



Planning
Assessment
Commission

WALLARAH 2 COAL PROJECT

PAC REPORT

November 2010

EXECUTIVE SUMMARY

The Wallarah 2 Coal Project (the project) relates to the establishment of longwall mining within the Wallarah-Great Northern coal seam to the west of the F3 Freeway, northwest of Wyong. The Wyong Areas Coal Joint Venture (the proponent) seeks approval for the extraction of up to 5 million tonnes of coal per year for 28 years.

The Minister for Planning referred the project to the Planning Assessment Commission (the Commission) to:

- review the Environmental Assessment for the Wallarah 2 Coal Project, taking into consideration any issues raised in submissions, the findings of the strategic review into the *Impacts of Potential Underground Coal Mining in the Wyong LGA*, the *Wyong Water Study* and the *Wyong Water Study: International Peer Review*;
- hold public hearings during this review;
- assess:
 - the potential subsidence-related impacts of the project, paying particular attention to its ability to adversely affect the Central Coast's drinking water supply; and
 - any other potentially significant impacts of the project;
- recommend appropriate measures to avoid, minimise or offset these impacts;
- provide advice on the merits of the project as a whole.

The Commission was constituted by Emeritus Professor Jim Galvin, Dr Lloyd Townley, Dr Steve Perrens, Mr John Court, and Ms Gabrielle Kibble AO (Chair). The Commission examined the Environmental Assessment (EA) and other relevant documents, received submissions, held public hearings, examined experts, undertook site inspections and held Commission meetings. The Commission also directed formal questions to the Proponent and to a number of government agencies.

The EA was publicly exhibited from 31 March 2010 until 2 June 2010. 247 submissions were forwarded to the Planning Assessment Commission by the Department of Planning. The Commission held public hearings on 28 October 2010 at Wyong Council chambers, and received 26 verbal and four written submissions.

In accordance with the terms of reference, the Commission had close regard to the studies, findings and recommendations of the 2007 strategic review into the *Impacts of Potential Underground Coal Mining in the Wyong LGA*. While highly relevant and discussed fully in Appendix D, this review was not an early assessment of the present application, despite a possible impression to the contrary given in the proponent's Environmental Assessment.

The Commission also carefully considered the *Wyong Water Study* and the *Wyong Water Study: International Peer Review* which were commissioned in 2010, and provides its own critique of the material and its relevance for this assessment in Appendix E. Overall the Commission was disappointed that the brief for the study did not call for a more comprehensive assessment of the groundwater situation, including independent modelling.

The project would involve three above ground sites: shafts, administrative buildings and gas and water management facilities at Buttonderry (the Buttonderry site); coal handling and storage facilities, rail loop and loading infrastructure and drift entry at a site on Tooheys Road (the Tooheys Road site); and an air intake shaft within Wyong State Forest (the Western Shaft site). The construction of the project would cost \$613.5 million and operational expenditure would average \$130.8 million per year. The project would employ at least 800 workers during construction and 300 workers during operation.

The Commission notes that the mine plan has evolved over a decade of planning. The result of this evolution has been the minimisation of the subsidence, groundwater and surface water risks. The surface configuration is not ideal because it is spread over sites either side of the F3 Freeway, with stockpiling and loading of the coal taking place to the east of the Freeway. However, this configuration can be managed with appropriate operational and control measures.

The predictions of conventional subsidence, primarily in the Dooralong valley, are adequate to assure that consequences for groundwater and surface water will be minimal and manageable, provided adaptive mining management is practiced and the Commission's recommendations are implemented.

Only a small proportion of the Central Coast water supply comes from this catchment. There will be no significant adverse consequences for the Central Coast water supply, provided that no connectivity of surface water with the mining strata is caused by any major unidentified geological fault. This is very unlikely and avoidable in the Commission's judgment. Nevertheless, the Commission recommends close monitoring of the water table in the alluvial valleys to ensure early identification and addressing of any drawdown.

The Commission notes that, although the mine water balance is unresolved, the demands of water for the operation will not place inappropriate demands on the Central Coast water supply. There are uncertainties in the predictions of groundwater inflow to the mine workings mining which could result in either a surplus or deficit of water in the project water balance after an initial development period of several years. Any deficit needed for dust management could be supplemented from treated sewage effluent from the Charmhaven sewage treatment plant. Any surplus water and effluent from the project could be treated and released but this type of activity would require better definition and further analysis.

Mine subsidence management should result in satisfactory outcomes for undermined houses and owners of structures using adaptive management, although a more wavy final landform may result if pillars do not collapse as predicted. The predictions of non-conventional subsidence and upsidence in the hilly forested country in the western part of the mining area need considerable further refinement which should be undertaken well before mining of that area commences in 12 to 15 years time.

Flooding predictions indicate that the extent of flooding will not be significantly changed due to subsidence and that technical measures are possible to address road flooding. However,

further work is required on changes to water flows and quality in the hilly forested country well before mining of that area commences.

Particulate air pollution predictions are adequate and within State and national limits. However, DECCW will need to be satisfied as to the initiatives proposed to address air pollution. Given uncertainties in estimating emissions and the range of options available for mitigation, a goal for PM_{2.5} (when established) as monitored must be achieved, even if this requires eventual enclosure of the stockpiles.

Noise from mining surface activities should be adequately controlled, and, if criteria are not satisfied, additional engineering measures are to be applied to the satisfaction of DECCW. Noise from rail movements of coal will need to comply with DECCW criteria. This will depend on the availability of suitable locomotives and rolling stock to ensure engine noise and wheel-squeal are controlled to DECCW criteria.

Ecological impacts from surface activities should be offset to the satisfaction of DECCW. Ecological impacts due to subsidence should be manageable in the alluvial valleys, with confirmation of this by ecological studies required as soon as possible after mining commences. Ecological impacts in the hilly forested area to the west should be adequately defined to ensure protection or offset well before underground mining is allowed to commence in this area.

Transport of the extracted coal by rail to Port Newcastle is feasible within the existing corridor, and traffic impacts in the Wyong area are acceptable. The economic and social consequences of the proposal are also acceptable.

The Commission wishes to express its disappointment at the level of information provided in the EA. Although sufficient information was provided to allow the Commission to complete its review and assessment, the Commission would not have had to recommend as many conditions on the approval of the project if more information had been provided in the EA. After detailed consideration the Commission has concluded that the application may be approved subject to the imposition of a substantial number of conditions covering the full range of issues.

In summary, the Commission recommends that:

1. If the proposal is approved, the dimensions of longwall panels and interpanel pillars, including mining height, not be permitted to be relaxed beyond those proposed for Longwalls 1N to 5N until a reliable subsidence prediction methodology has been demonstrated to the satisfaction of the Director-General of the Department of Planning.
2. Any changes to the proposed mine layout, other than of a minor nature as foreshadowed in the EA (and excluding a reduction in the extent of the mining footprint), should be permitted only after undergoing comprehensive assessment to the satisfaction of the Director-General of the Department of Planning.

3. No secondary extraction¹ be permitted beneath the Jilliby State Conservation Area and the Wyong State Forest (including Myrtle Creek, Armstrong Creek and beneath any watercourse within the Terrigal Formation²), until a comprehensive assessment of surface features and potential subsidence effects and impacts within these areas has been undertaken to the satisfaction of the Director-General of the Department of Planning.
4. Any Extraction Plan should include provision for developing and implementing a program for detecting and recording all geological structures and assessing the potential impacts of these structures on subsurface and surface features. Such a program is to be implemented in a manner which provides adequate time to modify mining plans if a structure is likely to result in unacceptable environmental impacts.
5. The program for detecting and recording geological structures should be premised on the philosophy of a ‘trigger, action, response plan’ (TARP) which includes thresholds for stopping mining operations, reporting the occurrence of geological features to relevant government agencies, for initiating formal risk assessments and reviews that include external, independent expert representation, and for the resumption of mining if and when appropriate.
6. Any conditions of approval require that measured versus predicted surface subsidence effects be reported on a quarterly basis to the Department of Planning, the Department of Industry and Innovation (Minerals Section), the Department of Environment, Climate Change and Water, and the Wallarah 2 Community Consultative Committee for a period of 5 years or until such time as the subsidence prediction methodology has developed to being a reasonably reliable tool, whichever period of time is longer.
7. Any conditions of approval require that an end of longwall panel report be prepared for public display within 6 months of the completion of extraction of each longwall panel, with this report encompassing all monitoring of subsidence (and environmental) effects (and impacts) and being provided to the Department of Planning, the Department of Industries and Innovation (minerals section), the Department of Environment, Climate Change and Water, and the Wallarah 2 Community Consultative Committee.
8. All subsidence monitoring processes and outcomes (including those relating to surface water, groundwater, ecology and indigenous heritage) are externally audited on an annual basis for the first five years of mining and, subject to these audit outcomes being favourable, every three years thereafter for verification of ongoing adequacy and accuracy of subsidence effects predictions.
9. As part of the Extraction Plan, the proponent should develop and implement a Groundwater Management Plan that includes the requirements listed in Schedule 1.
10. The Extraction Plan should require the proponent to develop plans for ensuring recovery of pressures within the deep aquifer system if this is necessary to achieve

¹ Secondary extraction encapsulates all mining operations other than the drive of main development (access) roadways. Hence, it includes longwall mining.

² As defined in Figure 1 of WACJV (2020c).

recovery of water table elevations at the surface. Such plans should give consideration to options for supplementing natural water inflow to facilitate recovery.

11. As part of each Extraction Plan, the proponent should develop and implement a Surface Water Management Plan relating to the area that will be subject to subsidence. The plan should include the requirements listed in Schedule 2.
12. The Extraction Plans for longwalls that run under the steep rocky catchments should include contingency plans to manage any unexpected release of soluble oxidised metals due to fracturing of drainage lines. The contingency plans should canvass options such as not mining under these drainage lines, or to reduce mining dimensions such that fracturing is minimised.
13. Prior to commencement of extraction under the alluvial floodplain of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek, the relevant Extraction Plan should address measures to manage or mitigate any unwanted or unexpected effects of subsidence leading to the creation of new wetlands/depressions or increased potential for channel avulsion.
14. Property Management Plans should document the agreed flood mitigation measures for each dwelling as well as measures to mitigate any subsidence impacts on access along the driveways.
15. Any additional flood modelling necessary for the preparation of Property Management Plans should be based on updated calibration of the hydrologic and hydraulic models, use ALS data to characterise the land surface and take account of any updated subsidence predictions based on monitored subsidence in the W2CP area.
16. All measures for control of air pollution shall deliver air quality outcomes that are equal to or better than the air quality outcomes identified in the EA and that correspond to best practice or the application of best available technology economically achievable.
17. The proponent should develop and implement an Air Quality Management Plan to ensure air quality goals are achieved and a satisfactory amenity is achieved in the neighbourhood. This should include the requirements listed in Schedule 3.
18. Before any clearing on the proposed surface sites, ecological surveys should be undertaken of sufficient intensity and to the satisfaction of DECCW so as to allow an adequate and appropriate area of offset land to be determined to compensate for ecological impacts caused by the provision of surface facilities.
19. Additional land(s) should be acquired or provided through security into perpetuity to make up for any deficiency in lands already held against ecological offset; the determination and offset provision should be to the satisfaction of DECCW.
20. A comprehensive Ecological Management Plan (EMP) for all lands liable to subsidence should be developed as part of the Extraction Plan. This plan should be in two parts as follows, and include the information listed in Schedule 4:

- a) Part A: Hue Hue Creek and the alluvial floors of the Dooralong and Yarramalong Valleys; and
 - b) Part B: The steeply-sloping forested lands of the Wyong State Forest and the Jilliby Conservation Area.
21. Mining should not be permitted beneath any area until an assessment of Indigenous heritage in that area has been undertaken in accordance with an Aboriginal Cultural Heritage Management Plan (ACHMP) prepared to address the requirements in Schedule 5 and to the satisfaction of DECCW.
 22. All plant and equipment shall deliver noise outcomes that are equal to or better than the noise outcomes identified in the EA.
 23. A regular neighbourhood noise survey regime should be established and operated to the satisfaction of DECCW in accordance with consent and EP licence conditions to ensure compliance with the project noise goals as defined in the EA.
 24. A Noise Management Plan to minimise all noise impacts to the maximum extent feasible during construction should be developed to the satisfaction of DECCW before construction commences and implemented during the whole construction period; the plan should include regular noise surveys of sensitive locations.
 25. If regular noise surveys indicate that any of the project noise goals are not being met, appropriate additional noise mitigation measures will be designed and installed to the satisfaction of DECCW, including such measures as:
 - a) Further enclosure of identified equipment generating excessive noise;
 - b) Provision and/or modification of equipment to enhance noise abatement;
 - c) Modification of stockpile management, including restricting the operation of dozers on its surface; and
 - d) Design and provision of mechanical stacking and recovery equipment for stockpiles if noise abatement levels cannot be met after a reasonable period of operation using the proposed method of coal handling.
 26. DECCW should further explore the impact of noise from coal train operations on the rail corridor (including 'wheel squeal') and at the Tooheys Road site. The proponent should contribute to this exploration.
 27. Prior to commencement of construction, separate Surface Facilities Water Management Plans should be prepared for the Buttonderry site and the Tooheys Road site. These plans should be prepared in consultation with DECCW and Wyong Shire Council and should be to the satisfaction of the Director General of the Department of Planning. The plans should specifically address the issues identified in Schedule 6.
 28. In consultation with DECCW, appropriate water quality criteria should be developed for each body of receiving water based on procedures for assessing local specific criteria as set out in ANZECC 2000 for the protection of downstream ecosystems.

Separate assessments should be prepared for Wallarah Creek and Buttonderry Creek to reflect the different aquatic and riparian conditions of each creek and the ultimate receiving waters (Budgewoi Lake and the Porters Creek Wetlands respectively).

29. The Proponent should bear all costs associated with the installation and maintenance of the new crossover and turnout with the Main North rail corridor.
30. The Proponent should not transport any coal off site by public road, except during emergencies and with the written approval of the Director-General of the Department of Planning.
31. The Proponent should monitor the amount of coal and coal reject transported from the site each year, and report the results of this monitoring on its website every six months.
32. Prior to the commencement of construction, the Proponent should submit a Road Condition Report to the Director-General of the Department of Planning. The Road Condition Report must include:
 - a) an assessment of the pre-construction condition of all roads used to access the Buttonderry, Tooheys Road and Western Shaft sites,
 - b) a program for periodic review of the condition of these roads during construction and operation in consultation with the RTA and Wyong Council, and
 - c) procedures for quantifying the role of the project in any road damage and repairing this damage.
33. Prior to the commencement of construction, the proponent should submit a Traffic Management Plan for the project to the Director-General of the Department of Planning. This plan must be prepared in consultation with the RTA and Wyong Council. This Plan must describe the traffic management structures and procedures to be put in place during the delivery of major components and equipment to the project sites, the closure or partial closure of roads, and the construction of the rail spur crossings over Tooheys Road.
34. Prior to the commencement of construction, the proponent should provide evidence of an agreement with the RTA regarding a contribution to the upgrade of the eastern intersection of the Sparks Road/F3 Freeway interchange. This must include evidence of the RTA's satisfaction with the terms of the agreement.
35. If Transport NSW undertakes a review of the Main North rail corridor's capacity at any stage during the construction and operation of the project, the Proponent should:
 - a) make an appropriate contribution to the funding of this review,
 - b) participate in this review, and
 - c) implement the recommendations of this review to the satisfaction of the Director-General.

36. Prior to the commencement of construction, the proponent should submit a Landscape Management Plan to the Director-General of the Department of Planning. The Landscape Management Plan does not apply to any areas that form part of the project's offset strategy, which must be managed separately. The Landscape Management Plan must include:
- a) detailed plans and plant species schedules for landscaping at the Tooheys Road and Buttonderry sites,
 - b) a program for the monitoring and ongoing maintenance of landscaping for the life of the project.
37. Upon receiving a written request from an owner of privately-owned land with direct views to the Tooheys Road site from a residence within two (2) kilometres of the Tooheys Road site, the proponent should implement reasonable and feasible additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, and to the satisfaction of the Director-General of the Department of Planning.
- If, within 3 months of receiving this request, the proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General of the Department of Planning for resolution.
38. The proponent should minimise light spill and the off-site lighting impacts of surface works and ensure that all external lighting associated with the project complies with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting.
39. Prior to the commencement of construction, the proponent should submit a Community Enhancement Program (CEP) to the Director-General to fund (or provide in kind) community infrastructure and services in the locality of the project. The CEP must:
- a) identify directly affected landowners that will be consulted on the terms of the CEP
 - b) be prepared in consultation with those directly affected landowners and Wyong Council, and provide evidence of their involvement
 - c) identify specific initiatives that will be funded by the proponent, and the timing and costs for those initiatives, and
 - d) detail procedures for the review of the CEP throughout the life of the project.
40. Any approval should make provision for the establishment of a Community Consultative Committee.

Schedule 1 – Groundwater Management Plan (GMP)

The GMP should:

1. Describe measurements of piezometric heads, water quality and any other attributes that may inform ongoing assessment of impacts of mining and subsidence on groundwater, and explaining how such measurements will be interpreted and used in such assessment.
2. Be developed as part of the Extraction Plan, in order to ensure tight integration of ongoing subsidence management and the ongoing need for vigilance in monitoring impacts of subsidence on groundwater.
3. Include provision for assessing the contributions to seepage via significant geological structures such as faults and dykes. Such a program is to be implemented in a manner which provides adequate time to modify mining plans if a structure is likely to result in unacceptably high mine inflows. The program should be premised on the philosophy of a ‘trigger, action, response plan’ (TARP) which includes thresholds for stopping mining operations, reporting the occurrence of significant geological features to relevant government agencies, for instigating formal risk assessments and reviews that include external, independent representation, and for the resumption of mining if and when appropriate.
4. Be linked to a Surface Water Management Plan, recognising the concern of stakeholders about loss of water from streams caused by leakage to deeper hard rock systems. This component of the plan should be developed in consultation with the NSW Office of Water.
5. Include all monitoring proposed by the proponent in the EA, including:
 - a) an undertaking to estimate the age of groundwater by isotope analysis at a number of locations within the hard rock aquifers and aquitards likely to be affected by mining, within the coal seam and in overlying formations.
 - b) measurements of flows into and out of the mine, with sufficient accuracy to allow interpretation of the potential source of groundwater seeping into the mine.
 - c) measurements of water table elevations in the alluvial aquifers of the Yarramalong and Dooralong Valleys, such monitoring to commence as soon as practicable, thereby ensuring a long record of natural seasonal fluctuations prior to the potential impact of mining.
6. Require that all groundwater monitoring processes and outcomes be audited externally annually for the first five years of mining and, subject to these audit outcomes being favourable, every three years thereafter for verification of ongoing adequacy and accuracy of predictions, such predictions being revisited and revised at time of audit taking into account the results of monitoring and modelling.

