock and cracking of the base of the dam or dam wall, require further consideration regarding potential impacts to surface and groundwater from leakage.

Water dependent ecosystems

14. North Wambo Creek, Stony Creek and Wambo Creek are ephemeral and originate in the Wollemi National Park. Many of the creeks support persistent pools (some of which are large, for example in North Wambo Creek there is a pool approximately 250–300 m long). Further consideration of the complexity and value of ecosystems associated with the ephemeral creeks and associated pools is required to adequately assess impacts. These pools are likely a legacy of previous mining but may now constitute important refuges for aquatic biota in these modified systems. These refuges may be vulnerable to sedimentation from altered geomorphology. It is also unclear whether the frequency and duration of low flows in the ephemeral creeks will be changed with potential impacts on aquatic biota and water quality.

15. Potential subsidence impacts such as soil cracking, ponding and loss of surface water flows, were not adequately assessed for listed flora.

Question 2: Has WCPL provided reasonable strategies to avoid, mitigate or reduce the likelihood, extent and significance of impacts?

<u>Response</u>

16. The assessment documentation only presents a summary of the approved Management Plans. The proponent states that impacts associated with the proposal will be managed in accordance with these plans. Limited by the information provided in the assessment documentation and in light of the issues raised in response to Question 1, the IESC is not able to formulate advice with regards to whether the strategies to avoid, mitigate or reduce the likelihood of impacts are reasonable.

Explanation

17. Existing strategies within monitoring and management plans should take into consideration:

    a. Changes to drawdown within the alluvium and regolith.

    b. Altered flood hydrology and hydraulic characteristics, given the change in subsidence-related impacts.

    c. Updates to the mine water balance with particular regard to increased groundwater inflows, storage and the requirement for discharge of surface water.

    d. Groundwater drawdown and subsidence impacts to GDEs and terrestrial vegetation overlying mine workings and in areas of predicted drawdown. Potential GDEs and aquatic ecosystems, other than Parnell Spring, were not adequately characterised and assessed in the groundwater assessment report (EA, App. B).

    e. Surface water flow and quality monitoring requirements for all creeks including the unnamed tributaries of Wollombi Brook. This baseline information can be used to set trigger levels and to assess the success of mitigation strategies.

    f. Surface water quality (including additional parameters such as aquatic invertebrate community composition) in dams and creeks to enable a baseline to be assessed and performance indicators and management triggers to be determined.

Question 3: Are there further strategies the IESC would recommend to avoid, mitigate or reduce the likelihood, extent and significance of impacts on water resources? And if so, why?

Response

18. A strategy to avoid, mitigate or reduce impacts of longwall mining is to alter the mine layout, including narrower longwalls and wider inter-panel pillars. In this light, consideration could be given to reduce longwall extents and altering configurations in the vicinity of Stoney and Wollombi creeks to reduce subsidence impacts.

Question 4: In addition to the proposed monitoring and management regime recommendations in the EA, does the IESC recommend additional monitoring and management measures to minimise the risks of the project to water resources?

Response

19. Additional monitoring and management measures may include:

    a. Regular review and updates to the numerical groundwater model to validate predictions and inform ongoing monitoring and management measures.

    b. Additional groundwater monitoring locations in Area 4 and Area 3 to monitor groundwater levels within areas of subsidence, including determination of groundwater level and quality requirements of GDEs.

    c. Nested piezometers to the west and south of the South Wambo Dam to monitor the high salinity zone observed in monitoring bores P114 and P116.

    d. Groundwater sampling to include metals and other potential contaminants of concern. It is unclear from the EA whether these are considered or included in the current water quality sampling regime.

e. Surface water sampling for metals and ionic composition (see paragraph 20 below), including development of trigger values associated with ecotoxicological effects, and required response actions where triggers are exceeded.

f. Upgrading surface water gauges and updating the surface water model with recent data to achieve adequate calibration and inform ongoing management strategies.

g. Further consideration of the three unnamed drainage lines to the south east of the proposal that drain to Wollombi Brook. This may include continuous data loggers.

h. Geochemical testing of coal reject, waste rock and tailings materials to characterise and inform ongoing management strategies.

i. Ecological monitoring in Wollombi Brook, downstream of discharge sites and in persistent pools of ephemeral creeks for aquatic biota as biomonitors of ecological responses to altered flows (especially low flows) and water quality.

20. Further assessment of the potential impacts of physical and chemical composition of discharge water, including the impacts of metals and PAHs, on downstream ecosystems and environments would improve understanding of potential regional cumulative impacts of mining. This is consistent with the findings of Krogh et al. (2013) which recommends experimental studies to fully understand the effects of different components of saline water including metals/metalloids and ionic compositions discharged to the Hunter River.

21. The Northern Sydney Basin, which includes the Hunter Subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposal should be made accessible to this Bioregional Assessment and related research projects.

Date of advice	4 August 2016
Source documentation available to the IESC in the formulation of this advice	ANZECC/ARMCANZ 2000. Australian Guidelines for Water Quality Monitoring and Reporting. *National Water Quality Management Strategy (NWQMS).* Canberra: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Wambo Coal Pty Ltd, 2016. *South Wambo Underground Mine Modification, Environmental Assessment*. April 2016, Wambo Coal Pty Ltd. Wambo Coal Pty Ltd, 2015. *2015 Annual Review*, Wambo Coal Pty Ltd.
References cited within the IESC's advice	IESC. 2015. *Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* [Online]. Available: http://www.iesc.environment.gov.au/system/files/resources/012fa918-ee79-4131-9c8d-02c9b2de65cf/files/iesc-information-guidelines-oct-2015.pdf. Krogh, M., Dorani, F., Foulsham, E., McSorley, A., and Hoey, D. 2013. Hunter Catchment Salinity Assessment. Final Report. NSW Environment Protection Authority.