7. Require that the results of groundwater monitoring be reported and prepared for public display as part of reporting on subsidence within 6 months of the completion of extraction of each longwall panel.

Schedule 2 – Surface Water Management Plan (SWMP)

The SWMP should :

1. Develop a program of flow and water quality monitoring to be undertaken on two small forested upland sub-catchments of comparable size, shape and aspect. One of these catchments is to be on a catchment that will not be affected by subsidence while the other is to be on one that will be affected. Continuous flow, salinity and pH monitoring should be undertaken for at least 5 years prior to undermining of the sub-catchment that will be subject to subsidence in order to provide an adequate baseline to detect any water quality changes such as pH that could be indicative of potential for iron staining.
2. Be linked to a Groundwater Management Plan, recognising the concern of stakeholders about loss of water from streams caused by leakage to deeper hard rock systems. This component of the plan should be developed in consultation with the NSW Office of Water.

Schedule 3 – Air Quality Management Plan (AQMP)

The AQMP should include the following requirements:

1. Monitoring and management arrangements that:
 - a) Establish a comprehensive monitoring network for TSP, PM₁₀, PM_{2.5} and deposition;
 - b) Ensure the monitoring network has the capacity to apportion the component of emissions from the proponent's surface operations using a combination of dual synchronized monitors and meteorological instruments, supplemented by elemental or chemical methods of source apportionment as appropriate; and
 - c) Establish a predictive management system for high-wind events.
2. The proponent should ensure that there is compliance with an appropriate local equivalent of the PM_{2.5} goal, when this is finalised nationally and at State level, using its licensing mechanism to enforce a Pollution Reduction Program should this be necessary.
3. The Proponent should develop, in conjunction with DECCW, a monitoring system for detecting any adverse short-term amenity impacts resulting from high-wind events.
4. All air quality management measures should be included in the Air Quality Management Plan of the Extraction Management Plan and be incorporated into the

Environment Protection Licence issues under the *Protection of the Environment Operations Act 1997*. The AQMP and Licence conditions (after the first Licence review period) should be comprehensively and periodically reviewed.

Schedule 4 – Ecological Management Plan (EMP)

Part A of the EMP for the alluvial valleys should meet the following requirements:

1. Studies should be undertaken, to determine whether threatened or endangered water-dependent species can adequately adapt to the changes in surface and groundwaters resulting from progressive changes to landform ('advancing wave') caused by subsidence as longwall mining progresses;
2. To the extent EECs and threatened species cannot be adequately protected, offset lands are should be identified and protected in perpetuity;
3. An adaptive management component for the alluvial valleys should be developed as part of the EMP within the Extraction Plan considering the full suite of avoidance, mitigation and management approaches and, if adaptive management is an option, it should meet the test laid out in *Stoneco*³;
4. The plan should be finalized and implemented as soon as possible after the mining subsidence predictions for the area have been validated and not less than one year after that date;

Part B of the EMP for the steep forested areas should meet the following requirements:

Surveys for EECs and endangered species of flora and fauna should be undertaken:

1. The impacts of subsidence and upsidence in the creek beds in this terrain should be refined and comprehensively defined and mapped using the best predictive techniques available at the time of plan development;
2. The impacts of subsidence and upsidence on water quality should be assessed;
3. An adaptive management component for the steeply sloping forested lands should be developed as part of the EMP within the Extraction Plan considering the full suite of avoidance, mitigation and management approaches and, if adaptive management is an option, it should meet the test laid out in *Stoneco* (see above)

³ The NSW Land and Environment Court has recently defined adaptive management as:
„Adaptive management is a concept which is frequently invoked but less often implemented in practice. Adaptive management is not a “suck it and see”, trial and error approach to management, but it is an iterative approach involving explicit testing of the achievement of defined goals. Through feedback to the management process, the management procedures are changed in steps until monitoring shows that the desired outcome is obtained. The monitoring program has to be designed so that there is statistical confidence in the outcome□.
Newcastle and Hunter Valley Speleological Society Inc v. Upper Hunter Shire Council and Stoneco Pty Limited [2010] NSW LEC 48.

4. To the extent EECs and threatened species cannot be adequately protected, offset lands are should be identified and protected in perpetuity;
5. This component of the EMP planning should be finalized three (3) years before mining beneath the area commences, so as to allow adequate time for changes to the mining plan which may be necessary;
6. DG of Planning and DECCW should be advised five (5) years before mining is planned to reach the area;
7. This component of the EMP should be implemented before mining commences in the area.

Parts A and B of the EMP should meet the following requirements:

1. The EMP, including any survey work to be undertaken, should be developed:
 - a) In consultation with and to the satisfaction of DECCW;
 - b) Survey work should be at an acceptable intensity to identify occurrence of EECs and endangered species of flora and fauna; and
 - c) Should be adequate to identify action needed for protection to the satisfaction of DECCW;
2. The plan should endorsed by DECCW and in consultation with WSC; and
3. The plan should be reviewed biennially and re-endorsed by DECCW or, if DECCW is not prepared to re-endorse, changed to the satisfaction of DECCW.

Schedule 5 – Aboriginal Cultural Heritage Management Plan (ACHMP)

The ACHMP is to:

1. provide for the classification and management of all indigenous sites to be undertaken in consultation with DECCW and the relevant Aboriginal communities.
2. provide for the systematic identification of indigenous sites within the Wallarah 2 Project Area in consultation with the relevant Aboriginal communities at least 3 years ahead of the mine plan being approved in order to provide the opportunity to implement appropriate control measures.
3. be externally audited every three years for the duration of the project by a suitably qualified person appointed by the Department of Planning in consultation with the DECCW and relevant Aboriginal communities.

Schedule 6 – Surface Facilities Water Management Plan (SFWMP)

The SFWMP should meet the following requirements:

1. Site specific detailed analysis should be undertaken to demonstrate how the required water quality will be achieved for all site discharge. The analysis should include water balance modelling using daily climate data for a period of at least 25 years.
2. Serious consideration should be given to maintaining separate water management systems for mine water, surface runoff and treated effluent.
3. The water management facilities should be designed and managed so as to achieve uncontrolled discharge with probability of no more than one event in 5 years. The design and supporting analysis to be undertaken to the satisfaction of the Director General of the Department of Planning.
4. Detailed proposals should be prepared for water supply for each site during construction and initial mine operations. These proposals should include anticipated volumes required for sources of different quality (potable, treated sewage effluent and any other) and details of how the water is to be imported to the site (pipeline or tanker). In the case of any proposed pipeline, details of the proposed route should be provided. The water supply proposals should include details of how water would be managed on site in the event of wet or dry years.
5. The SFWMP should include a detailed program for monitoring water quality in the receiving waters upstream and downstream of each site and in any discharge from the site. The plan should include appropriate trigger levels and contingency actions to be taken in the event that discharge water quality fails to meet requirements.
6. Site investigations should be undertaken to characterise area to be used for disposal of effluent from each site in accordance with the DECC guidelines *Environmental Guidelines: Use of Effluent by Irrigation* (2004). The effluent disposal scheme (including method of irrigation and capacity of wet weather storage) should to be designed and operated in accordance with the guidelines including measures to control public access. A detailed management, monitoring and contingency management plan should be prepared.
7. Firm proposals should be developed for provision of potable water for staff use including detailed analysis of the volume and reliability of supply available from roof runoff and measures to supplement the supply as necessary.

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GLOSSARY

ACARP: Australian Coal Association Research Program, an industry-wide research program administered by the Australian Coal Association and funded by a per-tonne levy on all coal production.

Aquatic dependent: aquatic dependent species and ecological communities occur primarily in aquatic or wetland habitats, as well as species that may use terrestrial habitats during all or some portion of their life cycle, but that are still closely associated with, or dependent upon, aquatic or wetland habitats for some critical component or portion of their life-history.

Aquiclude: an impermeable body of rock that may absorb water slowly but does not transmit it.

Aquifer: a permeable body of rock or regolith that both stores and transmits groundwater.

Aquitard: a layer of rock having low permeability that stores groundwater but delays its flow.

ARTC: Australian Rail Track Corporation.

BHPB: BHP Billiton.

BSO: Bulli Seam Operations.

CBA: Cost Benefit Analysis.

Commission: Planning Assessment Commission

dBA: Sound pressure level in decibels on the A frequency weighting scale

DECC: Department of Environment and Climate Change. This agency regulates impacts to air, flora and fauna, water and Aboriginal heritage.

DECCW: Department of Environment, Climate Change & Water, formerly DECC and now incorporating NSW Office of Water (NOW), the latter also cited independent of DECCW.

DEWHA: The Commonwealth Department of Environment, Water, Heritage and the Arts.

Director-General's Requirements: Requirements provided by the Director-General of the Department of Planning for an environmental assessment or environmental impact statement.

DoP: Department of Planning.

DII: Department of Industry and Investment.

DPI: Department of Primary Industries.

EA: Environmental Assessment.

EEC: Endangered Ecological Community.

EP: Extraction Plan.

EP&A: Environmental Planning and Assessment.

EPBC: Environment Protection and Biodiversity Conservation.

FLAC: Fast Lagrangian Analysis of Continua.

GDE: Groundwater dependent ecosystem.

GWCWA: Gosford Wyong Councils' Water Authority

IPM: Incremental Profile Method.

Kores: Kores Australia Pty Ltd.

LGA: Local Government Area.

MCP: Metropolitan Coal Project.

MER: Mackie Environmental Research

MSB: Mine Subsidence Board.

MSEC: Mine Subsidence Engineering Consultants.

NGO: Non-Government Organisation.

NOW: NSW Office of Water.

NPWS: National Parks and Wildlife Service.

PAC: Planning Assessment Commission.

PM₁₀: Particulate matter with an aerodynamic diameter smaller than 10 micrometres.

PM_{2.5}: Particulate matter with an aerodynamic diameter smaller than 2.5 micrometres.

Pore Pressure: The groundwater pressure applying to a pore space at a nominal depth. Often expressed in metres head of water or kPa.

The proponent: The applicant under Part 3A of the *EP&A Act 1979*, in this report being the Wyong Areas Coal Joint Venture (WACJV). 'Proponent' includes the proponent's EA consultants.

The proposal: The subject of the application under Part 3A of the *EP&A Act 1979*, in this report being the Wallarah 2 Coal Project (W2CP).

Primary Porosity: The intergranular or matrix storage in between pore spaces in an aquifer – often expressed as a percentage (by volume) of a rock mass.

Piezometer: A non-pumping well or borehole, generally of small diameter, used to measure

the elevation of the water table or potentiometric surface.

Regolith: The blanket of soil and loose rock fragments overlying bedrock. It includes dust, soil, broken and weathered rock, and other related materials.

Riparian Zone: The area of land adjacent to a river or stream. It includes the riverbanks and land immediately adjacent to riverbanks.

RMZ: Risk Management Zone.

SCI: Southern Coalfield Inquiry

SCT: SCT Operations Pty Ltd.

SMP: Subsidence Management Plan, required under any mining lease granted for underground coal mining under the *Mining Act 1992*.

Subsidence: The deformation of the ground mass surrounding a mine due to the mining activity. The term is a broad one, and includes all mining-induced ground movements, including both vertical and horizontal displacement and curvature.

TOR: Terms of Reference.

TSC: Threatened Species Conservation.

TSP: Total suspended particulate matter

Upsidence: Relative upward movement, or uplift, created by the horizontal compression and buckling behaviour of the rock strata in the vicinity of a valley floor. It reflects shearing and buckling of near surface strata, generally at or close to the valley centreline, caused by valley closure.

Valley closure: A phenomenon whereby one or both sides of a valley move horizontally towards the valley centreline, due to changed stress conditions beneath the valley and its confining land masses.

W2CP: Wallarah 2 Coal Project.

WACJV: Wyong Areas Coal Joint Venture.

WGN: Wallarah and Great Northern combined seam section.

WSC: Wyong Shire Council

WSR: *Wyong Strategic Review*.

Note: Where future action is attributed to a government agency, such as DECCW, the reference should be construed to include any future successor government organisation (or organisations) which take(s) on the relevant regulatory function presently exercised by that agency.

Risk Assessment Terms:

Acceptable risk / acceptable level of risk: The outcome of a decision process of determining an acceptable option. The choice of an option (and its associated risks, costs and benefits) depends on the set of options, impacts, values and facts examined in the decision-making process.

Consequence: Outcome or impact of an event, which may be multiple, may be positive or negative, can be expressed qualitatively or quantitatively, and are considered in relation to the achievement of objectives.

Ecological risk assessment: A set of formal scientific methods for estimating the likelihoods and magnitudes of effects on plants, animals and ecosystems of ecological value resulting from human actions or natural incidents.

Environmental impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Environmental objective: the overall environmental gain, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where possible.

Likelihood: Used as a general description of probability or frequency.

Probability: A measure of the chance of occurrence expressed as a number between 0 and 1.

Risk: The chance that something happening that will have an impact on objectives.

Risk analysis: Systematic process to understand the nature of and to deduce the level of risk.

Risk assessment: The overall process of risk identification, analysis and evaluation.

Risk management process: The systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, monitoring and reviewing risk.

Tolerable risk: Risk which is accepted in a given context based on the current values of society.

Uncertainty: A lack of knowledge arising from changes that are difficult to predict or events whose likelihood and consequences cannot be accurately predicted.

1.0 INTRODUCTION AND TERMS OF REFERENCE

On 5 July 2010, the Minister for Planning issued directions to the Chairman of the Planning Assessment Commission (PAC) to:

- review the Environmental Assessment for the Wallarah 2 Coal Project, taking into consideration any issues raised in submissions, the findings of the strategic review into the *Impacts of Potential Underground Coal Mining in the Wyong LGA*, the Wyong Water Study and the international peer review of the Wyong Water Study;
- hold public hearings during this review;
- assess:
 - the potential subsidence-related impacts of the project, paying particular attention to its ability to adversely affect the Central Coast's drinking water supply; and
 - any other potentially significant impacts of the project;
- recommend appropriate measures to avoid, minimise or offset these impacts;
- provide advice on the merits of the project as a whole.

A copy of the signed ToR is at Appendix A to this Report.

The briefing note from the Department of Planning to the Minister for Planning recommended that the Panel should include the following casual members:

- Emeritus Professor Jim Galvin , a subsidence and mining expert
- Dr Lloyd Townley, a groundwater expert, and
- Dr Steve Perrens, a water expert.

Ms Gabrielle Kibble, chairman of the PAC, was appointed as Chair of the Panel. Current PAC member Mr John Court (air and noise expertise) was also appointed to the Commission. Dr Shepherd, a PAC member, also provided advice.

The types of expertise represented on the Commission included in planning, subsidence, underground mining, water management, groundwater, surface water, air quality, noise, transport and heritage.

The Panel is referred to as the Commission throughout this report to distinguish it clearly from various other references to Panels in related studies and reviews.

2.0 PROJECT DESCRIPTION

The Wallarah 2 Coal Project (W2CP), henceforth referred to as '*the proposal*', is located within the Wyong Local Government Area, some 70 km north of Sydney, NSW. It originates out of an invitation from the NSW Government in 1995 for companies to submit a competitive tender for the Wyong Coal Development Areas. The Wyong Areas Coal Joint Venture (WACJV), henceforth referred to as '*the proponent*', won the tender. The majority venture partner was Coal Operations Australia Ltd, with minority partners being Kores Australia Pty Ltd and other Korean and Japanese interests. Coal Operations Australia Ltd was subsequently acquired by BHP Billiton. In 2005, Kores Australia Pty Ltd acquired BHP Billiton's interests in the project, thereby lifting its equity to 82.25%.

Exploration, mine planning and environmental investigations undertaken since 1995 have identified significant coal resources beneath Tuggerah Lake in the east and beneath the Yarramalong and Dooralong Valleys, the Hue Hue area, Wyong and Olney State Forests, Jilliby State Conservation Area and the surrounding ranges in the west. The Study Area for the project being assessed is contained within the western resource, Figure 2.1. Figure 2.2 illustrates six of the 12 progressions in mine planning since 1995 to arrive at the proposed layout shown in Figure 2.3. This layout is stated to be *the preferred layout, although some minor adjustments to panel orientation and geometry may be made as a result of ongoing environmental and engineering studies*.⁴

Over half of the mineable resources lie beneath the Wyong State Forest and surrounding ranges, whilst the remainder lie beneath the Dooralong Valley, the Hue Hue Valley and, to a much lesser extent, the Yarramalong Valley. The targeted coal seam is a combined section of the Wallarah and Great Northern (WGN) Seams and is termed the WGN section. This section varies between 4.5 and 7.0 m in thickness, of which it is proposed to extract between 3.5 and 4.5 m utilising longwall mining. Depth of mining ranges from 345 to 690 m. It is planned to extract 46 longwall panels, with longwall panel width varying between 125 m and 255 m and interpanel pillar width varying between 45 and 75 m. Annual production is scheduled to peak at around 5 million tonnes.

The overlying strata of the WGN comprise interbedded siltstones, sandstones and mudstones of the Dooralong Shales in the immediate roof, progressing up to the more dominant sandstone-conglomerate sequence of the Munmorah Conglomerate, Figure 2.4. Above this sequence is a weak section of interbedded sandstone and claystones within the Tuggerah Formation. The Patonga Claystone in turn overlies the Tuggerah Formation. These units are characterised by abundant interbedded green and red claystone units of low bedding plane and material strength. The Patonga Claystone tends to outcrop mid hill slope and constitutes about 20% of the subsidence affected area, while the Terrigal Formation also comprises ridge caps and constitutes about 46% of the surface geology. Unconsolidated Quaternary alluvium

⁴ EA, p2-6.

(silts and sands) occurs as fill along the Yarramalong and Dooralong Valleys with recorded depths of up to 50m. It constitutes about 22% of the surface geology.

The geological floor section over the mining area is variable from thick conglomerate in the east, through a transitional zone of the Warnervale Conglomerate unit and then onto the Awaba Tuff unit in the western area.

Access for mine workers is proposed via a vertical shaft winding system at the Buttonderry Site, which immediately overlies the north east corner of the mine workings, Figure 2.1. A 3 km long drift (inclined tunnel) is planned to be driven from the Tooheys Road site at a gradient of 1 in 10 to provide access for plant and equipment and to convey coal from the mine to a 50 000 tonne capacity run of mine (ROM) stockpile. From the ROM stockpile, the coal is to be crushed and screened before being placed on a 250 000 tonne capacity stockpile to await loading and transport to the Port of Newcastle by rail.

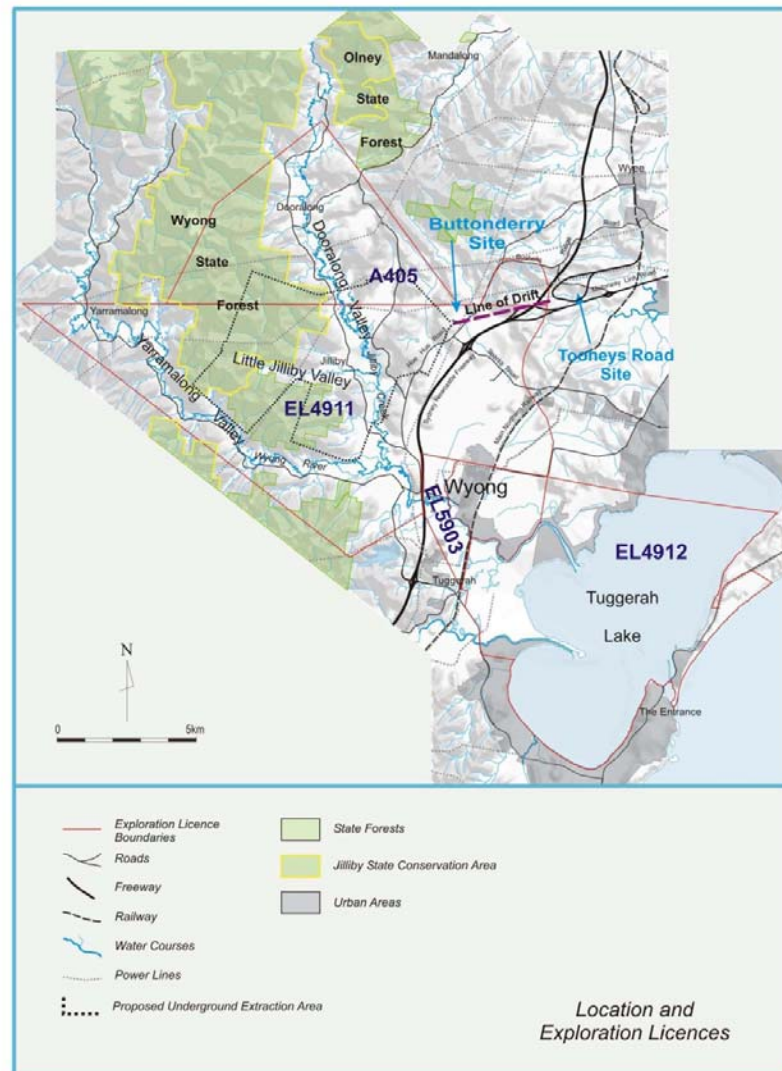
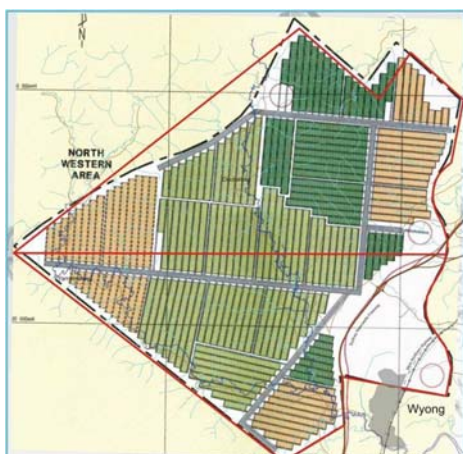
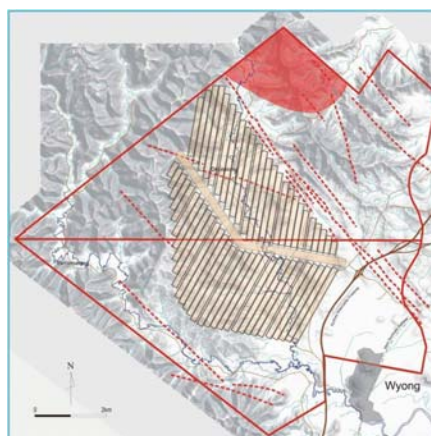


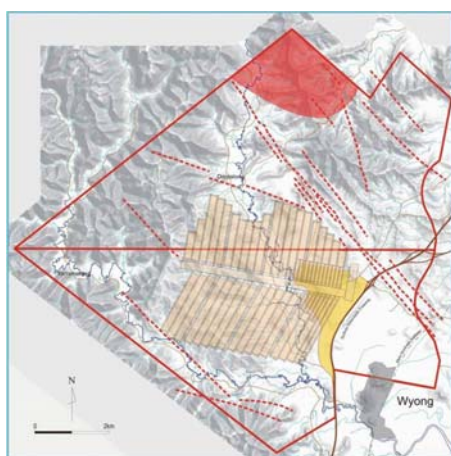
Figure 2.1 Project Location and Exploration Licences



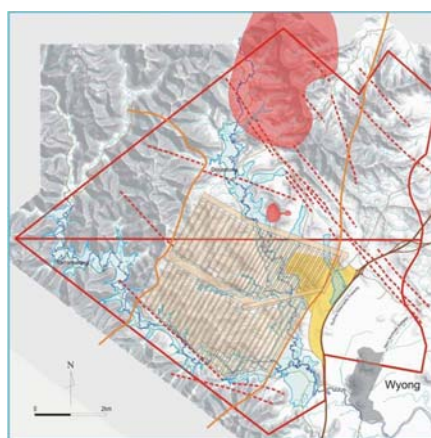
1995



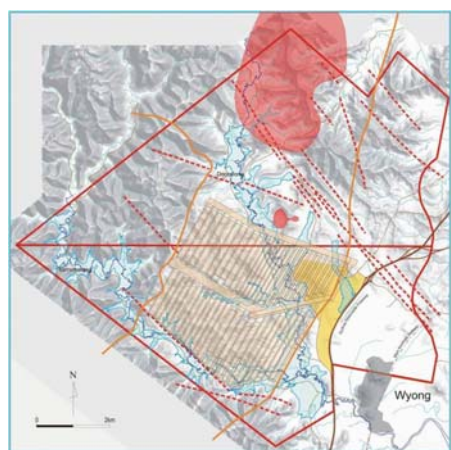
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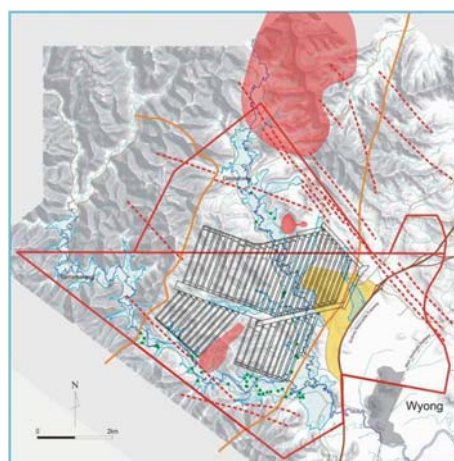
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Figure 2.2 Progression in Mine Planning since 1995

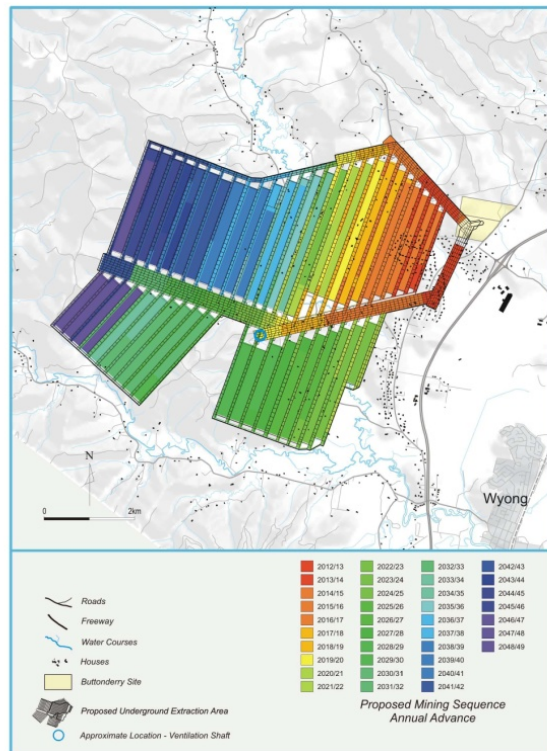


Figure 2.3 Proposed Mine Layout and Annual Extraction Sequence

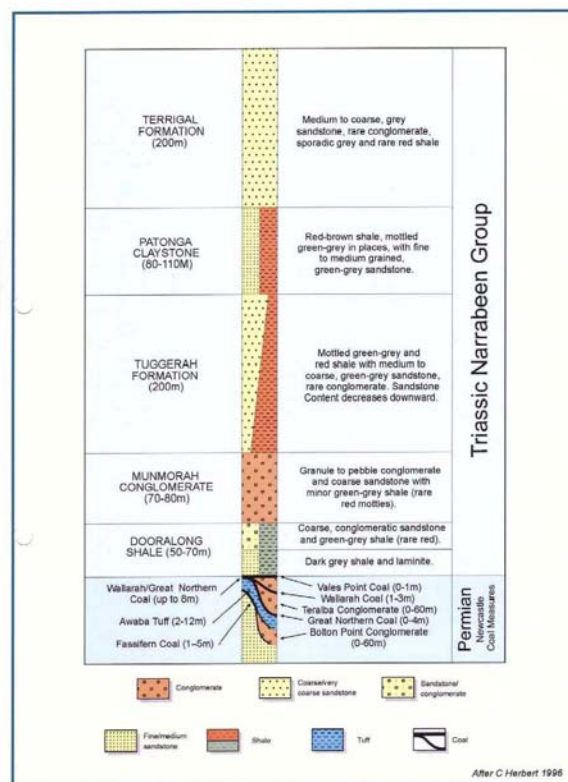


Figure 2.4 Generalised Stratigraphic Column

3.0 COMMISSION ACTIVITIES

3.1. PUBLIC HEARING AND SUBMISSIONS

In accordance with the Minister's direction, public hearings were held on 28 October 2010 at Wyong Council Chambers. A total of 26 verbal submissions were made to the Commission at the hearings, comprising 1 from the State Member for Wyong, 1 from Wyong Council, 1 from the Gosford Wyong Joint Water Authority, 1 from the Mayor of Wyong Council, 2 from Wyong Councillors, 5 from special interest groups and 15 from individuals. All persons seeking to be heard were heard. Four written submissions were also made to the Commission. A summary of these submissions is at Appendix B to this Report.

247 submissions were provided by the Department of Planning to the Commission for their information. A summary of the issues raised in these submissions is at Appendix C to this main Report.

3.2. DOCUMENTATION, MEETINGS & SITE INSPECTIONS

Through the course of the review, the Commission accessed a wide range of documents including:

- the Wyong Water Study (SKM, 2010);
- the Impacts of Potential Underground Coal Mining in the Wyong LGA – Strategic review (DoP, 2008);
- the Centennial Mandalong Mine Annual Environmental Management Report (Centennial Mandalong, 2010);
- the Proponent's Environmental Assessment (February 2010);
- the Proponent's Interim Response to Submissions (3 September 2010);
- the Proponent's Response to Submissions (17 September 2010);
- the Proponent's Response to Submissions (28 September and various 2010);
- the Proponent's Rail Study for the Wallarah 2 Coal Project (September 2010);
- Additional information provided by the Proponent and its consultants;
- submissions from government agencies and the public;
- a submission from Dr P. Lewis NSW Health; and
- additional information from government agencies.

During the review, the Commission met with the Department of Planning (6 August 2010), the Department of Environment, Climate Change and Water (9 September 2010) and the Proponent (20 September 2010 at their offices).

The Commission undertook 2 site visits of the mining location and environs, on 8 and 20 September, the latter including an information session with the proponent and its consultants.

3.3. REFERENCE STUDIES

Wyong Strategic Review (WSR)

In February 2007, the NSW Government appointed an Independent Expert Panel to conduct a strategic inquiry into potential coal mining impacts in the Wyong Local Government Area (Wyong LGA). The WSR reported on potential impacts of underground mining on the Wyong water supply catchment and infrastructure, on surface and groundwater resources, on subsidence and on amenity. The social and economic significance of mining at a local, regional and State level was also considered. The Commission had close regard to the studies, findings and recommendations of this Review. It is possible to draw the conclusion from the proponent's EA that the Review assessed the present application, but it did not.

Wyong Water Study and Peer Review

The *Wyong Water Study* was commissioned by the Department of Planning in April 2010. The study was commissioned to address the concerns expressed in the *Wyong Strategic Review* regarding the lack of information relating to groundwater in the Wyong LGA. The brief for the study required the consultants to assess the availability of surface and groundwater data within the Wyong LGA and its adequacy for assessment of any impacts on surface and groundwater resources as a result of mining.

The study was undertaken by SKM (NSW) and peer reviewed by Aqualinc (NZ). The Commission has carefully considered this study and the peer review and provided its own critique of the material and its relevance for this assessment in Appendix E.

Overall the Commission was disappointed that the brief for the study did not call for a more comprehensive assessment of the groundwater situation, including independent modelling.

3.4. ENVIRONMENTAL ASSESSMENT AND COMMISSION RESPONSE

The proponent lodged an Environmental Assessment (EA) with its Part 3A Application under the *Environment Planning and Assessment Act 1979 (EP&AA Act)*. The EA covers all aspects of the impact of the proposal and the Commission considers it contains sufficient information, supplemented by responses to submissions and subsequent requests, to make an assessment and recommendation for approval subject to appropriate conditions.

The Commission considers there were many aspects of the impacts which will require more robust and detailed investigation during the life of the project. This is particularly so given the magnitude of the proposal in its regional context, its long life (28 years for the approval and over 40 years for the anticipated life of the mine) and the need for adaptive management as mining proceeds. The Commission notes that drafting of consent conditions is extremely important in dealing with the longer term aspects of this proposal.

Some conditions drafted by the Commission may limit the extent of mining in the future, if certain criteria cannot be met over time. This arises because there are inherent uncertainties

related to many of these aspects, for example in the management of subsidence, groundwater, flooding, ecology and dust. Consequently, meeting the requirements of the conditions drafted may present some impediments to future production or impose additional costs. The Commission has come to the view that complete cessation of mining before the project is complete as a result of complying with the conditions is very unlikely. Nevertheless, should that be the case, it becomes a commercial risk which the proponent should appropriately bear. That is why the Commission has recommended strong conditions be imposed on the mine. These conditions will require the progressive production of more detailed work to the satisfaction of the Director-General (DG) of Planning to enable further mining to proceed.

3.5. INTERACTING ELEMENTS IN ASSESSMENT

In assessing the project the Commission has needed to engage with the complexity of the issues involved and the interaction between them. It has focused on the key issues, being aware that the Department in its assessment will address the many secondary issues raised by a project of this magnitude.

The key impacts arise from essentially two segments of the proposed operation, underground mining and activities undertaken on the surface. The latter are mainly related to handling the coal product and providing access to underground workings and ventilation for mining employees. The foot print of the underground operations is approximately 37 square kilometers, lying to the west of the Sydney-Newcastle freeway under the Dooralong valley and foothills of the forest and nature reserve, while that of surface activities is a much lesser area lying to both the east and west of the freeway adjacent to the 'link' road.

A 'map' of issues is useful in conceptualizing these interactions.

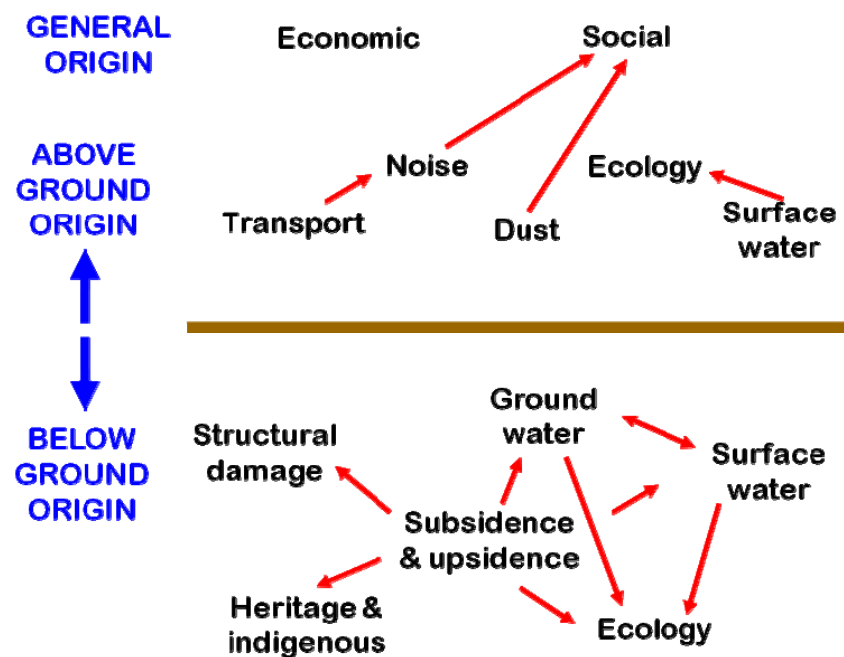


Figure 3.1 Diagram or 'map' of interrelated issues in assessment

Social and economic impacts arise from a consideration of the project as a whole and therefore interact with all aspects of the proposal.

Key impacts originating from above-ground activities of the mine relate to transport of the product and people involved, dust and noise from coal handling and transport, changes to surface waters and those aspects of ecology related directly to the above-ground operations, for example clearing of vegetation and runoff to wetlands. The interactions are relatively clear and relate in a straightforward manner.