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24 August 2016

Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Attention: Ms Jessie Evans, Resource Assessments and Compliance

Dear Ms Evans

RE: MODIFICATION 12 TO DA 305-7-2003 – RESPONSE TO ADVICE FROM THE IESC

Please find enclosed responses to the advice provided by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) as part of the bilateral assessment process for the South Wambo Underground Mine Modification (EPBC 2016/7636).

These responses have been prepared in consultation with the groundwater and surface water specialists that contributed to the Environmental Assessment (Dr Noel Merrick and Dr Steve Perrens).

Please do not hesitate to contact the undersigned should you have any queries.

Yours faithfully

Micheal Alexander
Director Projects and Portfolio Management (NSW)
PEABODY ENERGY AUSTRALIA PTY LIMITED

Enclosures (1)

cc: Mr Howard Reed, Director, Resource Assessments, Department of Planning & Environment.

ENCLOSURE 1

RESPONSE TO ADVICE FROM THE IESC ON
SOUTH WAMBO UNDERGROUND MINE MODIFICATION PROJECT
(EPBC 2016/7636; STATE DA 305-7-2003 MOD 12)

Response to Advice from the IESC (dated 4 August 2016) on South Wambo Underground Mine Modification Project (EPBC 2016/7636; State DA 305-7-2003 Mod 12)

No.	Comment	Response
1a.	Further consideration is required regarding improved characterisation of water requirements of GDEs [Groundwater Dependent Ecosystems] associated with impacted alluvial systems and areas of regolith affected by drawdown and ponding.	The Modification would cause no discernible or negligible additional drawdown in alluvium and regolith (Figure 52 of Appendix B). Potential GDEs were identified in the Referral under *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (EPBC 2016/7636). This process involved a review of the relevant water sharing plans, the regional mapping of GDEs in the Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (2015), the vegetation mapping conducted by FloraSearch and consideration of the simulated depth to groundwater. GDEs in the vicinity of the Action area are likely to be associated with the riparian zone associated with Wambo Creek and the riparian, floodplain and alluvial zones on Wollombi Brook.
1b.	Further consideration is required regarding groundwater assessment and modelling: i. Improved characterisation of drawdown impacts to the shallow water table within the regolith in the vicinity of listed communities and GDEs. ii. Further consideration of potential impacts to alluvial groundwater systems, particularly in relation to identified GDEs. iii. Further discussion on the adequacy of the numerical groundwater model construction, boundary conditions, parameterisation, calibration, sensitivity and uncertainty analyses. iv. Further consideration of the influence of the Hunter Valley Cross Faults to the north and the Redmanvale Fault to the west on groundwater flow and drawdown.	A response to each of IESC's specific comments is below: i. As described further in the response to Item 4, the regolith in the numerical groundwater model is dry before and after mining. Potential GDEs have not been identified in regolith areas above the Action underground mining areas. ii. As described further in response to Items 1a and 5, the Modification would cause no discernible or negligible additional drawdown in alluvium, and there are no simulated risks of reduced beneficial uses of the alluvium as a result of the Modification. iii. Further discussion on the adequacy of the numerical groundwater model is provided in response to Item 4. The Groundwater Assessment was peer reviewed by Kalf and Associates (Dr Frans Kalf) in consideration of the requirements of the Australian Groundwater Modelling Guidelines. This review concluded the model was fit for purpose and the hydrogeological description, conceptualisation, model design, simulations and reporting had been conducted in a professional manner. iv. Further discussion on the consideration of faults is provided in response to Item 3. The numerical groundwater model is considered to be fit for purpose.

No.	Comment	Response
1c.	Further consideration is required regarding surface water assessment and modelling: i. The stream flow modelling is based on stream data in a separate catchment. Further information is required to assess the adequacy of surface water modelling for the affected catchment(s). ii. The surface water assessment does not estimate combined impacts to hydrology and water quality from subsidence, cracking and ponding. iii. Existing and planned water extraction and/or discharge was not described within the surface water assessment. iv. Details on monitoring frequency, location of the monitoring sites, derivation of site-specific water quality guidelines are required. The limited parameters measured and lack of proposed actions when parameters are exceeded, confound the ability to determine potential impacts on surface water quality.	A response to each of IESC's specific comments is below: i. As described further in the response to Item 6, Dr Steve Perrens (Advisian) considers the stream flow modelling is adequate to characterise the flow regime in North Wambo, Wambo and Stony Creeks for the purposes of assessment of potential subsidence impacts. ii. Potential consequences to water flow and quality associated with all potential subsidence impacts have been assessed in the Surface Water Assessment (Appendix C) and a consolidated management and monitoring program recommended. iii. The Modification would not include any material changes to the approved water management system, water supply or water demand. In addition, the mine water balance has recently been reviewed for the United Wambo Open Cut Project, including cumulative consideration of the Modification. iv. Approved management plans/monitoring programmes, including the Surface Water Monitoring Program and Surface and Groundwater Response Plan are available on WCPL's website (see response to Item 16).
1d.	Further consideration is required regarding impact of altered flow regimes associated with stream bed cracking and reduction in groundwater inflow, particularly during low flows, and the ecological implications for aquatic biota and, if present, stygofauna of ephemeral streams and other water dependent ecosystems is required.	HydroSimulations (Appendix B) concluded the Modification would have no discernible or negligible effect on stream baseflow or natural river leakage for Wollombi Brook, North Wambo Creek, Wambo Creek or Stony Creek stream systems, beyond the effects of approved mining. There may be short-term impacts of flows where there is surface cracking, prior to the underlying bedrock gradually filling with surface soils during subsequent flow events or being remediated. Section 6.1 of the Flora Assessment (Appendix D) concluded: *In conclusion, it is considered unlikely that vegetation on the Study area would be adversely affected by soil cracking. However, there may be a small loss of woodland due to surface ponding and possible effects to riparian vegetation where ponding occurs along creeks, or fracture networks develop below Stony Creek. However, these impacts would be lower for the Modification than for the approved arrangement…*