The key surface impact induced by underground mining is subsidence of the geological strata lying above the coal seam. It involves the complex science of rock mechanics and mining engineering. Exact prediction of changes to the structure of the overlying strata and to the ground surface relies on a combination of art, science and computer modelling. Expert judgment is important. In practice the predictive techniques employed are refined as mining proceeds and experience accumulates. Adaptive management becomes possible with the improved predictive capacity resulting from monitoring during mining.

Changes in groundwater movements and quality are dependent on the properties of the many overlying strata and these properties are significantly modified by the sub-surface and surface cracking caused by subsidence. Predicting groundwater changes in an already complex environment also relies on a combination of art, science and computer modelling. Expert judgment is important.

Changes in surface water flow and quality result from changes to the contours and slopes of the ground surface induced by subsidence. Changes to groundwater movements and quality also impact in turn on the behaviour of surface water. The changes in surface water in terms of predicting flooding characteristics, flows, occurrence of wetlands and water quality are equally as difficult to predict as changes in groundwater and subsidence. Again the combination of art, science and computer modelling calls for expert judgment.

Ecology above the areas mined is also dependent on modifications to the ground contours and on changes to surface waters and groundwater. Cracking of valley floors due to the phenomenon of upsidence above mined areas with consequent 'drying out' of previously 'wet' surface environments can have serious consequences for ecology. Predicting ecological changes is probably the least exact science of those involved in the project.

Movements of the land surface clearly have structural consequences for buildings and infrastructure above mining, and techniques for managing these have been developed over many years of protection against and accommodation to mine-subsidence. Surface movements also have consequences for heritage structures and indigenous sites.

Adaptive management becomes critically important because of the above issues. To address the interacting complexities in assessment, an adaptive management approach is essential as mining progresses. Mining techniques and plans can be varied (with a lead time of two to

three years) to reduce or eliminate impacts based on experience gained after mining commences. Measured outcomes allow for refinement of the predictive techniques.

This adaptive management approach, integrating all key aspects of the mining activities over the full period of a mining project, requires a sound management framework for success. The Commission notes that the Department has developed the application of Extraction Plans to apply under consent conditions throughout the life of mining projects. These will subsume and expand on what has hitherto been managed through Mine Subsidence Plans.

4.0 SUBSIDENCE

4.1. INTRODUCTION

The term *subsidence* has two meanings in subsidence engineering. In the most general case as adopted by the Commission, it encapsulates all ground movements that result from mining. Its second meaning, which features in some submissions to the Commission, relates specifically to the vertical component of mining induced surface ground movement. A full consideration of subsidence as it relates to the proposal is at Appendix F.

The Southern Coalfield Inquiry defined the meaning of the terms *effects*, *impacts*, and environmental *consequences* as they pertain to subsidence of natural features (DoP, 2008b). The PAC report for the Metropolitan Coal Project extended these definitions to incorporate subsidence of man-made features (DoP, 2009) and the Commission has adopted these for the Wallarah 2 proposal in its discussion of subsidence, being:

- The term *effect* describes subsidence itself;
- Any physical change to the fabric of the ground, its surface, or man-made features is described as an *impact*;
- The environmental *consequence* is used to describe any change in the amenity or function of a feature that arises from an impact.

Figure 4.1 shows a conceptual model of rock mass behaviour above a mining excavation. As excavation panel width, W , increases, four zones progressively develop, namely a *caved zone*, a *fractured zone*, a *constrained zone*, and a *surface zone*⁵. In a multiple excavation situation, such as for the Wallarah 2 proposal, excavated panels are separated by pillars of insitu coal referred to as *interpanel pillar* or *chain pillars*.

So-called *conventional* surface subsidence results from a combination of sag of the roof strata into each excavation and compression of the interpanel pillars and surrounding strata, resulting in the surface subsiding in the form of a trough. The amount of subsidence due to roof strata sag increases with increase in mining height, h , and excavation width, W , (up to a limiting value) and decreases as depth of mining, H , increases. The amount of subsidence due to compression of the strata between excavations is determined by the width of the interpanel pillars, w , the height of the interpanel pillars and the nature of the roof and floor strata in the near vicinity of the coal pillar. These are all adaptive management variables in the mine layout for Wallarah 2 and as the EA correctly describes, this is a complex interaction⁶.

The main conventional subsidence parameters of interest are as described in the EA, being:

- *Angle of draw*, which defines the limits of the subsidence trough;

⁵ Sometimes the caved and the fractured zone are combined as one zone.

⁶ EA, Appendix A1, p2.

- *Curvature*, which defines the degree of outwards (convex/hogging) or inwards (concave/sagging) bending of the surface of the subsidence trough (Fig 4.2);
- *Vertical displacement* of surface points;
- *Horizontal displacement* (in two dimensions) of surface points;
- *Tilt, or slope*, induced by differential vertical displacement between adjacent points;
- *Strain (tensile or compressive)*, induced by differential horizontal displacement due to stretching (hogging) or compression (sagging) of the surface.

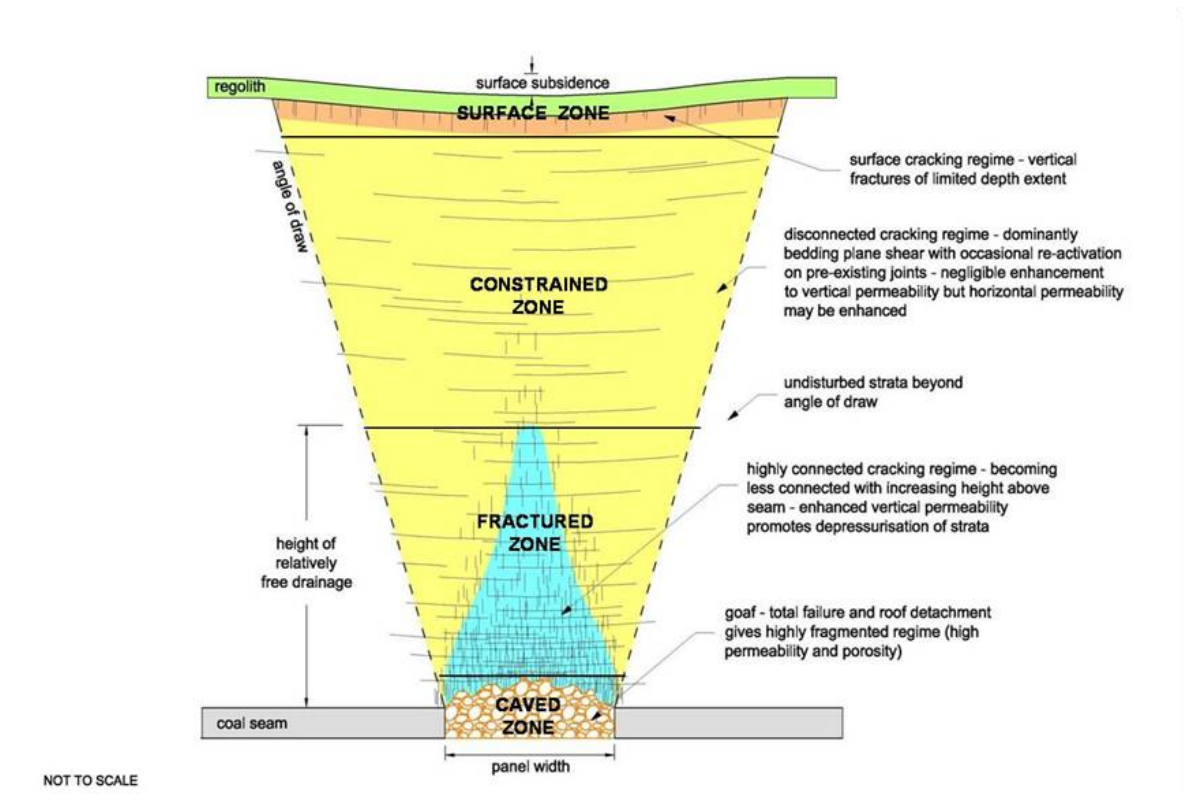


Figure 4.1 Conceptual Model of Caving and the Nature of Fracturing above a Mine Excavation⁷

⁷ Mining progressing 'into' the page.

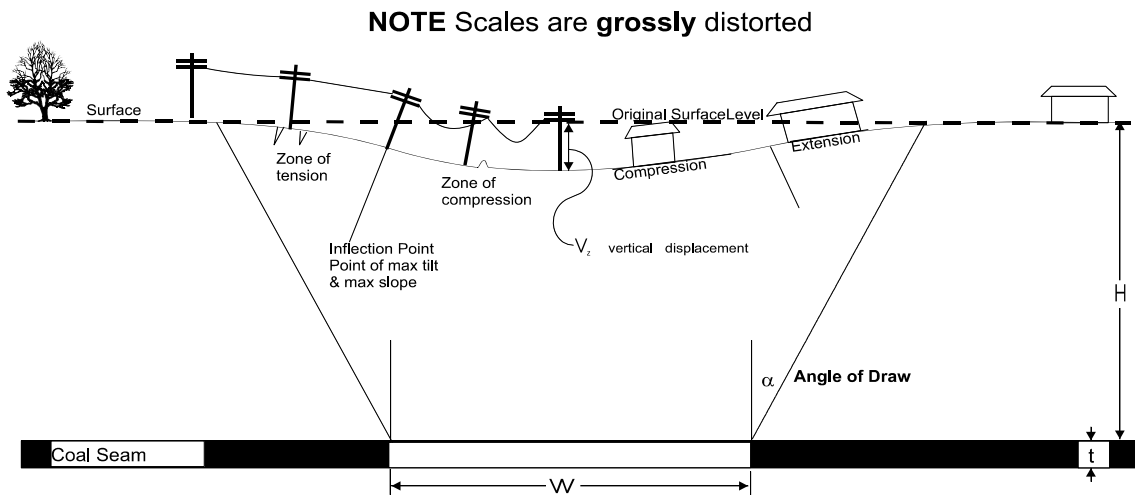


Figure 4.2 Diagrammatic Representation of Surface Subsidence Components in Flat Topography

Non-conventional surface subsidence refers to situations where subsidence behaviour is dominated by site specific conditions, these usually being steep topography, valleys and gorges, and geological structures. In steep topography, gravity can result in high levels of ground movement in a downhill direction, causing tensile strain to accumulate towards the top of hill sides, where it can result in one or more wide open surface cracks. Undermining of deep incised valleys and gorges, such as in the Southern Coalfield of NSW, can result in:

- *Valley closure* whereby the two sides of a valley move horizontally towards the valley centreline, and
- *Uplift* of the valley floor due to valley closure, which can cause buckling and shearing of the valley floor and near surface strata and create new or additional sub-surface flow conduits. The difference between the amount of vertical displacement that could have been anticipated in the absence of a valley and that which eventuates is referred to as *upsidence*. (Figure 4.3)

At relatively shallow depth, displacement may occur at a point above an excavation within a few months of it being undermined. However, as depth of mining increases, roof sag above an extracted panel and compression of the pillar system can increase each time a subsequent mining panel is extracted. This gives rise to additional vertical displacement, referred to as *incremental vertical displacement* which in turn, generates *incremental tilt* and *incremental strain*. This is the type of behaviour that has been predicted over the Wallarah 2 Study Area.⁸

⁸ Illustrated in Figure 6.8 to Figure 6.11 of the EA for the Wallarah 2 proposal.

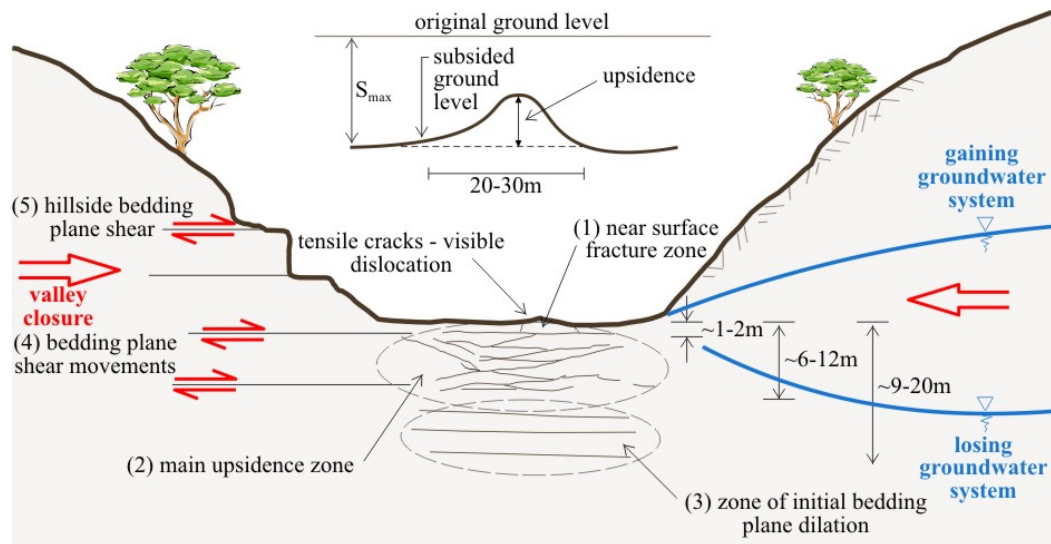


Figure 4.3 Upsidence Fracture Network Determined from Surface and Subsurface Monitoring at Waratah Rivulet, Metropolitan Colliery⁹

4.2. SUBSIDENCE PREDICTION TECHNIQUES

Subsidence is site specific, being a function of the local geology, topography, depth of mining and mine layout. A more detailed consideration of subsidence phenomena and prediction are in Appendix F.

Conventional subsidence

There are two basic approaches to predicting surface behaviour for conventional subsidence, namely:

- Empirical, whereby predictions are based on a large database of subsidence outcomes collected from sites with similar geological, topographical and geometric conditions.
- Analytical, whereby the behaviour of the rock mass is predicted using mathematical modelling. Because of limited knowledge of rock behaviour and limits on numerical computational capability, there are limits on predictions by modelling.

One empirical subsidence prediction technique which finds extensive application in NSW is the Incremental Profile Method (IPM). This utilises large data bases of subsidence information to define a suite of characteristic shapes for each increment of vertical displacement resulting from the successive extraction of mining panels¹⁰. It has significant advantages over many other empirically based techniques because it provides an effective and rapid method of evaluating how changes in mining depth, mining height, excavation

⁹ Sourced from Mills (2008).

¹⁰ A detailed description of the IPM method is available at <http://www.minesubsidence.com>

width and depth, and interpanel pillar width (which are all variables in the case of the Wallarah 2 proposal) affect surface subsidence outcomes.

However, differences in depth, mining height and geology distinguish the Wallarah 2 Study Area from other NSW mining districts, so the proponent has adopted a hybrid approach to subsidence prediction. A mathematical model was developed by Strata Control Technologies (SCT) based on numerical techniques, validated against known geological conditions and subsidence outcomes at other mining sites, and applied to a number of cross sections through the Study Area. The outcomes were then utilised to calibrate the Incremental Profile Method to Wallarah 2 conditions so that it could be utilised across the whole site.

In assessing the reasonableness and accuracy of this approach, particular consideration needs to be given to the mechanical behaviour of Awaba Tuff strata encountered in the Wallarah 2 study area. This strata can display poor strength properties and has been implicated in a number of unplanned subsidence events during the 1980s and early 1990s over partial pillar extraction panels¹¹ beneath parts of Lake Macquarie, Lake Munmorah and Budgewoi Lake in the Wyong LGA.

The numerical model developed for the Wallarah 2 proposal is based on a well established and internationally accepted 2 dimensional version of the computing code (FLAC¹²) developed specifically for solving mining and geotechnical engineering problems. It incorporates rock failure and permeability subroutines developed by Strata Control Technologies which are intended to enhance the model's capability to simulate subsurface deformation mechanics and changes in hydrogeological permeability in addition to producing profiles of vertical displacement. These subroutines have not been disclosed and the Commission is unaware of whether they have been peer reviewed. However, evidence from applications in NSW indicates that good subsurface correlations are an indicator, albeit not definitive, that the model does provide a reasonable representation of rock mass fracturing and caving. The EA claims that the methods used and assumptions made result in conservative predictions of subsidence and should be adequate for assessment provided that adaptive management is practised after mining commences.

While acknowledging the limitations of the modelling the EA presents results for the 'Hue Hue' area to represent *the shallower, urbanised area where tilts and ground strains are of primary consideration*, and for the 'Valley' area to represent *the deeper rural flood plain area where vertical subsidence and ground water impacts are the key issues*.¹³

The Hue Hue and Valley modelling for a range of possible mining heights indicates that caving related fracturing and changes in permeability extended to approximately 175 m above the seam in the Hue Hue cross-section, and to 200 m above the seam for the Valley

¹¹ Also referred to as *secondary workings, secondary extraction or panel and pillar mining*, involves extracting selective rows of pillars such that surface subsidence is restricted.

¹² Fast Lagrangian Analysis of Continua.

¹³ EA, Appendix A1, p11.

cross-section. Above these heights, disturbance to the strata was limited to bedding plane shear and localised, non-continuous fracturing. Hence, based on the modelling results, the minimum thickness of the constrained zone in the Wallarah 2 Study Area is reported to be of the order of 120 to +170 m thick beneath alluvium in the Dooralong Valley, increasing rapidly to 300 m or more in elevated areas.

Predicting strain with any modelling technique adopted is difficult. This is discussed in detail in Appendix F. Based on the EA material and its further interrogation of the proponent, the Commission accepts that the predictions are adequate for assessment but will need to be validated early in the mining process for use in adaptive management.

The mine design is premised on causing the interpanel pillar system (comprising the coal pillar and the immediate roof and floor strata, including the Awaba Tuff) to yield¹⁴ at the time of mining. This is intended to avoid past situations where pillars associated with Awaba Tuff have sometimes yielded unexpectedly some time after the completion of mining, resulting in additional subsidence which could not be controlled. Should the Wallarah 2 mine design not result in the pillars yielding as planned, vertical displacement over the pillars is likely to be less, resulting in a more irregular (or ‘wavy’) final surface profile. This, in turn, could result in larger final tilts and strains, albeit that vertical displacement is less.

Unconventional subsidence

The phenomena of valley closure, upsidence, and far field horizontal movements have only come to be recognised in the last 15 to 20 years as a result of ground behaviour observations in the Southern Coalfield of NSW. They are known to occur in escarpment and mountainous areas in the Western Coalfield but have been of less concern in the Newcastle Coalfield to date. This is often attributed to the different topography in this coalfield, in particular, the absence of deeply incised valleys and gorges in a plateau setting, and different geology and stress fields.

Standard survey techniques can be used to measure valley closure reasonably accurately. However, valley floor upsidence measurements are prone to considerable error because survey stations are susceptible to extreme localised movements caused by buckling of near surface strata.

Predictions of upsidence and closure in the EA rely on a methodology developed from research some eight years ago¹⁵ in the Southern Coalfield, where in-situ stresses are notably high and the topography includes steep, deep gorges.¹⁶ The EA notes that confidence in these predictions is not as high as for conventional subsidence and that an (undefined) “sensible factor of safety” should be applied.

¹⁴ Exceed their maximum load carrying capacity and deform, to result in increased pillar compression and therefore, increased subsidence.

¹⁵ Waddington and Kay (2002).

¹⁶ EA, Appendix A2, p46.

In its discussion of predictions of unconventional subsidence the EA points to the differences between the geomorphology of the Southern Coalfield and that associated with the Wallarah 2 Study Area, including:

- The ridges in the forested areas of the Study Area are jointed and stress relieved.¹⁷
- The upland streams in the Study Area are contained within V-shaped gullies separated by unconfined ridges, in contrast to the Southern Coalfield streams which are contained in more U-shaped gorges cut into a plateau.¹⁸
- The valleys in the Study Area are not only much broader than the gorges of the Southern Coalfield but are filled with some 20-30 m of alluvium.¹⁹
- Rock bars and associated pools typical of the Southern Coalfield do not exist in the upland streams in the proposed Wallarah 2 mine area.²⁰
- Streams in the alluvial filled wide valley floors above the proposed longwalls have water levels that are generally above the surrounding groundwater levels and the water levels in these streams are not controlled by a series of exposed rock bars.²¹

4.3. SUBSIDENCE EFFECTS

The Commission accepts the EA predictions of conventional subsidence for the proposal as adequate for assessment. The extent of the Wallarah 2 Study Area in relation to mine subsidence has been defined by combining the areas bounded by the following limits:

- 26.5° angle of draw
- 20 mm vertical displacement contour
- Features sensitive to far-field movement.

The Commission considered this acceptable for assessment given the apparent limited variety and density of natural features in the Study Area and the limited impacts from valley closure and upsidence recorded to date in the Newcastle Coalfield, although in the Commission's view it is not consistent with leading practice as found in the PAC's recent assessments in the Southern Coalfields.

The EA presents predictions of conventional subsidence effects for the Wyong State Forest and the Jilliby State Conservation Area although there is no reference to numerical modelling being utilised to calibrate the Incremental Profile Method for these areas (calibration being confined to the Hue Hue area and the Valley areas). Given that within the hilly landform areas there is an additional 100 to 200 m depth of cover, the Awaba Tuff is closer to floor of the mining section, mining height is proposed to be increased to 4.5 m, and longwall panel width is proposed to be increased to 255 m, such calibration is warranted.

¹⁷ EA, p4-57 and WACJV (2010c), p6.

¹⁸ WACJV (2010c), p6.

¹⁹ EA, p4-57.

²⁰ WACJV (2010c), p6.

²¹ EA, Appendix A2, p65.

In many respects, the situation appears to remain unchanged from that reported by the Wyong Strategic Review in respect of both the Jilliby State Conservation Area and the Wyong State Forest. The hilly landform areas, in general, receive limited consideration in the EA. For example:

- The water courses have not been characterised.
- No predictions of valley closure and upsidence effects have been provided.
- Only approximately ½ a day was spent in the forests reconnoitering for significant / special habitat types in the subsidence area²².
- There is little consideration to potential upsidence and closure impacts on valley floors within the hilly areas.
- The first indigenous surveys were only undertaken from 25 to 20 January 2010, just weeks prior to submitting the EA.

These shortcomings have been addressed to varying degrees in subsequent responses to the Commission's questions of the proponent. These issues were also raised in the Wyong Strategic Review.

The Commission concludes that, given the outcomes of characterization of the areas to date, its site inspections, and the extended timeframe until mining is projected to commence beneath these areas (some 12 to 15 years), the information sourced to date is adequate for the purposes of its assessment of the project as a whole at this point, but will need supplementation after experience in mining is accumulated and well before mining reaches this area. A comprehensive assessment of surface features and potential subsidence effects and impacts within these areas must be undertaken to the satisfaction of the Director-General of the Department of Planning before secondary extraction²³ can commence beneath the Jilliby State Conservation Area and the Wyong State Forest. The Commission has drafted recommendations to address issues raised here.

4.4. CONNECTIVE CRACKING

A serious concern expressed in many submissions was the risk of loss of surface water and unconfined ground water in relation to regional water supplies. The EA concludes from the numerical modelling undertaken by Strata Control Technologies (Appendix A1 of the EA) that caving related fractures and changes to vertical permeability will occur up to approximately 175 to 200 m above the mining horizon in the Dooralong Valley, resulting in a constrained zone of 120 to +170 m in thickness which, in the absence of geological features, will prevent connective cracking.

The Commission is satisfied based on the subsidence and water studies undertaken by the proponent that direct connectivity of surface waters to the coal seam measures being mined

²² WACJV (2010b), p5 -54.

²³ Secondary extraction encapsulates all mining operations other than the driveage of main development (access) roadways. Hence, it includes longwall mining.

due to connective cracking of the overlying strata will not occur. However, this conclusion is qualified by the Commission, as it was in the Wyong Strategic Review, in the EA, and in submissions from the NSW Office of Water and the Wyong Shire Council, to the extent that there are no major unidentified geological features which would promote such connectivity.

To assist its assessment, the Commission undertook a review of dimensions associated with NSW mines that have extracted longwall panels successfully beneath water bodies in the Sydney Basin and beneath alluvial valleys in the vicinity of the Wallarah 2 Study Area, Appendix F. The two most critical controlling factors are mining height and panel width to depth ratio, W/H. Whilst direct comparisons cannot be made because of the different geological and geotechnical settings of the various case studies, the comparison indicates that the mining dimensions associated with the Wallarah 2 proposal are at the conservative end of past mining experiences.

One of the mines involved in this review was Mandalong Colliery, which operates longwall panels of similar mining height and panel width beneath the Mandalong Valley (immediately to the north of the W2CP exploration leases) to that proposed beneath the Dooralong Valley. Another was South Bulli Colliery in the Southern Coalfield, where research concluded that higher than 185 m above the seam (equivalent to 1.7 times panel width), there was no evidence of any change in the hydraulic conductivity of water from the Cataract Reservoir to the mine workings (Byrnes, 1999).

The Commission concludes that the mining dimensions proposed by Wallarah 2 for mining beneath the Dooralong Valley are not inconsistent with those which have been utilised successfully to avoid direct hydraulic connections to the surface at other mining operations.

4.5. GEOLOGICAL FEATURES

Although the proponent has undertaken an extensive exploration program using a range of modern geophysical technologies to determine the geology of its exploration leases and has laid out the mine workings to avoid the geological features identified from this process, it nevertheless, acknowledges that not all geological disturbances may have been identified. There are limitations associated with geophysical techniques as to the size of geological discontinuities that they can detect.

Several submissions have raised the possibility of a major fault zone in the vicinity of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek. After examining EA material and responses to its requests (Appendix F), the Commission accepts that the proponent has advanced a reasonably compelling case for the absence of faulting orientated along these creeks. The Commission also considers that if such faults do exist, they are unlikely to constitute major features.

In any case there are opportunities to detect geological features well in advance of longwall mining. These including in-fill exploration drilling, in-seam long-hole drilling for up to more than one kilometre ahead of mining, and exposure of features during the development of

main roadways and long-wall gate-roads. The Commission has drafted recommendations to address this uncertainty.

4.6. ADAPTIVE MANAGEMENT

The proponent has committed to adaptive management. The Wallarah 2 mine layout permits longwall panel length, longwall panel width, mining height and interpanel pillar width to be varied throughout the life of the operation although a change in longwall panel width and/or interpanel pillar width usually requires a lead time of two to three years. Mining height is the easiest and quickest parameter to change and can be quite effective given that numerical modeling undertaken for the proposal has indicated that vertical displacement at the surface changes in direct proportion to mining height.

A specific issue arises with respect to validating the subsidence predictions from the start of the project if it goes ahead. Because subsidence develops incrementally, the various conventional subsidence parameters may not approach their limiting (final) value at a point until after the next one or two longwall panels have been extracted. The Commission notes that the first three longwall panels proposed to be extracted extend beneath the Hue Hue Mine Subsidence District. Hence, the need for any adaptive management measures may not become apparent in time to fully benefit properties undermined by the first one or two longwall panels in this area. This is a matter for consideration when developing and approving any Extraction Plans.

The Commission concludes that the subsidence prediction methodology and outcomes are reasonable and adequate for the purposes of its assessment.

4.7. CONCLUSIONS

The Commission concludes that:

- The hybrid prediction methodology for conventional subsidence is leading practice but this is not to say that the predictions are accurate or more accurate than those produced by alternative techniques.
- There is a high degree of conservatism built into the prediction of conventional subsidence effects.
- An unexpected problem may arise from this conservatism if the interpanel pillars do not yield as designed, thereby resulting in vertical displacement over the interpanel pillars being less than predicted but final tilts and strains possibly being considerably higher, consistent with a final landform more ‘wavy’ than predicted.
- There is considerable uncertainty associated with the methodology used to predict non-conventional subsidence effects. However, currently there is no better alternative technique available and predictions of effects are likely to have been overestimated.

- The assessment of subsidence effects, impacts and consequences in the hilly landform areas of the W2CP Study Area is minimal and will need to be defined before mining commences thereunder well into the proposed life of the proposal.
- In general, the mine plan is well suited to adaptive management and continuous improvement. However, the opportunity to practice adaptive management in the Hue Hue Subsidence District may be limited and needs to be planned for prior to commencement of any mining operations.
- For the proposed mine layout, the predicted worst case upsidence and closure values could be expected to result in negligible impacts for the Wyong River and Jilliby Jilliby Creek and for Little Jilliby Jilliby Creek up to the start of LW 23N. Site specific impacts cannot be ruled out but these are likely to be sparsely distributed and of a very localised nature.
- In the absence of major, unforeseen geological anomalies (eg faults and dykes), subsidence-induced hydraulic connectivity between Wyong River, Jilliby Jilliby Creek or their alluvial systems and any underlying mine workings is extremely unlikely.
- Geological anomalies are likely to be present in the proposed mining area and to go undetected until they are exposed by mining. The potential for them to impact on surface and subsurface drainage is likely to be low given the considerable depth of mining, the considerable thickness of the alluvium and the drainage characteristics of the alluvium and shallow aquifer systems.
- If the project is approved, there is a need to validate the longwall caving model, the hybrid subsidence prediction methodology and upsidence and closure predictions very early into the mining process.

4.8. RECOMMENDATIONS

The Commission recommends that:

1. If the proposal is approved, the dimensions of longwall panels and interpanel pillars, including mining height, not be permitted to be relaxed beyond those proposed for Longwalls 1N to 5N until a reliable subsidence prediction methodology has been demonstrated to the satisfaction of the Director-General of the Department of Planning.
2. Any changes to the proposed mine layout, other than of a minor nature as foreshadowed in the EA (and excluding a reduction in the extent of the mining footprint), should be permitted only after undergoing comprehensive assessment to the satisfaction of the Director-General of the Department of Planning.
3. No secondary extraction²⁴ be permitted beneath the Jilliby State Conservation Area and the Wyong State Forest (including Myrtle Creek, Armstrong Creek and beneath any watercourse within the Terrigal Formation²⁵), until a comprehensive assessment of

²⁴ Secondary extraction encapsulates all mining operations other than the drivage of main development (access) roadways. Hence, it includes longwall mining.

²⁵ As defined in Figure 1 of WACJV (2020c).

surface features and potential subsidence effects and impacts within these areas has been undertaken to the satisfaction of the Director-General of the Department of Planning.

4. Any Extraction Plan should include provision for developing and implementing a program for detecting and recording all geological structures and assessing the potential impacts of these structures on subsurface and surface features. Such a program is to be implemented in a manner which provides adequate time to modify mining plans if a structure is likely to result in unacceptable environmental impacts.
5. The program for detecting and recording geological structures should be premised on the philosophy of a 'trigger, action, response plan' (TARP) which includes thresholds for stopping mining operations, reporting the occurrence of geological features to relevant government agencies, for initiating formal risk assessments and reviews that include external, independent expert representation, and for the resumption of mining if and when appropriate.
6. Any conditions of approval require that measured versus predicted surface subsidence effects be reported on a quarterly basis to the Department of Planning, the Department of Industry and Innovation (Minerals Section), the Department of Environment, Climate Change and Water, and the Wallarah 2 Community Consultative Committee for a period of 5 years or until such time as the subsidence prediction methodology has developed to being a reasonably reliable tool, whichever period of time is longer.
7. Any conditions of approval require that an end of longwall panel report be prepared for public display within 6 months of the completion of extraction of each longwall panel, with this report encompassing all monitoring of subsidence (and environmental) effects (and impacts) and being provided to the Department of Planning, the Department of Industries and Innovation (minerals section), the Department of Environment, Climate Change and Water, and the Wallarah 2 Community Consultative Committee.
8. All subsidence monitoring processes and outcomes (including those relating to surface water, groundwater, ecology and indigenous heritage) are externally audited on an annual basis for the first five years of mining and, subject to these audit outcomes being favourable, every three years thereafter for verification of ongoing adequacy and accuracy of subsidence effects predictions.

5.0 GROUNDWATER

If the proposed project proceeds:

- mining will cause subsidence,
- mining and subsidence will cause changes in groundwater flow patterns and rates, and
- changes in groundwater flow patterns and rates may or may not affect streamflow and stream ecosystems.

The impact of subsidence on the structure and hydraulic properties of the ground and hence on groundwater flow is of great interest to stakeholders. Changes will occur. The key questions relate to the magnitude and significance of these changes, which can only be predicted by computer simulation modelling.

The Proponent's groundwater study was not assessed by independent experts in the Wyong Water Study and peer review. An attempt is made here to review and assess the proponent's groundwater flow modelling using a methodology similar to one that might have been followed in an independent peer review.

Groundwater is considered in more detail in Appendix G.

5.1. FUNDAMENTALS OF GROUNDWATER

Groundwater in the hydrological cycle

When rain falls to the land surface, some water evaporates almost immediately, some flows across the land surface towards streams and rivers as “surface runoff”, and some infiltrates into the soil and evaporates or transpires (is taken up by plants) soon afterwards. The rainfall that infiltrates into the ground and seeps downwards, through the unsaturated zone, in a process known as “percolation”, becomes known as “groundwater”.

Groundwater is water found in pores and fractures within soil and rock beneath the land surface. The “water table” is the level below which pores and fractures are saturated with water and above which the pores and fractures are dry or partially saturated. Groundwater flows within and between interconnected pores and fractures very slowly because the resistance to flow is large and the driving force (caused by differences in elevation and pressure) is generally small. Groundwater is often considered to be a subsurface reservoir that acts to regulate the hydrological system. Because groundwater moves slowly, rapid changes in groundwater storage rarely occur.

When percolation reaches the water table it is known as “recharge”. Groundwater flows slowly from areas where recharge occurs towards lower parts of the landscape, discharging to streams, rivers or sometimes the ocean. The travel time of an idealised “particle” of groundwater from source to sink can be hundreds, thousands or tens of thousands of years, depending on the distance from source to sink and the nature of geological materials along the travel path.

In many hydrological systems, the volume of groundwater flow is almost insignificant relative to the volume of water that flows on the surface. But, the contribution of groundwater to baseflow in streams can be significant during long periods between rainfall events. “Baseflow” in some systems is derived almost entirely from shallow groundwater.

Contributions to surface water supply storages are often dominated by a small number of large streamflow events each year. Baseflow contributes to the support of ecosystems along the length of streams. If baseflow stops, as it does in streams that cease to flow for some months of the year, stream ecosystems can be supported by groundwater, even though groundwater itself may not appear to flow into the stream itself. In such cases, it is the groundwater in the shallow alluvial aquifers within which the streambed is incised, that supports the ecosystem. It is the fact that the pores and fractures beneath the water table are “full” of water that is important, even if the elevation of the water table falls between intermittent runoff and recharge events.

Flow of groundwater

At the simplest level of detail, the rate of flow of groundwater (in m^3 or kL per day) is equal to the product of:

- “hydraulic conductivity” (sometimes called “permeability”), which is a property of the medium (measured in metres per day, or m/d),
- the cross-sectional area through which flow occurs (m^2), and
- hydraulic gradient, which is the slope of the driving force (dimensionless).

The driving force, or “piezometric head” is a combination of elevation and water pressure. Prediction of rates of groundwater flow in real physical systems requires the use of computer simulation models that take account of the nature of the ground in three dimensions to calculate the spatial and temporal distribution of piezometric heads, gradients and flows. Since the gradients depend on land surface and other elevations, a good representation of three-dimensional geometry is necessary for accurate predictions to be made. Land surface elevations in uplands and lowlands influence the “boundary conditions” and define the overall driving force.

Under natural conditions, groundwater moves from uplands to lowlands, following the overall path of least resistance. Groundwater always seeks to flow from source to sink via the easiest possible route. If hydraulic conductivities were equal at all locations (“homogeneous”) and in all directions (“isotropic”), the easiest route would be the shortest route. But not all of the flow can take the same shortest route, so the overall flow spreads out, following paths with a wide range of “travel times”.

If hydraulic conductivity is larger in a specific layer, e.g. in a coal seam, then that layer acts as a conduit for groundwater, and is known as an “aquifer”. Adjacent units of “interburden” with lower hydraulic conductivity are known as “aquitards”. In layered sequences of aquifers

and aquitards, the easiest path for groundwater to take from source to sink is via the aquifers, via the more conductive (less resistive) materials, but only if the water can reach the aquifers without passing across layers of very low hydraulic conductivity. Even a single low permeability aquitard can limit the transmission of water to the aquifers, thereby reducing the total flow through the system.

In regional groundwater flow systems, groundwater tends to flow almost horizontally within the sub-horizontal aquifers and almost vertically across the aquitards between aquifers. Vertical hydraulic conductivity in aquitards can be much smaller than horizontal hydraulic conductivity in aquifers. The “anisotropy ratio” (the ratio of horizontal to vertical hydraulic conductivity) within aquifers and aquitards, and averaged over a sequence of both, can be 1000, 10000 or more. Even if coal seams have the capacity to allow flow, the adjacent layers can be almost impermeable.