No.	Comment	Response
1d.	(Continued)	Section 4.1 of the Fauna Assessment (Appendix E) concluded: *As some impacts are expected upon natural features, including streams and steep slopes due to subsidence, minor potential impacts could occur upon threatened fauna species including reptiles, cave roosting microbats and ground dwelling mammals (for a full list see Table 7). These impacts are not considered to be significant as the impacts are minor and suitable habitat resources would remain present outside the Modification area…*
2.	Layer 1 in the numerical groundwater model combines the alluvium and regolith. Given the significance of the alluvium in the region, these units should be separated for the purposes of assessing impacts to the alluvium and shallow water table within the regolith. It is unclear from the assessment documentation whether there is a water table within the regolith, thus further characterisation and discussion is needed.	This comment misunderstands the construction of a numerical groundwater model. Layer 1 is used for both alluvium and regolith, however these two geologies are separately assigned appropriate (and different) recharge parameters (Figure 24 of Appendix B), storage parameters (Table 13 of Appendix B) and hydraulic conductivities (Tables 14 to 17 of Appendix B). Separate assessments are conducted for potential impacts on alluvial aquifers and shallow Permian aquifers in Section 5 of Appendix B. Drawdown presented in Figure 52 of Appendix B also clearly shows the adopted alluvial extent so that the predicted drawdown in alluvium and regolith can be delineated. The simulated depth to groundwater in the Action area (i.e. the shallow groundwater table) was presented in Figure 11 of the Referral under the EPBC Act (EPBC 2016/7636). The regolith is dry before and after mining.
3.	The Redmanvale Fault and Hunter Valley Cross Faults are stated to be major geological structures within the Wambo area. The southern Hunter Valley Cross Fault appears to be present within the northern boundary of the mine lease and intersecting the alluvium in this region (EA, App B, Figure 6). It is stated that the influence of these geological structures on groundwater flow is not known with certainty (EA, App B, pg 20), however the proponent also states that faults are likely to act as barriers to local groundwater flow rather than conduits. This assumption needs to be justified and validated with assessment data and strategically positioned monitoring bores so that the influence of faults on groundwater head and flow can be determined.	The southern Hunter Valley Cross Fault intersects Area 1 of the mine layout for a distance of about 1.6 km. Previous United underground mining successfully mined through about 4 km of coal at the projected location of the fault. No adverse inflows were reported. The fault is straddled by piezometers P16 and P20 which consistently differ in groundwater levels by only 0.3 m. There is no evidence for the fault causing any significant disturbance to the groundwater flow pattern. According to the Principle of Parsimony (advocated in modelling guidelines), the simplest conceptualisation of the geology should be favoured in a model. Implementation of a fault that has no observable hydrological effect would be contrary to this Principle. In the groundwater model, as the geometry of strata in the vicinity of the fault is honoured, there is an implicit assumption of coal seam continuity. This acts conservatively to propagate drawdown effects farther than would occur if the fault causes dislocation of the seam.

No.	Comment	Response
4.	To provide confidence in the numerical groundwater model predictions, further consideration and discussion is required on: a. Model assumptions and limitations. b. The hydraulic parameters used for all model layers. While laboratory core testing has been performed on Permian horizons to determine hydraulic conductivity, these results should be supported with direct field measurements. c. The derivation of recharge and evapotranspiration rates, including the justification for the 3m extinction depth. d. The influence of the southern boundary condition on predicted drawdown. e. Inclusion of sensitivity and uncertainty analyses to enable determination of parameters that are most important in controlling model predictions, including an assessment of how uncertainties in those parameters affect model predictions. This should also include a sensitivity analysis of faults and their influence on groundwater drawdown predictions and groundwater flow patterns.	The Groundwater Assessment was peer reviewed by Kalf and Associates (Dr Frans Kalf) in consideration of the requirements of the Australian Groundwater Modelling Guidelines. This review concluded the model was fit for purpose and the hydrogeological description, conceptualisation, model design, simulations and reporting had been conducted in a professional manner. A response to each of IESC's specific comments is below: a. The Wambo Coal Mine regional numerical groundwater model has been subject to ongoing development and update since 2012. In addition to the peer review by Dr Frans Kalf, a previous version of the numerical groundwater model was subject to an independent peer review by Hugh Middelmis in 2015 (commissioned by the DP&E). The model assumptions and limitations are considered well justified and acceptable. b. The hydraulic parameters used for all layers have been adopted based on a transient calibration process involving 13,056 individual target points (direct measurements of groundwater levels). Calibration against hydrographs is essentially a form of macro aquifer testing which is superior to traditional short-term localised testing. c. Recharge rates have been determined by calibration to shallow groundwater responses, supported by experience gained at similar sites. The maximum evapotranspiration (ET) rate (1 mm/day) is consistent with Actual ET estimates by the Bureau of Meteorology, allowing for the linear decay function enforced by MODFLOW software. The extinction depth of 3 m is a suitable estimate for riparian vegetation. Due to the depth of water being greater than 3 m except along creek corridors, the ET process is not active in the model over areas of regolith; hence the adopted extinction depth has no relevance where regolith vegetation occurs. d. A no-flow boundary condition is adopted along the southern boundary. In some model layers, predicted drawdown does reach the boundary. In such cases, the predicted drawdown would be an over-estimate. Consideration can be given to extension of the model boundary to the south for future modelling, but the consequence for this Project is that predicted drawdown impacts would be conservative.