5.2. MINING IMPACTS ON GROUNDWATER

The impact of mining on groundwater needs to be considered from three points of view:

- From an operational point of view, the groundwater that seeps into mines, needs to be pumped out to ensure safe working conditions for workers and mining equipment. Accurate estimates of groundwater inflows are necessary to design water management infrastructure such as pumps, pipes, ponds and water treatment works.
- From an environmental point of view, during and shortly after mining, the potential for leakage of groundwater from streams and their connected alluvium towards the mined areas become important, to avoid unacceptable impacts on streamflow and surface water supplies, or on ecological conditions nearby.
- From a longer term point of view, indeed long after mine closure, the time that it may take for the hydrological system to recover to or near the pre-mining conditions become important, i.e. the period during which the hydrological system may continue be impacted by the mining operations.

The act of mining changes the nature of the ground within the area that is mined, and also above the area that is mined. These physical changes affect the flow of groundwater near a mine.

By removing coal and interburden within drifts and longwall panels, some water is released immediately, but only from pores and fractures within the mined material and the collapsed roof immediately above. Since the effective porosity of fractured rock is very low, only a relatively small amount of ‘old’ water is released.

The most significant impact of mining from a hydrogeological point of view is that internal air pressure on the roof, walls and floor of mined cavities is effectively atmospheric (Figure 5.1), so the piezometric head on the surfaces of the mine becomes equal to elevation. New hydraulic gradients are established near the mined volume, causing flow of groundwater towards the mine. The mine becomes the new low point in the hydrological system, the new sink, until such time (long after mining) that pressures and heads return to pre-mining values.

Initially, the drop in head in the mine causes groundwater within the coal seam aquifer to flow almost horizontally towards the mine. As heads decline in the coal seam aquifer, to larger and larger distances from the mine, a “cone of depressurisation” is established. The reduced heads within the cone lead to a tendency for vertical seepage to occur in adjacent aquitards, both downwards from above and upwards from below. The vertical hydraulic conductivity of aquitards is sometimes so low that leakage into the coal seam aquifer is minimal.

In some circumstances, the leakage from above could induce flow downwards from the water table. The rate of downwards flow is controlled by the distribution of vertical hydraulic conductivity throughout the geological layers above the coal seam. In a layered system, the effective vertical hydraulic conductivity is dependent on the properties of each layer and the effective overall resistance is dominated by the layer with the lowest hydraulic conductivity, albeit this might be a relatively thin layer. Mining may cause an increase in hydraulic conductivity in some layers, through the formation of fractures. But horizontal compressive stresses in the so-called “constrained zone” may cause such fractures to remain closed. Desaturation at the top of the goaf may lead to a lowering of effective hydraulic conductivity, and the formation of a “capillary barrier”.

In some circumstances, an alluvial aquifer at the land surface can be almost isolated from hydrogeological processes and flows at depth. Movement of groundwater at depth is very slow. Surface hydrological processes on the other hand are dynamic, and there are many ways in which systems respond to small changes.

Any lowering of the water table leads to the possibility of a phenomenon called “induced recharge”. If the water table is lowered, by any means, the hydrological system can sometimes evolve towards a new equilibrium with slightly lower surface runoff, slightly lower evapotranspiration, slightly higher recharge and slightly higher rate of groundwater flow into the regional groundwater system.

In groundwater terminology it is useful to distinguish between “seepage” into a mine and “leakage” from nearby surface water. Seepage starts the moment that mining starts. Leakage may occur much later, or may not occur at all. How a hydrological system responds to mining can only be assessed by groundwater flow modelling.

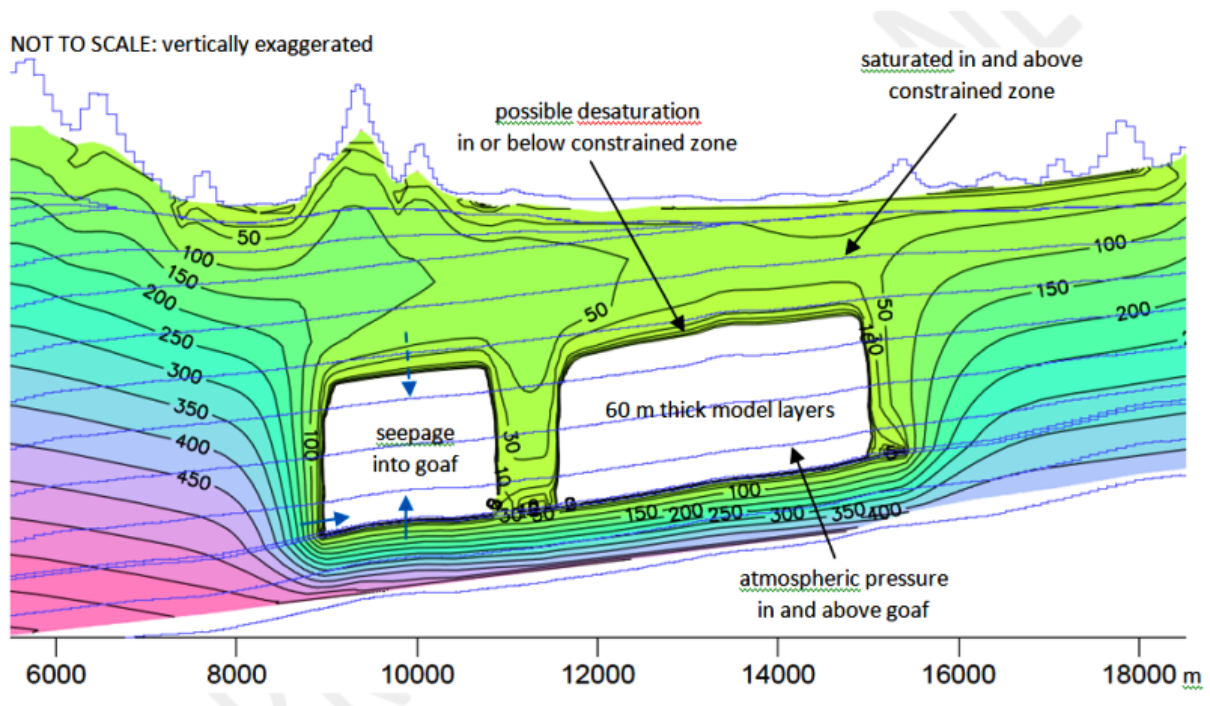


Figure 5.1 Extract from Figure E15b of EA Appendix B, being a South-North Section Through the Proposed Mine

5.3. MODELLING OF GROUNDWATER FLOWS

Given the importance of modelling as the only way to predict the potential impacts of the proposed project, a brief introduction to groundwater modelling is provided here, together with a brief assessment of the approach used by the proponent. More details are provided in Appendix G.

Methodology

Development of predictive models for flows in a groundwater system involves the following steps:

- Developing conceptual models of the physical systems;
- Representing these models mathematically; groundwater hydrologists use Darcy's Law to model flow rates and water balances to account for conservation of mass;
- Since the formulated mathematical models are not usually amenable to analytical solution, numerical computational techniques are used;
- Practitioners select from a range of commercial software packages; experience in application and use of these packages is important for groundwater hydrologists; the packages commonly used are outlined in Appendix G;

- The key input data, the "hydraulic properties" (hydraulic conductivities, and two types of storage coefficients, representing specific storativity and specific yield) for the many calculation cells in the model domain are estimated using all available information; and
- Application of the modelling software involves calibration against measured systems, sensitivity analysis, making predictions and assessing robustness against the uncertainty in model parameters.

Model predictions are only as good as the extent to which the model represents the physical system and the judgments of modellers in selecting input parameters. Given that there are acknowledged limitations in both aspects and that modelling effort can be variable from project to project, it is appropriate to use models at a level matched to the quality of output required.

Standards

There is no Australian or internationally agreed standard for groundwater modelling. The Murray Darling Basin Commission guideline²⁶ is commonly used for reference by Australian practitioners. Of the three levels of complexity identified in the guidelines, the middle level for 'impact assessment' is generally used for mining impact assessments. The guidelines distinguish between appraisals, peer reviews and audits. The Commission agreed that if a formal independent review had been undertaken of modelling for the proposed project, the appropriate level of review would have been a peer review of the modelling. Detailed comments on the modelling are presented in Appendix G.

Conceptual model

The conceptual model proposed in the EA assumes the occurrence of groundwater in shallow and highly variable unconsolidated alluvial deposits (sands, silts, clays), in shallow weathered sandstone (with flow in fractures that have been opened through stress relief) and in deep regional sedimentary rocks and coal measures. The coal measures are well defined based on exploration bores that cover the project area as shown in Figure 5.2.

²⁶ Middlemis, H., Groundwater Flow Modelling Guideline, Murray-Darling Basin Commission, 2001.

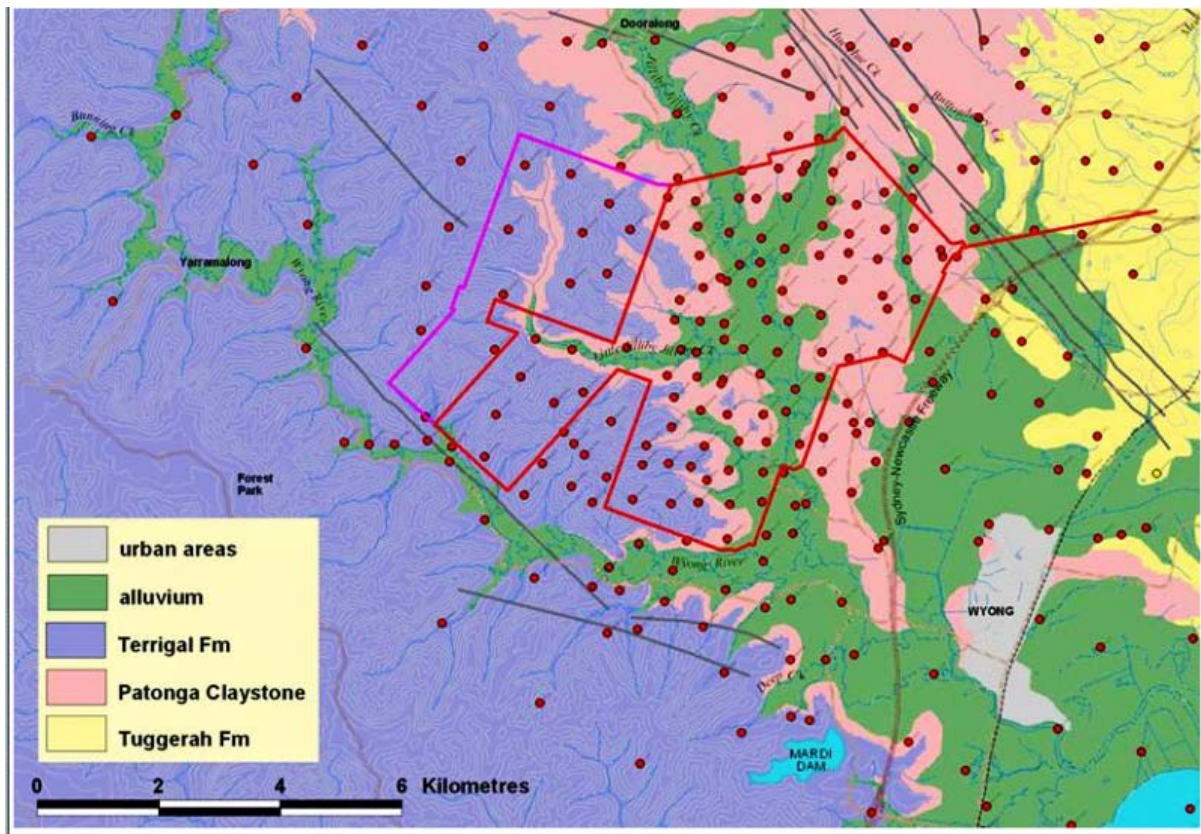


Figure 5.2 Exploration Boreholes, Superimposed on Surface Geology and Known Dykes

The stratigraphy dips generally to the southwest, as shown in Figure 5.3. The conceptual hydrogeological model assumes that recharge in the hills flows towards nearby streams but also towards the streams in valleys, and at depth towards the Pacific Ocean in the east. This concept of nested flow systems at local and regional scales is well understood and accepted.

In conceptualising the system in this way, an experienced modeller sets out to simulate pre-mining conditions using boundary conditions at rivers and streams that drive flow from recharge areas towards rivers and streams. To simulate the potential impacts of mining, hydraulic properties and boundary conditions are modified to represent a new low point in the hydrological system. The proponent's approach to developing estimates of hydraulic properties before and after mining is discussed further below.

The Commission accepts that the EA has developed a conceptual model that is appropriate for assessment of the proposal. The geometry of the system and the nature of regional boundaries are well defined. The Commission accepts the approach taken by the proponent in estimating hydraulic properties.

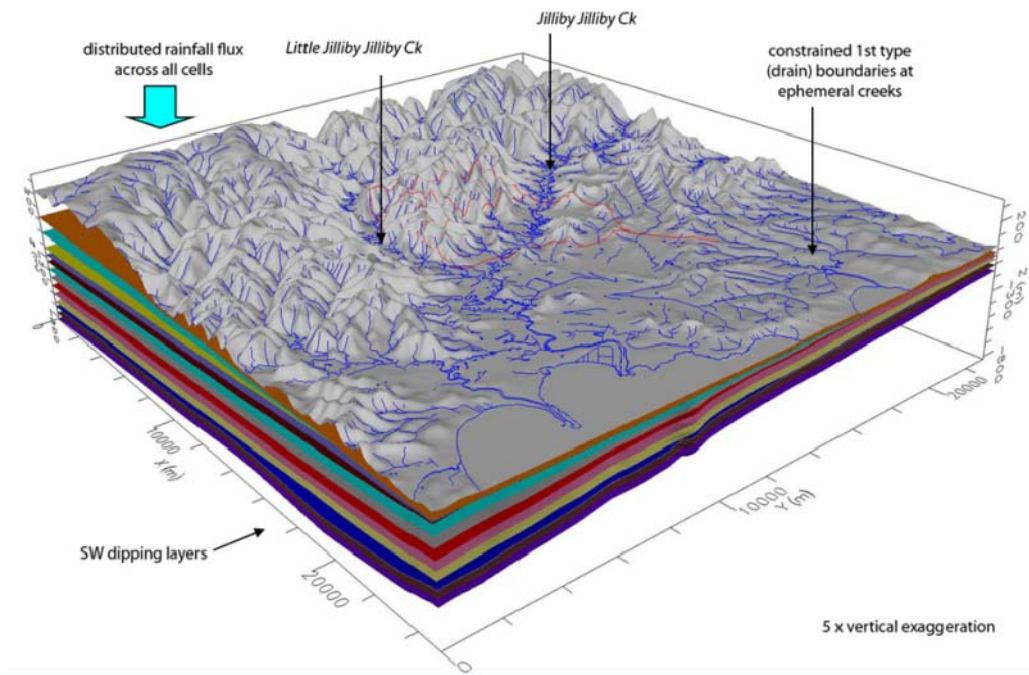


Figure 5.3 Three-dimensional model domain showing surface topography and dipping layers

Pre-mining hydraulic characteristics

The Commission reviewed the geological information in the EA and supplementary material in relation to possible geological faults.

The Commission has carefully reviewed the hydraulic conductivity data used in the EA groundwater modelling in the light of submissions on their inappropriateness. Conductivities derived from packer testing and lab-core testing have been compared. They show broad consistency for the key geological layers, given the expected uncertainties encountered in a pre-mining assessment. The Commission concluded that the proponent's justification for using core data and calculations of effective average vertical hydraulic conductivities by harmonic averaging is consistent with good practice in the industry.

The specific yield in sedimentary units is estimated to be 0.001%, based on the influence of joints and fractures, as distinct from drainable porosity in the matrix of intact rock. The implication is that there is very little free-drainable water in the hard rock system. A similarly small volume of water could drain through expansion of water due to changes in pressure.

Unconsolidated and variably saturated alluvial sediments occur at the surface within the Dooralong and Yarramalong Valleys. The bulk average horizontal hydraulic conductivity for a mixture of all material types is believed to be in the range 0.1 to 5 m/d.

The bulk average specific yield (drainable porosity) in the alluvium is estimated to be about 20%. This means that the bulk of the drainable groundwater in the region lies in the alluvium.

Post-mining hydraulic characteristics

Subsidence can have a significant impact on hydraulic characteristics if rock in the constrained zone is significantly cracked.

In the EA two distinct lines of reasoning have been used to argue that hydraulic properties will change very little in a so-called “constrained zone” above the mine, thereby limiting loss of water from the surface to the mine below.

- The first relies on geomechanical modelling of the subsidence process, and predictions of the type and magnitude of deformation in different zones. This style of modelling has been developing over the past 10 years, and is supported by observations in the field at numerous mines.
- The second relies on experience at other mines, and is particularly relevant when considering the impact of structural geological discontinuities.

The Commission has carefully reviewed the data relied upon in the EA modelling in Appendix G. On the balance of evidence, it accepts that it is likely that a constrained zone will exist and that on average, throughout the region of longwall mining, the effective vertical hydraulic conductivity through that zone will be close to pre-mining values as inferred from observations of core and laboratory testing. The Commission believes that an additional mechanism, specifically the reduction of effective hydraulic conductivity due to air entry and the creation of a partially saturated zone beneath the constrained zone is likely in practice to reduce seepage from above towards the mine.

Impact of geological discontinuities

The current mine plan has evolved through many iterations, taking into account new information as it became available. It is likely that some geological structures will be encountered.

In the event that geological features are present in the underground workings, they should be able to be identified sufficiently in advance of longwall extraction for the mine plan to be varied to avoid opening up any major hydraulic connectivity to the surface. Refer further to section 4.5 (Geological Features).

The Commission concludes that:

- There is a potential for geological structures to impact on surface and subsurface drainage.
- This potential is likely to be low given the considerable depth of mining, the considerable thickness of the alluvium and the drainage characteristics of the alluvium and shallow aquifer systems.

- Any conditions of approval should require management plans with requirements specific to geological discontinuities (structures) that are underpinned by at least an extensive groundwater monitoring system, continuous water balance assessments (water in – water out of the mine), and a requirement to review subsidence and groundwater related predictions whenever geological structures above nominated thresholds (displacement, width etc.) are encountered and to seek approval to continue to mine in those areas.

Impact of tensile cracking in bedrock

The EA predicts that the maximum final conventional strains across the Dooralong Valley on prediction line 1 are typically 2 mm/m tensile and 2.5 mm/m compressive, that these values are close to or the maximum experienced during the mining cycle, and that they are concentrated in long narrow zones.²⁷ The peak strains along Jilliby Jilliby Creek at any time during mining are predicted to be 2.3 mm/m tensile and 3 mm/m compressive.

As such, the bedrock beneath the Dooralong Valley could be expected to experience tensile cracking. Past field experience indicates that strains of this magnitude would most likely result in hairline fractures following the completion of mining, although it is possible that occasionally strain may concentrate at specific locations (for example, a strain of 2mm/m might be expressed as 20mm wide cracks at 10m intervals at some places). These wider cracks are likely to fill with sediment from the overlying alluvium. The volume of water consumed by any bedrock fracture network will be negligible and in the given circumstances, the potential for water loss from the catchment through this fracture network is considered minimal.

Due to the greater depth of mining, a large proportion of the forested areas are predicted to experience minimal residual tensile and compressive conventional strains and, therefore, impacts should also be minimal. The opportunity exists to confirm these predictions well ahead of mining beneath the forested areas and to adapt the mine plan as necessary.

The Commission concludes that:

- Water loss from filling of cracking at the top of the rock mass will not produce noticeable changes on the surface.
- The tension cracks are extremely unlikely to be sufficiently deep and connected that they could lead to pathways through the constrained zone to the mine below.
- The network of predominantly vertical tensile cracks is unlikely to lead to a significant increase in effective horizontal vertical hydraulic conductivity.
- The net impact of tension cracking, therefore, is likely to be localised and not widespread throughout the region above the mine.

²⁷ EA, Chapter 6, Figure 6.8, Figure 6.14 and Figure 6.15.

- Adaptive mining management provides a mechanism for responding to observations of surface impacts during mining of the first panels mined, well before mining occurs beneath the alluvium of the Dooralong Valley.

Boundary conditions and recharge

Boundary conditions at the horizontal extents of the model domain are not described in detail in the EA. A combination of prescribed head and no flow boundaries has been used. The boundaries are far enough away from the proposed mine that model predictions are not sensitive to the precise choice of boundary conditions.

Water table elevations have not been fixed in the hills. The EA modelling starts with an estimated distribution of steady heads that are influenced first by estimates of vertical and horizontal hydraulic conductivity, and then by assumed distributions of long term average recharge.

The Commission accepts that the choice of boundary conditions and recharge are reasonable.

Choice of modeling software and spatial resolution

After reviewing criticisms and reviews of the modelling package chosen in the EA, the Commission considers the fully three-dimensional MODFLOW-SURFACT model and the adopted spatial resolution to be adequate for assessment.

The model is a 14-layer model covering an area of 575 km². There are 105768 cells per layer, hence 1.48 million cells in total. The model is variably saturated, allowing cells to desaturate in and above the goaf.

Individual cells are as small as 50 m square. This allows a large number of cells to represent the shape of longwall panels. The degree of detail in the temporal representation of the mining schedule is not described by the EA, but it is likely that during each year of a simulation, the properties of cells in and above longwall panels mined in that year are changed to represent the act of mining – with effective hydraulic conductivities and porosity increased in the goaf and fracture zone.

Calibration and Sensitivity

After reviewing submissions and the Wyong Water Study and Aqualinc review, the Commission supports the conclusion that currently available data are sufficient for impact assessment and for development of an impact assessment model (see Appendix E). However additional data should be collected for the purposes of managing environmental impacts, if the project proceeds.

The *Wyong Water Study* stated *inter alia*:

Regular water level monitoring is re-instituted for an agreed observation bore network across the study area. This should ideally operate for 2 years (including previous

monitoring) prior to any in-seam mine development, so that natural variability can be captured in the data.

The Commission accepts that, “*ideally*”, two years of monitoring should be available before the commencement of “*in-seam mine development*”. However, it is worthwhile considering how this additional data could or would be used. The hydrogeological system is currently in quasi-equilibrium with the climate, and there is no reason to expect that climatic variations within a two-year period would lead to significant transients. Additional measurements of piezometric heads in lower Formations, or in the Wallarah / Great Northern seam itself, could lead to a revision of estimates of relative hydraulic conductivities in different units, but since recharge at the land surface is not known, there is no guarantee that additional measurements would significantly increase the degree of confidence in the calibration. The change in heads that would occur in the coal seam aquifer is so large that measurements over a period of two years would not change estimates of the change in head once it had occurred. Hence, the Commission concludes that two years of baseline data, whilst ideal, is not essential to the project proceeding. Sufficient data can be collected between the time of approval of the project and commencement of mining to determine baseline conditions and to support adaptive mining management.

The EA did not present as much sensitivity analysis as is sometimes presented. As a general principle in model development, it is important to utilise all available information. The proponent has argued that there is sufficient confidence in estimates of hydraulic conductivity that sensitivity analysis, particularly with much larger values of hydraulic conductivity, is not needed and would be incompatible with observations of flow through the natural hydrogeological system, as evidenced by measurements of baseflow. The Commission accepts this explanation.

5.4. PREDICTIONS

Groundwater seepage into the mine

The modelling predicts an inflow to the mine of 26.5 GL over the life of the project, peaking at 2.5 ML/d after 20 years. Most of this volume is predicted to derive from the expansion of water within the zone of depressurisation; some would derive from almost radial flow towards the mine, mostly within the coal seam; and some would derive from vertical leakage.

The proponent relies heavily on estimates of hydraulic conductivity and compressibility obtained by lab-core measurements. The approach used is arguably more rigorous than is often the case. However, given the uncertainty in hydraulic properties, the estimate of 26.5 GL could be too high or could be too low.

If the estimate is high, there would be less depressurisation and less seepage from above. The most significant impact would be on the proponent’s reliance on mine dewatering as part of the project water supply.

If the estimate is low, there would be more depressurisation and/or more seepage from above. In general, stakeholders are not concerned about depressurisation in deep hard rock systems *per se*, they are only concerned about the implications of depressurisation on seepage from above.

Rates of seepage from above depend on effective vertical hydraulic conductivities. If the average value were $\sim 2 \times 10^{-6}$ m/d, as in the proponent's model, then over an area of 50 km², being the footprint of the mine with allowance for nearby drawdown, this would account for 100 kL/d, or 4% of the inflow to the mine. If the average effective value were 10 times larger, the seepage would rise to 1 ML/d, and the overall inflow to the mine would rise by 0.9 ML/d to ~ 3.4 ML/d. However the potential for larger vertical hydraulic conductivity is naturally mitigated by the tendency towards desaturation above the goaf, and formation of at least a partial capillary barrier. Furthermore, for seepage to be sustained such that it becomes long term steady leakage from alluvial aquifers above, the alluvial aquifers themselves would need to be sufficiently permeable and extensive to maintain a supply. If this larger leakage were to be maintained, on average in the long term, the source of the water would derive from additional recharge to the alluvial aquifers following episodic rainfall-runoff and flood events. There would only be an impact at the surface if further recharge did not occur to balance the leakage. Consequently, a drying out of the alluvial aquifers due to leakage is very unlikely.

The Commission is of the opinion that the overall rate at which water is predicted to report to the mine is of the right order of magnitude.

Impact of leakage on the water table and shallow bores

The Commission accepts that the impact of lowering the water table in the alluvium in the Dooralong Valley and the Jilliby Jilliby Creek Valley as a result of mining will be negligible. A lowering of the water table by 0.34 m over 40 years is predicted, with recharge assumed to be a steady rate throughout the model simulation. This is an average drawdown, long after the perturbations caused by subsidence waves have passed.

In spite of this prediction, the water table elevation may slowly recover until the depth from the land surface to the water table is similar to that before mining. A phenomenon known as 'induced recharge' can cause the rate of recharge to the water table to increase after the water table has been lowered, thereby creating a tendency towards restoration of an earlier equilibrium. This possibility has not been taken into account in the modelling.

Subsidence will cause short term variations in water table elevation and depth to water table, as individual panels are mined. Mackie Environmental Research (2009) has shown that the time scale for adjustment of water table elevations, if not recovery, is months, rather than years or tens of years.

Shallow bores into the alluvium will not be affected. Shallow bores into low-yield hardrock aquifers in the Dooralong Valley will only be affected slightly and very slowly.

Long term impacts and rate of recovery

Creating a mine at depth initiates a long-term transient that tends to cause groundwater flow towards the void (depressurisation of deep confined layers, almost horizontal radial flow towards the void and vertical flow downwards from the surface towards the void), followed by long-term recovery during which pressures and water levels recover. Because the mine is created by extraction of rock mass, a volume is vacated that will ultimately need to be filled with water. Part of that volume is filled by the process of subsidence, because collapse of the goaf partially fills the void.

Predictions by the EA show partial recovery after 200 years, i.e. 160 years after the end of mining. Complete recovery will take much longer.

Just as the impacts of subsidence on groundwater and surface water depend on the accuracy of the assumption that the constrained layer will act as a barrier, it follows that predictions of recovery rely on the same assumption. If the modelling has overestimated leakage, as suggested above, then the time for recovery may also have been underestimated.

The concept of a recharge replenishment strategy is useful. There are several possibilities, ranging from gravity-fed recharge via boreholes during occasional flood events to pumping of seawater into the mine.

Assessment

The Commission has assessed the proponent's groundwater predictions based on the EA, responses to requests by the Commission for further information and various submissions from government agencies and interest groups. The peer review by Kalf and Associates Pty Ltd (2010)²⁸ provides support for the conceptual model utilised by Mackie Environmental Research. This review also considered examples of longwall mining beneath water bodies and the ocean, analysis of the results of testing of hydraulic properties before and after longwall mining and discussion of comments made in a number of key submissions.

The Commission accepts the approach taken by the proponent in the EA. The proposed project is a greenfields project. The geometry and stratigraphy in the project area are well understood. While the level of detail in modelling is not as high as in some studies in more developed mining areas, some aspects are more detailed than is often seen in greenfields projects. Significant attention has been paid to the critical questions related to the impact of subsidence on hydraulic properties above the mine.

5.5. CONCLUSIONS

If the project proceeds:

- mining will cause subsidence;

²⁸ Kalf and Associates Pty Ltd (2010), Wallarah 2 Coal Project, Review of the Mackie Environmental Research Modelling Report, field evidence and stakeholders comments, 27 October.

- deformation will cause changes in the hydraulic properties of the ground above the areas of longwall mining;
- groundwater in the goaf and free-draining zone immediately above longwall panels will drain into the mine;
- there may be changes in hydraulic properties in rock as far above the longwall panels as the land surface;
- some changes in rock properties may occur in rock overlain by alluvial sediments in valley floors;
- it is likely that there will be a zone at intermediate depths where horizontal hydraulic conductivities are enhanced due to shear along bedding planes, but where vertical hydraulic conductivities remain close to pre-mining values;
- leakage from the water table towards the mine will occur, but rates will be controlled by the low vertical hydraulic conductivity in the constrained zone, and by potentially lower vertical hydraulic conductivity in the fractured zone above the goaf and below the constrained zone because of air entry (partial desaturation), leading in some areas to formation of a partial capillary barrier;
- there will be short term changes in groundwater levels (elevations above sea level) as the surface subsides, and the depth of the water table beneath the land surface may change;
- impacts on baseflow are likely to be very small, and almost undetectable in the context of normal variability; and
- water table elevations may decline in the very long term, unless special efforts are made to flood the mine before very slow leakage has an impact on the water table.

5.6. RECOMMENDATIONS

The Commission recommends that:

1. As part of the Extraction Plan, the proponent should develop and implement a Groundwater Management Plan that includes the requirements listed in Schedule 1.
2. The Extraction Plan should require the proponent to develop plans for ensuring recovery of pressures within the deep aquifer system if this is necessary to achieve recovery of water table elevations at the surface. Such plans should give consideration to options for supplementing natural water inflow to facilitate recovery.

Schedule 1 – Groundwater Management Plan (GMP)

The GMP should:

1. Describe measurements of piezometric heads, water quality and any other attributes that may inform ongoing assessment of impacts of mining and subsidence on groundwater, and explaining how such measurements will be interpreted and used in such assessment.

2. Be developed as part of the Extraction Plan, in order to ensure tight integration of ongoing subsidence management and the ongoing need for vigilance in monitoring impacts of subsidence on groundwater.
3. Include provision for assessing the contributions to seepage via significant geological structures such as faults and dykes. Such a program is to be implemented in a manner which provides adequate time to modify mining plans if a structure is likely to result in unacceptably high mine inflows. The program should be premised on the philosophy of a 'trigger, action, response plan' (TARP) which includes thresholds for stopping mining operations, reporting the occurrence of significant geological features to relevant government agencies, for instigating formal risk assessments and reviews that include external, independent representation, and for the resumption of mining if and when appropriate.
4. Be linked to a Surface Water Management Plan, recognising the concern of stakeholders about loss of water from streams caused by leakage to deeper hard rock systems. This component of the plan should be developed in consultation with the NSW Office of Water.
5. Include all monitoring proposed by the proponent in the EA, including:
 - a) an undertaking to estimate the age of groundwater by isotope analysis at a number of locations within the hard rock aquifers and aquitards likely to be affected by mining, within the coal seam and in overlying formations.
 - b) measurements of flows into and out of the mine, with sufficient accuracy to allow interpretation of the potential source of groundwater seeping into the mine.
 - c) measurements of water table elevations in the alluvial aquifers of the Yarramalong and Dooralong Valleys, such monitoring to commence as soon as practicable, thereby ensuring a long record of natural seasonal fluctuations prior to the potential impact of mining.
6. Require that all groundwater monitoring processes and outcomes be audited externally annually for the first five years of mining and, subject to these audit outcomes being favourable, every three years thereafter for verification of ongoing adequacy and accuracy of predictions, such predictions being revisited and revised at time of audit taking into account the results of monitoring and modelling.
7. Require that the results of groundwater monitoring be reported and prepared for public display as part of reporting on subsidence within 6 months of the completion of extraction of each longwall panel.

6.0 SURFACE WATER

6.1. INTRODUCTION

Scope

Surface water is an important resource that contributes to the ecological functioning of the creek systems, the livelihood of rural landholders within the catchments and the reticulated water supply system for the urban population of the Central Coast. A full treatment of surface water issues is at Appendix H. The proposal has a number of potential impacts on the surface water regime:

1. Potential impacts as a result of subsidence within the surface water catchments, changing flow regimes and channel and floodplain morphology, surface runoff and water quality;
2. Impacts relating to the surface facilities arising from treatment and discharge of groundwater extracted in the course of mining, surface runoff from surface facilities and disposal of treated effluent from staff amenities.

This chapter addresses those matters relating to impacts as a result of subsidence within the catchments (Item 1. above), while potential impacts related to mine operations (Item 2. above) are considered in Chapter 12.

Hydrologic Processes

While it is common to consider surface water and groundwater as existing in different regimes, in practice the distinction is blurred by the interchange between the two. (See Chapter 5, Groundwater) Rainfall on a catchment can enter a creek directly as surface runoff or infiltrate the shallow groundwater aquifer system and emerge as baseflow in the stream over a much longer period. In dry times, almost all stream flow is baseflow derived from the shallow groundwater aquifers. In addition to the water that re-emerges as baseflow in the creeks, some of the water that infiltrates into the ground or occurs as shallow groundwater can permeate very slowly down to the deeper aquifers from where it will make very limited contribution to creek flow.

In addition to making the distinction between surface runoff and baseflow, two other important processes need to be considered in relation to the flow regime in a creek or river:

- While some reaches of a stream will contribute to baseflow, the converse will occur in other reaches and, rather than ‘gaining’ these reaches will be ‘losing’. This ‘losing’ process by seepage from the bed of a stream into the surrounding ground is particularly common along downstream sections of a river or creek.
- During times of flood, two competing processes occur as the flood wave progresses downstream. Additional flow from other tributaries will tend to increase the peak flow. However the natural attenuation processes associated with temporary storage of

floodwater on the floodplain work to reduce the peak flow. The attenuation of a flood is an important aspect of flood behavior that needs to be taken into account in assessing flood impacts on areas with wide floodplains, such as the Dooralong Valley.

Surface runoff is a highly variable phenomenon at all time scales. In common with all catchments in Australia, it is the extremes of flow patterns (floods and droughts) that are of greatest concern to the community, particularly in the face of a project that might alter the flow characteristics at these extremes.

Creeks

For purposes of this aspect of the review a distinction has been drawn between the ‘V-shaped’ valleys within the steep rocky hills and the broad flat (‘U-shaped’) alluvial valleys. While it is recognised that there is a gradation between these valley types, these provide a basis for assessing differences in geomorphic character and the likelihood of significant loss of flow.

Many submissions drew attention to loss of undermined surface waters in the Southern Coalfields due to subsidence and upsidence cracking of rocky creek beds in deeply incised gorges. The topography at the location of the proposed Wallarah 2 mine is significantly different. In the current situation the main streams flow mainly over alluvial-filled wide valley floors..

Notwithstanding the differences between the V shaped upland valleys and the U shaped alluvial valleys, the EA focused most attention on the alluvial valleys and provided no analysis of subsidence effects on the upland catchment areas that account for about 55% of the mine footprint. There are scattered acknowledgements in the EA of the potential for upsidence and valley related movement in hilly terrain and along watercourses in this terrain²⁹. However, there is minimal discussion of any associated impacts and environmental consequences.

Floodplains and Wetlands

Wyang LGA contains around 4,370 ha of ‘officially recognised’ wetlands which are predominantly located in the low lying areas east of the F3 Freeway. However, none of these are located within the area that lies within the footprint of the proposal.

Approximately 17% (620 ha) of the footprint of the W2CP mine lies under the alluvial floodplains of Jilliby Jilliby Creek and its tributaries. This floodplain is criss-crossed by numerous ancestral channels, some of which form ox-bow channels, billabongs and paperbark wetlands. Although not identified in the EA as ‘wetlands’, these areas would appear to contribute to the diversity of habitat on the Jilliby Jilliby Creek floodplain. These areas, identifiable from aerial photographs and visible from public roads, have unfortunately not been acknowledged or assessed in terms of subsidence in the EA.