<table>
<tr><th>No.</th><th>Comment</th><th>Response</th></tr>
<tr><td>4</td><td>(Continued)</td><td>e. Several sensitivity analyses have been conducted on the Wambo Coal Mine regional numerical groundwater model over its development. The drawdown response from previous and approved mining at the Wambo Coal Mine is already available and this has been considered in the development and calibration of the model, which reduces the model uncertainty. WCPL has committed to review the performance of the numerical groundwater model predictions annually as part of the Annual Review required under Condition 5, Schedule 6 of the Development Consent (DA 305-7-2003).</td></tr>
<tr><td>5.</td><td>There is limited discussion on groundwater quality and potential impacts to GDEs including stygofauna if present. Improved understanding of existing groundwater quality conditions, including greater understanding of water quality requirements of all potentially affected GDEs would assist in developing suitable management triggers.</td><td>In relation to potential impacts on groundwater quality, HydroSimulations (Appendix B) concluded there are no simulated risks of reduced beneficial uses of the alluvium as a result of the Modification (refer to Section 5.7 and Tables 22 and 23 of Appendix B).

Therefore, there would be no significant impact on GDEs as a result of change in groundwater quality.</td></tr>
<tr><td>6.</td><td>Limited flow data was available for creeks in the area of the proposal. Creek flow was modelled based on a Gilbert & Associates (2009) AWBM model developed for Doyles and Appletree creeks, which are located in a separate catchment to the west of North Wambo Creek and adjusted "to take account of" North Wambo creek flow data (EA, App. C, pp. 15–19). The following limitations with the surface water model were identified within the EA:

a. Doyles and Appletree creeks were not mapped or described.

b. The surface water model was not described in detail, however the assessment documentation stated that the model was adjusted to take account of flow data at only one monitoring site (FM3) at North Wambo Creek. While this site was considered by the proponent to be the longest, most representative flow record, additional monitoring points would be beneficial to calibrate the model.

c. Only one year of data (Feb 2014 to Jan 2015) from FM3 appears to have been used to calibrate the model (EA, App. C, p. 17, para 1). However, the data summary in the assessment documentation (EA, App. C, p. B-3, Table B1) does not include the entire time period, and does not clearly indicate that it is the most representative available flow record.

d. Model representativeness was not demonstrated by comparison with available flow data. On-site flow monitoring sites were established in late 2008. The model should be updated with current and recent measured data.</td><td>As described in the Surface Water Assessment (Appendix C), the ephemeral nature of flow in the creeks above the Modification area, the relatively short duration of the records and missing records due to equipment failure mean that recorded flows at the Wambo Coal Mine do not provide an adequate basis for characterising the long-term average flow regime in these creeks.

Given the absence of a long-term reliable dataset that would allow direct analysis, the flow regime in North Wambo, Wambo and Stony Creeks was characterised by hydrologic modelling using long-term flow data from two analogous catchments (Doyles Creek and Apple Tree Creek) with comparable geology, landuse and climate. The Australian Water Balance Model (AWBM) was selected to model the flow regime as it is a well-recognised, standard model developed specifically for assessment of runoff from Australian catchments.

Streamflow data was sourced from PINEENA (Version 9.3, 2010). Details of these gauging stations are provided in the table below, and the location of these stations is show on a map here:

http://waterinfo.nsw.gov.au/pinneena/print/210-hunter.pdf

<table>
<tr><th>Gauging Station Name</th><th>Station Number</th><th>Catchment Area (km^2)</th><th>Latitude</th><th>Longitude</th><th>Years of Data</th></tr>
<tr><td>Doyles Creek</td><td>210087</td><td>202</td><td>-32.5119</td><td>150.7996</td><td>7</td></tr>
<tr><td>Apple Tree Creek</td><td>210120</td><td>29</td><td>-32.5595</td><td>150.847</td><td>15</td></tr>
</table></td></tr>
</table>

No.	Comment	Response
6	(Continued)	The period of data used for FM3 was a complete 12 months of data from the gauging station that aligned with data available from the nearby Wambo meteorological station. For purposes of benchmarking the AWBM model, Advisian took account of the daily Wambo rainfall data, the recorded number of flow events and flow rates estimated by AECOM. This data is presented in Attachment 1. Dr Steve Perrens (Advisian) considers the AWBM model is adequate to characterise the flow regime in North Wambo, Wambo and Stony Creeks for the purposes of assessment of potential subsidence impacts. Note that WCPL replaced two flow monitoring stations (FM7 and FM8) on Stony Creek in 2015 to improve the reliability of data being collected on this creek. WCPL has committed to a review of flow monitoring along Wambo Creek in 2016 in consultation with the DP&E. This data will be used to monitor potential changes in flow and implement contingency responses if required.
7.	Predicted impacts to Wollombi Brook were only discussed in the context of mean annual flow (EA, App. C, p. 45). Impacts are likely to be greater in periods of low flow as relative losses in creeks on-site due to cracking and ponding will be greater in low-flow periods. Impacts to Wollombi Brook should be compared across a range of flow conditions including low flows.	It is important to note that the Modification would have no discernible or negligible effect on stream baseflow or natural river leakage for Wollombi Brook, North Wambo Creek, Wambo Creek or Stony Creek stream systems, beyond the effects of approved mining. The predominant gaining/losing natures of the streams would not be altered (Appendix B). The Surface Water Assessment (Appendix C) considered the cumulative nature (i.e. including existing and approved impacts) of increased leakage from Wollombi Brook and concluded that the cumulative increase in leakage from Wollombi Brook is less than 0.1% of the mean annual flow in Wollombi Brook. The contributing catchments above the Action underground mining area are ephemeral streams, and therefore surface water flows in these creeks do not materially contribute to baseflows in Wollombi Brook. For example, Advisian's analysis indicates flows in excess of 1 ML/day can be expected on approximately 34 days per year in North Wambo Creek (9% of days), whereas, Wollombi Brook is generally considered a semi-perennial stream (with flow on over 80% of days). The Modification will not significantly affect the frequency of flow in the contributing creeks, and therefore would have negligible impact on the low flow in Wollombi Brook.

No.	Comment	Response
7	(Continued)	Further modelling of the impacts on flows in Wollombi Brook is not considered to be required for the Modification given: • the Modification would have negligible effect on natural river leakage for Wollombi Brook or low flow in Wollombi Brook; and • the cumulative water take would be licensed under the *Hunter Unregulated and Alluvial Water Sources Water Sharing Plan 2009*.
8.	The diverted North Wambo Creek has elevated pH, salinity and total suspended solids (TSS). Potential sources and reasons for the observed water quality were not discussed, nor were the consequences of exceedences. Management actions associated with exceedence of water quality guideline levels, if determined, are not clearly described.	The North Wambo Creek Diversion is an approved and constructed water management structure, which does not form part of the Action (EPBC 2016/7636) referred under the EPBC Act. It was approved as part of the Wambo Development Project Action (EPBC 2003/1138) approved in November 2004. The Modification would involve no changes to the approved structure of the North Wambo Creek Diversion. The North Wambo Creek Diversion is managed in accordance with the North Wambo Creek Diversion Plan, Surface Water Monitoring Program and Surface and Groundwater Response Plan approved under the Development Consent (DA 305-7-2003).
9.	The 2016 flood study prepared for the proposal was not provided, only referenced and summarised. Information in relation to flood volume, depth, duration, extent and velocity were not provided. These details as well as details of the flood assessment itself, are required to assess adequacy of the flood assessment.	The potential impacts and risks associated with changes in flood behaviour are considered low risk, and therefore the level of assessment is considered fit for purpose. A flood frequency analysis was undertaken by WRM to estimate the 10% and 1% Annual Exceedance Probability (AEP) design discharges in Wollombi Brook based on 53 years (1949 to 2016) of recorded stream flow data at the Bulga stream gauge (gauge no. 210028). The design peak discharge in Wollombi Brook for a 10% AEP and 1% AEP was estimated at 1,000 m^3/s and 2,891 m^3/s, respectively. A TUFLOW hydrodynamic model was used to estimate design flood levels along Wollombi Brook and validated against recorded peak water levels in Wollombi Brook at the pipeline crossing for the June 2007, June 2011, February 2013, March 2013 and April 2015 flood events. The predicted peak flood levels in Wollombi Brook adjacent to the proposed South Wambo Underground Mine infrastructure area is approximately 61.5 m AHD for the 1% AEP event. The flood modelling showed that the impact of constructing the proposed flood mitigation infrastructure would result in an increase of less than 0.05 metres adjacent to the Wambo Mine access road and no change on non-mine owned land.

No.	Comment	Response
10.	Potential impacts to flood behaviour in the area of the proposal were only considered in the context of a levee to be constructed near the surface infrastructure area (EA, App. C, p. 45). Potential changes to flood extent due to subsidence and ponding impacts should be considered.	Advisian (2016) concluded that the Modification would not increase the risk of flooding or materially affect the flood hazard or flood behaviour in the vicinity of the Modification in consideration of the predicted subsidence and ponding impacts. The Modification would cause negligible subsidence on any privately-owned land, and therefore ponding would not affect privately-owned land or significant public infrastructure. The potential consequences of ponding on ecology and agricultural resources was assessed in the EA.
11.	Fracturing is predicted to reach the surface in some areas. The proponent's statement that mining induced fracturing does not have long-term adverse effects on ephemeral streams with natural soil beds (EA, App. A, p. 52) requires justification. Some of the ephemeral streams (e.g. Stony Creek) in the potential subsidence zones have large areas of bedrock or coarse rocky streambeds.	Stony Creek would be undermined by Area 2, which does not form part of the Action (EPBC 2016/7636) referred under the EPBC Act. As described in the Surface Water Assessment (Appendix C), the first 600 m of Stony Creek within Area 2 has a steep gradient with the stream bed comprised of quite large boulders and coarse gravels. This portion of Stony Creek has been previously undermined by the North Wambo Underground Mine. The Subsidence Assessment (Appendix A) and Environmental Assessment relevantly concluded: • Subsidence may result in dilation and the development of bed separation in the topmost bedrock. • Due to the ephemeral nature of Stony Creek, in times of heavy rainfall, the majority of the runoff would flow over the natural surface soil beds and would not be diverted into the dilated strata below. In times of low flow and prior to remediation, surface water flows could be diverted into the dilated strata below the beds. • It is expected that any fracturing that develops in the underlying bedrock of the natural watercourses would gradually be filled with surface soils during subsequent flow events. This is the preferred management method for stream bed cracking due to the likely level of disturbance associated with other management measures. • If necessary, minor surface cracks would be in-filled with soil or other suitable materials and the surface re-graded and re-compacted. • It is not expected, that there would be a direct hydraulic connection between the surface at Stony Creek and proposed longwalls. The Extraction Plan process would outline the process for monitoring potential subsidence impacts and determining the need for any remediation of stream impacts.

No.	Comment	Response
12.	The proponent indicates it will be necessary to remediate some sections of creeks, using regrading and infilling methods, and expects no long-term adverse impacts on the creeks after remediation. The success or otherwise of these techniques will need to be assessed and exceedence triggers developed to inform ongoing management options.	These concerns are addressed through Condition 22C, Schedule 4 of the Development Consent (DA 305-7-2003), which requires an Extraction Plan for second workings, including: • *appropriate revisions to the Rehabilitation Management Plan required under condition 94C; and* ... • *Water Management Plan, which has been prepared in consultation with EPA and DPI-Water, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on surface water resources, groundwater resources and flooding, and which includes:* - *surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality;* - *a program to monitor and report groundwater inflows to underground workings; and* - *a program to manage and monitor impacts on groundwater bores on privately-owned land;* Under Condition 22D, Schedule 4, these plans are required to include a contingency plan that expressly provides for adaptive management.
13.	Potential subsidence impacts on South Wambo Dam, including fracturing and buckling of the uppermost bedrock and cracking of the base of the dam or dam wall, require further consideration regarding potential impacts to surface and groundwater from leakage.	These concerns are addressed through Condition 28B, Schedule 4 of the Development Consent (DA 305-7-2003): *The Applicant shall design, construct and operate the South Wambo Dam to the satisfaction of the DSC and DRE. The design of the dam must be accompanied by a detailed assessment of the potential operational and environmental risks associated with the dam, particularly in relation to potential subsidence-related impacts.*

No.	Comment	Response
14.	North Wambo Creek, Stony Creek and Wambo Creek are ephemeral and originate in the Wollemi National Park. Many of the creeks support persistent pools (some of which are large, for example in North Wambo Creek there is a pool approximately 250–300 m long). Further consideration of the complexity and value of ecosystems associated with the ephemeral creeks and associated pools is required to adequately assess impacts. These pools are likely a legacy of previous mining but may now constitute important refuges for aquatic biota in these modified systems. These refuges may be vulnerable to sedimentation from altered geomorphology. It is also unclear whether the frequency and duration of low flows in the ephemeral creeks will be changed with potential impacts on aquatic biota and water quality.	The potential for changes in ponding is considered in Section 3.3 of the Surface Water Assessment (Appendix C). The Surface Water Assessment (Appendix C) concluded that changes in creek gradients would be minor or very localised, and that significant increases in erosion and sediment load is not expected with the implementation of monitoring and management measures (e.g. localised scour protection) through the Extraction Plan process. A riparian habitat assessment was undertaken as part of the Fauna Assessment and is summarised in Section 3.3 of Appendix E. In relation to impacts on fauna that rely on surface water, the Fauna Assessment concluded: *As some impacts are expected upon natural features, including streams and steep slopes due to subsidence, minor potential impacts could occur upon threatened fauna species including reptiles, cave roosting microbats and ground dwelling mammals (for a full list see Table 7). These impacts are not considered to be significant as the impacts are minor and suitable habitat resources would remain present outside the Modification area…* HydroSimulations (Appendix B) concluded the Modification would have no discernible or negligible effect on stream baseflow or natural river leakage for Wollombi Brook, North Wambo Creek, Wambo Creek or Stony Creek stream systems, beyond the effects of approved mining.
15.	Potential subsidence impacts such as soil cracking, ponding and loss of surface water flows, were not adequately assessed for listed flora.	Section 6.1 of the Flora Assessment (Appendix D) includes an assessment of potential subsidence impacts on flora, including soil cracking, ponding and changes in surface water. This assessment concluded: *In conclusion, it is considered unlikely that vegetation on the Study area would be adversely affected by soil cracking. However, there may be a small loss of woodland due to surface ponding and possible effects to riparian vegetation where ponding occurs along creeks, or fracture networks develop below Stony Creek. However, these impacts would be lower for the Modification than for the approved arrangement. In addition, Advisian (2016) concludes that remediation of ponding by regrading creek beds are likely to result in a greater disturbance (e.g. erosion and surface disturbance) than the ponding itself.* The NSW Office of Environment and Heritage did not raise any concerns regarding the assessment of potential impacts on listed flora.

No.	Comment	Response
16.	The assessment documentation only presents a summary of the approved Management Plans. The proponent states that impacts associated with the proposal will be managed in accordance with these plans. Limited by the information provided in the assessment documentation and in light of the issues raised in response to Question 1, the IESC is not able to formulate advice with regards to whether the strategies to avoid, mitigate or reduce the likelihood of impacts are reasonable.	As described in Section 2.14 of the EA, approved management plans/monitoring programmes are available on WCPL's website: http://www.peabodyenergy.com/content/422/australia-mining/new-south-wales/wambomine/approvals-plans-and-reports-wambomine These management plans and monitoring programmes have been approved under the Wambo Coal Mine Development Consent (DA 305-7-2003).
17.	Existing strategies within monitoring and management plans should take into consideration: a. Changes to drawdown within the alluvium and regolith. b. Altered flood hydrology and hydraulic characteristics, given the change in subsidence-related impacts. c. Updates to the mine water balance with particular regard to increased groundwater inflows, storage and the requirement for discharge of surface water. d. Groundwater drawdown and subsidence impacts to GDEs and terrestrial vegetation overlying mine workings and in areas of predicted drawdown. Potential GDEs and aquatic ecosystems, other than Parnell Spring, were not adequately characterised and assessed in the groundwater assessment report (EA, App. B). e. Surface water flow and quality monitoring requirements for all creeks including the unnamed tributaries of Wollombi Brook. This baseline information can be used to set trigger levels and to assess the success of mitigation strategies. f. Surface water quality (including additional parameters such as aquatic invertebrate community composition) in dams and creeks to enable a baseline to be assessed and performance indicators and management triggers to be determined.	WCPL's monitoring and management plans will be reviewed, and if necessary revised, following approval of the Modification (as required under Condition 6, Schedule 6 of the Development Consent (DA 305-7-2003). A response to each of IESC's specific recommendations is below: a. The latest numerical groundwater model predictions will be considered in updates to the Groundwater Monitoring Program, noting that the Modification would cause no discernible or negligible additional drawdown in alluvium and regolith. b. Potential ponding impacts would be monitored and managed through the Extraction Plan process. c. The Modification would not include any material changes to the approved water management system, water supply or water demand. In addition, the mine water balance has recently been reviewed for the United Wambo Open Cut Project, including cumulative consideration of the Modification: https://majorprojects.affinitylive.com/public/dbb2f464d6f0dee9417dc592d6e975fe/16.%20United%20Wambo%20-%20EIS_Appendix%2011_Surface%20Water%20Assessment_Part%202.pdf d. Potential impacts on vegetation would be monitored and managed through the Extraction Plan process. e. Surface water flow and quality monitoring for North Wambo, Wambo and Stony Creeks is incorporated in the Surface Water Monitoring Program. Surface water quality monitoring of unnamed tributaries above Area 3 would be considered prior to mining in the area. Installation of gauging stations along the ephemeral unnamed streams is not considered warranted given the infrequent flows in these streams (likely to be less than 30 days per year) do not provide support for any significant riparian ecosystems or surface water users. f. Surface water sampling in dams and creeks is conducted in accordance with the Surface Water Monitoring Program approved under Condition 33, Schedule 4 of the Development Consent (DA 305-7-2003).

No.	Comment	Response
18.	A strategy to avoid, mitigate or reduce impacts of longwall mining is to alter the mine layout, including narrower longwalls and wider inter-panel pillars. In this light, consideration could be given to reduce longwall extents and altering configurations in the vicinity of Stoney [sic] and Wollombi creeks [sic] to reduce subsidence impacts.	Longwall mining associated with the Action would have no subsidence impact on Wollombi Brook as: • mining of longwall panels would be constrained by the subsidence exclusion zone limited to an angle of 26.5° from the vertical to a 40 m lateral buffer from the Wollombi Brook high bank; and • main development drivages beneath the Wollombi Brook would be designed to be permanently stable. Stony Creek would be undermined by Area 2, which does not form part of the Action (EPBC 2016/7636) referred under the EPBC Act. In Area 2, the modified mine layout includes a reorientation and minor extension of the approved mine layout. The approved mine layout involves extraction beneath Stony Creek. The proposed objective of any altered mine layout is not clear from the IESC advice.

No.	Comment	Response
19.	Additional monitoring and management measures may include: a. Regular review and updates to the numerical groundwater model to validate predictions and inform ongoing monitoring and management measures. b. Additional groundwater monitoring locations in Area 4 and Area 3 to monitor groundwater levels within areas of subsidence, including determination of groundwater level and quality requirements of GDEs. c. Nested piezometers to the west and south of the South Wambo Dam to monitor the high salinity zone observed in monitoring bores P114 and P116. d. Groundwater sampling to include metals and other potential contaminants of concern. It is unclear from the EA whether these are considered or included in the current water quality sampling regime. e. Surface water sampling for metals and ionic composition (see paragraph 20 below), including development of trigger values associated with ecotoxicological effects, and required response actions where triggers are exceeded. f. Upgrading surface water gauges and updating the surface water model with recent data to achieve adequate calibration and inform ongoing management strategies. g. Further consideration of the three unnamed drainage lines to the south east of the proposal that drain to Wollombi Brook. This may include continuous data loggers. h. Geochemical testing of coal reject, waste rock and tailings materials to characterise and inform ongoing management strategies. i. Ecological monitoring in Wollombi Brook, downstream of discharge sites and in persistent pools of ephemeral creeks for aquatic biota as biomonitors of ecological responses to altered flows (especially low flows) and water quality.	A response to each of IESC's specific recommendations is below: a. The performance of the numerical groundwater model predictions are reviewed annually as part of the Annual Review required under Condition 5, Schedule 6 of the Development Consent (DA 305-7-2003). b. WCPL has committed to revise the Groundwater Monitoring Program to include the Modification (subject to approval of the Modification). This will include augmentation of the program in Areas 3 and 4 to allow for collection of adequate baseline data prior to the commencement of mining in these areas. c. WCPL has committed to revise the Groundwater Monitoring Program to include the Modification (subject to approval of the Modification). This will include the proposed installation of nested piezometers in 2017. Specific consideration will be given to monitoring in the vicinity of P114/P116. d. The approved Groundwater Monitoring Program includes sampling for metals and other contaminants. e. Surface water sampling is conducted in accordance with the Surface Water Monitoring Program approved under Condition 33, Schedule 4 of the Development Consent (DA 305-7-2003). f. WCPL replaced two flow monitoring stations (FM7 and FM8) on Stony Creek in 2015 to improve the reliability of data being collected on this creek. WCPL has committed to a review of flow monitoring along Wambo Creek in 2016 in consultation with the DP&E. g. Installation of gauging stations along the ephemeral unnamed streams is not considered warranted given the infrequent flows in these streams (likely to be less than 30 days per year) do not provide support for any significant riparian ecosystems or surface water users. In addition, installation of gauging stations in ephemeral streams has practical constraints associated with the requirement to cap sensors during extended periods of no-flow to avoid damage to the sensors. When rainfall does occur after an extended no-flow period, the streams are typically inaccessible for the caps be removed in a timely manner and therefore the gauging stations fail to capture flow data. h. Geochemical testing of the coal seams and coal rejects has been conducted for the coal seams proposed to be mined at the Wambo Coal Mine. i. Riparian monitoring of North Wambo Creek, North Wambo Creek Diversion, Wambo Creek and Stony Creek is conducted in accordance with the Flora and Fauna Management Plan approved under Condition 44, Schedule 4 of the Development Consent (DA 305-7-2003).

No.	Comment	Response
20.	Further assessment of the potential impacts of physical and chemical composition of discharge water, including the impacts of metals and PAHs, on downstream ecosystems and environments would improve understanding of potential regional cumulative impacts of mining. This is consistent with the findings of Krogh et al. (2013) which recommends experimental studies to fully understand the effects of different components of saline water including metals/metalloids and ionic compositions discharged to the Hunter River.	The site water management strategy for the Wambo Coal Mine is based on the containment and re-use of mine water within the water storage dams at the Wambo Coal Mine. This limits the potential for off-site release of salt and heavy metals. The Wambo Coal Mine releases water to the Wollombi Brook in accordance with its Environment Protection Licence (EPL) 529, which operates under the arrangements of the Hunter River Salinity Trading Scheme (a state water quality management plan). The outcomes of the Hunter Catchment Salinity Assessment (Krogh *et al.*, 2013) are being implemented by the Environment Protection Authority through its ongoing Review of the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation, 2002.*
21.	The Northern Sydney Basin, which includes the Hunter Subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposal should be made accessible to this Bioregional Assessment and related research projects.	Noted. WCPL monitoring data is presented in the Annual Reviews that are publicly available on the WCPL website.

Attachment 1 – FM3 Summary of Results for 1 February 2014 to 31 January 2015

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate (m^3/s)	Maximum Theoretical Flow Rate (m^3/s)
1	16/02 14:00	16/02 14:20	0.01	0.013	0.022	<0.001	<0.01
2	16/02 15:20	16/02 16:00	0.03	0.011	0.015	<0.001	<0.01
3	16/02 17:20	16/02 17:50	0.02	0.034	0.056	0.002	0.01
4	19/02 16:10	19/02 17:00	0.03	0.027	0.043	0.001	<0.01
5	19/02 18:20	19/02 21:30	0.13	0.102	0.250	0.062	0.23
6	23/02 08:50	23/02 17:00	0.34	0.014	0.029	<0.001	<0.01
7	28/02 13:50	28/02 19:50	0.25	0.082	0.187	0.039	0.17
8	24/03 10:20	24/03 10:50	0.02	0.031	0.045	0.001	<0.01
9	27/03 05:10	27/03 22:10	0.71	0.043	0.090	0.005	0.02
10	28/03 17:10	28/03 19:20	0.09	0.024	0.057	0.001	0.01
11	04/04 04:20	04/04 05:20	0.04	0.010	0.018	<0.001	<0.01
12	04/04 21:40	05/04 01:00	0.14	0.073	0.159	0.028	0.11
13	05/04 19:20	05/04 21:20	0.08	0.058	0.147	0.015	0.09
14	06/04 00:20	06/04 00:50	0.02	0.017	0.023	<0.001	<0.01
15	25/04 07:10	25/04 09:00	0.08	0.045	0.129	0.013	0.06
16	26/07 05:20	26/07 05:50	0.02	0.006	0.009	<0.001	<0.01
17	26/07 08:20	26/07 09:20	0.04	0.024	0.035	<0.001	<0.01
18	26/07 13:30	26/07 14:10	0.03	0.007	0.014	<0.001	<0.01
19	17/08 01:00	17/08 03:20	0.10	0.016	0.034	<0.001	<0.01
20	27/08 01:20	27/08 08:20	0.29	0.075	0.130	0.021	0.06
21	10/09 07:10	10/09 08:10	0.04	0.033	0.059	0.002	0.01
22	13/10 18:10	13/10 18:30	0.01	0.018	0.022	<0.001	<0.01
23	14/10 23:30	15/10 00:00	0.02	0.011	0.018	<0.001	<0.01
24	05/12 21:20	05/12 23:40	0.10	0.091	0.271	0.055	0.28
25	06/12 16:40	06/12 23:40	0.29	0.043	0.268	0.026	0.28
26	08/12 03:30	08/12 05:50	0.10	0.018	0.049	<0.001	<0.01
27	10/12 18:00	10/12 23:50	0.24	0.100	0.251	0.056	0.231
28	11/12 05:20	11/12 09:30	0.17	0.023	0.056	0.001	0.01
29	24/12 15:00	24/12 15:50	0.03	0.042	0.084	0.004	0.02
30	25/12 18:40	26/12 01:50	0.30	0.061	0.186	0.019	0.17
31	02/01 00:40	02/01 03:50	0.13	0.028	0.108	0.004	0.03
32	11/01 17:30	11/01 22:30	0.21	0.012	0.034	<0.001	<0.01
33	20/01 02:10	20/01 09:00	0.28	0.122	0.318	0.091	0.43
34	24/01 21:40	24/01 23:30	0.08	0.018	0.034	<0.001	<0.01
35	27/01 10:50	27/01 19:30	0.36	0.050	0.154	0.016	0.10

Source: AECOM, 2015.