²⁹ EA, Appendix A2, p29, p45 & p69; WACJV (2010b), p4-21.

The EA identifies two wetland areas that have been considered in the assessment:

- Porters Creek wetlands which lie to the east of the F3 and which receive flow from Buttonderry Creek as well as numerous smaller creeks. In response to pressure from surrounding urban development, including the effects of increased runoff, Council has developed strategies to limit urban stormwater draining to the wetlands in order to improve their hydrologic and ecological functioning. The EA acknowledges the important ecological values of the wetlands³⁰ but dismisses the possible impact from the Buttonderry site facilities, which drain to Buttonderry Creek, “*However, the direct impacts associated with surface facilities will not affect the wetland.*”³¹ Stormwater discharge from the Buttonderry site or runoff from the associated effluent disposal facilities located within the catchments of the Porters Creek Wetlands needs to be considered. This issue is discussed further in Chapter 12.
- The EA identifies an area of Narrabeen Alluvial Drainage Line Complex located along a tributary of Wallarah Creek immediately south of the TransGrid 300 kV easement that runs in an east-west direction to the north of the Tooheys Road site. The alignment of the proposed rail line is located on the northern side of the TransGrid easement in the vicinity of this ecological community and thus avoids direct impact. Notwithstanding, location of this habitat is designated as a “wetland conservation area” on the plans for the development of the Tooheys Road site.

6.2. POTENTIAL THREAT TO CENTRAL COAST WATER SUPPLY

Numerous submissions express concerns about the potential impact of the proposal on the Gosford-Wyong Joint Water Supply. The Gosford-Wyong Councils’ Water Authority (the Water Authority) notes that:

The Wyong River and Jilliby Jilliby Creek catchments (Yarramalong and Dooralong Valleys) provide approximately 48% of the catchment area and annual stream flows.

and,

*The water resources on the Central Coast are extremely limited and are fully committed to meeting the water demands of a rapidly growing area. It is essential that these limited resources are protected.*³²

The Water Authority submission concludes:

Given the significant contributions that Wyong River and Jilliby Jilliby Creek makes to the water supply and the level of uncertainty surrounding the impacts of the proposal on the groundwater and streamflows, this presents an unacceptably high level of risk to the Central Coast Water Supply.

³⁰ *Environmental Assessment: Wallarah 2 Coal Project*, Page 13-5

³¹ EA, page 13-5

³² Submission by Gosford Wyong Councils Water Authority, 2 June 2010, page 1

Because of the severe water supply shortages in recent years, any potential threat to the supply as a result of mining is of significant concern to the community. Numerous submissions from the public and community groups re-stated the concerns originally expressed in submissions to the Wyong Strategic Review, that the project posed an unacceptable threat to the water supply for the Central Coast. The NSW Office of Water also called for caution.

The Central Coast Water Supply System

In order to provide a sound basis for assessing the potential impacts of the W2CP on the water supply for the Central Coast, a summary of the key aspects of the water supply system has been prepared (see Appendix H) based on information provided in the *WaterPlan 2050 Options Report*³³ prepared by the Water Authority together with catchment characteristics and flow data available from the *Pinneena* database³⁴ and the *Wyong Water Study*.

WaterPlan 2050 was prepared by the Water Authority and adopted by Gosford and Wyong Councils in 2007 in response to the ongoing water shortages experienced on the Central Coast and proposed changes to the rules for access to water particularly from the Wyong River. The essence of the *WaterPlan 2050* is summarised in Figure 6.1 which shows three stages of increase in the available water supply:

- Completion of various infrastructure upgrades and emergency measures initiated in 2007 in response to drought conditions. These measures are projected to raise the average annual yield of the system to 40,000 ML/year;
- Completion of the Mardi Dam to Mangrove Creek Dam transfer pipeline and increased pumping capacity from the Wyong River which would increase the yield to 45,600 ML/year;
- Potential installation of spillway gates on Mangrove Creek Dam to increase the yield to 50,000 ML/year.

Once these works have been completed the Water Authority expects to have access to facilities capable of meeting expected demand until after 2050.

³³ *WaterPlan 2050 Options Report for the Long Term Water Supply Strategy (GWCWA, 2007)*

³⁴ *Pinneena* database V9, NSW Office of Water, 2010

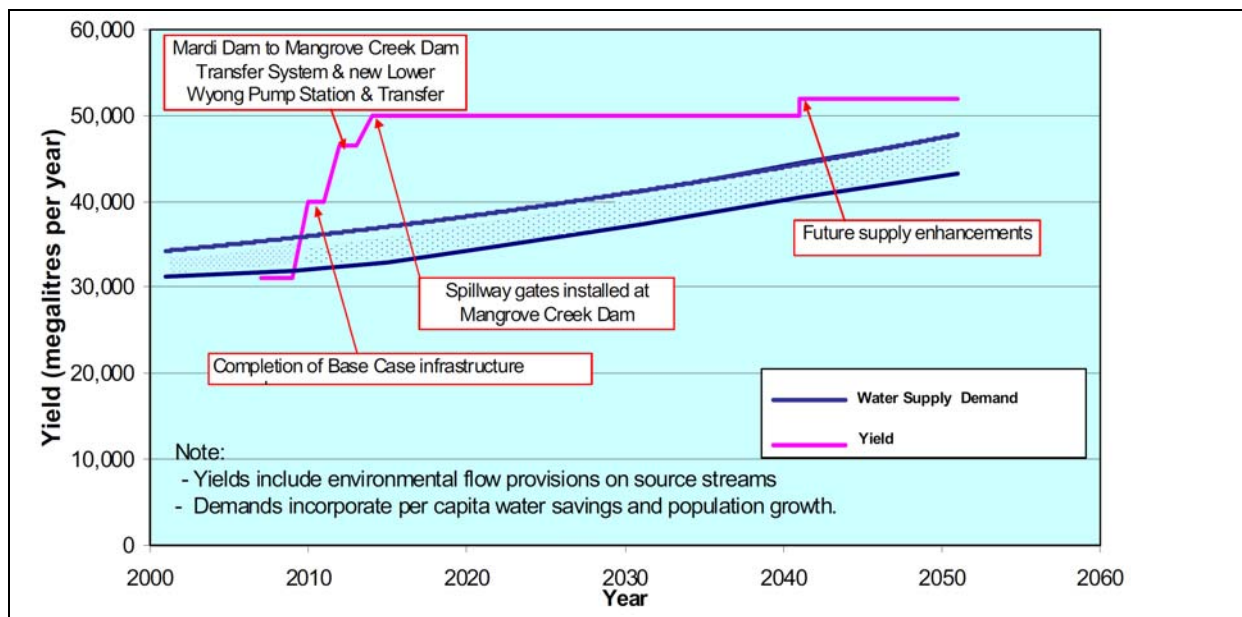


Figure 6.1 Projected Growth in Water Supply Demand and Yield from the GWCWA Water Supply System to 2060³⁵

As can be seen from Figure 6.1, the Mardi Dam to Mangrove Creek Dam pipeline is a key component of the *WaterPlan 2050*. This will address the main constraint which has been the ability to store water as distinct from overall access to surface water resources. Apart from Mangrove Creek Dam, the storage dams and weirs within the Central Coast system only have a storage capacity of 12,600 ML, about 5 months supply at current demand. Mangrove Creek Dam which has an existing storage capacity of 190,000 ML (equivalent to over 5 years supply at current demand) has only a relatively small catchment (about 101 km² – a little bigger than the catchment of Jilliby Jilliby Creek), and has not been used to its full potential.

The Mardi Dam to Mangrove Creek Dam pipeline will not only allow the Water Authority to more effectively use Mangrove Creek Dam as a storage for water extracted from Wyong River and Ourimbah Creek, but will also reduce the water losses that currently occur when water is released from Mangrove Creek Dam into the Wyong River about 20 km upstream of the Wyong Weir.

In addition to the surface water resources discussed above, the Water Authority has access to approximately 3,000 ML/year of groundwater³⁶

In the context of Figure 6.1, some of the claims made in submissions concerning the degree of stress suffered by the Central Coast water supply appear to relate to the situation that existed in the drought of 2002/3 to 2005/6 rather than to the situation following the completed interim works and the construction of the Mardi Dam to Mangrove Creek Dam pipeline and associated increase in the capacity of the pump at the Wyong Weir.

³⁵ *WaterPlan 2050*, Adopted by Gosford and Wyong Councils, August 2007

³⁶ GWCWA, 2007, Table 9.2

Water Sharing Plans and Access to Water

The Central Coast water supply system is integrated and takes water from a variety of sources including, Mangrove Creek and Mooney Mooney Creek which drain to the Hawkesbury River, and Ourimbah Creek, Wyong River and Jilliby Jilliby Creek which drain to Tuggerah Lake.

Modelling undertaken for the Water Authority, based on the climate records from 1885 to 2006, indicates average runoff from those catchments totals about 176,000 ML/year³⁷.

Rules for access to the surface water resources of these sources, is governed by a series of water sharing plans (WSPs) that have been implemented since 2003, and subject to review on a 10-year cycle. Each plan provides rules for various aspects of access by various users including such things as flow regimes for different classes of licenses, a daily extraction limit for each user, a maximum daily extraction limit for all users within a WSP area and the annual extraction limit for each user within each WSP area. Further details of these plans are contained in Appendix H which also outlines the specific provisions relating to access by the Water Authority for purposes of water supply to the Central Coast.

The total of the individual water access licences held by the Water Authority amounts to 108,800 ML/year from the five main sources. However, there is also a current limit of 36,700 ML/year from the combination of sources.

It should be noted that the current annual limit of 37,600ML is less than the capacity of the system following completion of the base case infrastructure (40,000 ML/year – see Figure 6.1). Accordingly, the Water Authority will, at some stage, need to seek amendments to its Water Licences to allow access to a greater proportion of the suite of sources totalling 108,800 ML/year.

Relative Importance of the Jilliby Jilliby Creek Water Source to the Central Coast Water Supply

The proponent in the EA and the Water Authority have provided different advice on the contribution of Jilliby Jilliby Creek, but without supporting details of the source of the statistics quoted. Notwithstanding, it appears that the contribution of Jilliby Jilliby Creek flow to the Central Coast water supply is of the order of 11-13%.

At the upper limit, if the Water Authority chose to extract up to the maximum allowed from the combined flow of Wyong River and Jilliby Jilliby Creek, (and virtually nothing from other sources), Jilliby Jilliby Creek would contribute about 27% of the supply to the Central Coast. However, if extraction from all sources occurred in proportion of each access licence to the total, the contribution from Jilliby Jilliby Creek would be about 9%.

³⁷ GWCWA, 2007, Table 9.1

Examination of the *Pinneena* database for runoff from the Wyong River, Jilliby Jilliby Creek and Ourimbah Creek indicates they are of similar order of magnitude per square kilometer (Appendix H). Although the catchment in the Dooralong Valley (Jilliby Jilliby Creek) has a higher proportion of alluvial floodplain, the runoff per square kilometre is not significantly different from the other two.

Potential Impacts of Subsidence on Surface Runoff

Subsidence of up to 2.25 - 2.5 m is expected in the hilly catchment to the north and south of Little Jilliby Jilliby Creek. While connective cracking to the mine strata in this area is considered very unlikely, there is potential for surface cracking on steep hillsides to affect surface runoff from the hills and floodplains.

The Commission requested the proponent to better characterise the watercourses in the hilly, forested areas above the western portion of the mine and to provide upsidence and closures predictions for these watercourses. (See Appendix F) The proponent responded with a stream classification, stream slope analysis and advice that no “significant rock bars and associated pools” had been found in the survey area. While the Commission has some issues with the proponent’s classification of streams and interpretation of the data, it nevertheless accepts as plausible that any creek bed cracking that might occur is unlikely to lead to a significant loss of flow or to have any impact on the water resource available to supply the Central Coast. As noted in Chapter 4, Section 4.7, for the proposed mine layout, the predicted worst case upsidence and closure values could be expected to result in negligible impacts for the Wyong River and Jilliby Jilliby Creek and for Little Jilliby Jilliby Creek up to the start of longwall 23N. Site specific impacts cannot be ruled out but these are likely to be sparsely distributed and of a very localised nature.

Unlike the watercourses in the steep rocky headwaters, the creeks in the alluvial valleys are incised into a relatively thick blanket of alluvium. The potential pathway for loss of flow in this part of the landscape is via lowering of the watertable within the alluvium, leading to an increase in seepage loss from the creek. However, as discussed in Chapter 5, Section 5.4, the controlling factor will be the constrained zone where it is likely that vertical hydraulic conductivities will remain close to pre-mining values. Accordingly, any loss of flow is likely to be very small and almost undetectable in the context of normal flow variability.

As previously discussed (Section 4.4), based on review of NSW underground mines that have extracted longwall panels successfully beneath water bodies in the Sydney Basin, and in the Mandalong Mine, which operates in leases immediately north of the proposal, the Commission is of the view that, in the absence of major unforeseen geological features, connectivity between the alluvial valleys and their streams and underground mine workings and consequent loss of surface water is extremely unlikely.

Despite the possibility of some subsidence cracking in the steep hillsides, the Commission concludes that the nature of the land surface and the physical characteristics of the soils and alluvium mean that any reduction in runoff due to subsidence is unlikely to be measurable

and would not have any significant impact on the Central Coast water supply or ‘cease-to-pump’ triggers. (See Appendix H)

Water Demand for Mine Operations

The EA contemplates that, although the mine will produce an excess of water from underground in the medium to long term, it will require external supplies in the start-up phase. Water requirements for both surface-facility sites are expected to peak at 500 ML in the first year of operation and to reduce to about 420 ML/year from Year 5 onwards. Approximately 210 ML/ year is expected to be obtained from runoff, but this is likely to be highly variable. As the mine develops, increased groundwater inflow is expected to occur leading to an anticipated excess of water from Year 5 onwards.

The EA contemplates that the shortfall of water for the operations will be met by a combination of potable supply and treated sewage effluent from the Charmhaven sewage treatment plant. The Commission considers either of these options would be feasible without compromising the central coast water supply:

- As noted in above, once the pipeline linking Mardi Dam to Mangrove Creek Dam and associated works are complete, the Central Coast water supply system should have capacity to supply up to 46,500 ML/year – an excess of more than 10,000 ML/year over the peak demand in 2001, prior to the imposition of water restrictions. Provision of up to 250 ML/year of potable water to the W2CP for up to 5 years should not, therefore, compromise the available supply to the community.
- The Charmhaven sewage treatment plant had an average dry weather flow of about 8 ML/day (2,920 ML/year) in 2000 and this is expected to triple by 2050. Treated effluent is currently discharged to the ocean at Norah Head. This source has the capacity to provide all the water required by the mine, even if there was no groundwater inflow to the mine.

Conclusions in Relation to Central Coast Water Supply

The Commission concludes that:

- Infrastructure upgrades since 2007 together with the construction of the Mardi Dam to Mangrove Dam pipeline significantly improve security of water supply to the Central Coast.
- The Water Authority will need to seek an increase in its extraction limits in order to meet the projected future demand.
- The water licences held by the Water Authority offer considerable flexibility to extract water from different sources and to use “carry over” entitlements of 30% of its annual allocation.
- For the proposed mine layout, the predicted worst case upside and closure values could be expected to result in negligible impacts for the Wyong River and Jiliby Jiliby

Creek and for Little Jilliby Jilliby Creek up to the start of LW 23N. Site specific impacts cannot be ruled out but these are likely to be sparsely distributed and of a very localised nature.

- The areas of the Jilliby Jilliby Creek catchment that have the potential to suffer from cracking of the creek channel comprise only 16% of the steep rocky headwaters catchments and are unlikely to suffer any significant loss of flow.
- The nature of the land surface and the physical characteristics of the soils and alluvium mean that any reduction in runoff due to subsidence is unlikely to be measurable and would not have any significant impact on the Central Coast water supply or 'cease-to-pump' triggers.
- The Commission is of the view that, in the absence of major unforeseen geological features, connectivity between the alluvial valleys and their streams and underground mine workings, with consequent loss of surface water, is extremely unlikely.
- In view of the relatively small contribution to the overall water resources of the Central Coast of flow from the steep rocky catchments that will be undermined, and the unlikely loss of significant flow from these headwater creeks, the proposal is unlikely to have any measurable effect on the available water supply for the Central Coast or water licence holders in the Jilliby Jilliby Creek catchment.
- The EA contemplates that any shortfall of water for the operations would be met by a combination of potable supply and treated sewage effluent. Supply from either of these sources would be feasible without compromising the Central Coast water supply.

6.3. FLOODING

Any change in the shape of the land surface has the potential to alter the way that floodwater affects different parts of the landscape in terms of depth of flow, direction of flow and velocity. The flood regime in the Dooralong and Yarramalong valleys has been the subject of ongoing studies by the proponent for more than a decade, involving 12 different mine plans.

Appendix J provides further details of the modelling approach documented in the *Flood Impact Assessment* (Appendix C of the EA). The analytical approach conforms to the conventional practice of estimating the flood impacts by means of separate computer models that are used to estimate runoff from the catchment into the creek system and the effect of flood flows on flood levels and flow velocities within the floodplain area of interest.

DECCW have questioned the applicability of the models used for flooding analysis. Notwithstanding shortcomings in the models and calibration issues identified in Appendix J, the Commission considers that the models provide an adequate indication of the nature and extent of flooding on the existing landform and to be expected once subsidence has occurred. However, the predictions of the models are based on current predictions of subsidence effects. Calibration of predictions with observed subsidence behaviour is likely to require further flood modelling capable of providing more detailed flood flow patterns and estimates of flood hazards for individual properties and along roads and driveways.

Climate Change Effects

Submissions to the effect that a 0.9 m sea level rise would be reflected in a 0.9 m flood level rise in the area of the proposed mine overlooks the fact that Wyong Weir acts as a hydraulic control for flood levels immediately upstream, not the level in Tuggerah Lake. Even if the weir was not in place, the so called “backwater” effect of sea-level rise in Tuggerah Lake would only extend a few kilometres upstream and would be unlikely to have a measurable effect beyond the junction of Wyong River and Jilliby Jilliby Creek.

Increases in rainfall intensity due to climate change can be expected to have an adverse impact on flooding in the Dooralong and Yarramalong valleys, irrespective of any impacts of mining. In general the impact of climate change will be the occurrence of more frequent large floods.

The Proponent has put forward a range of measures that could be used to ensure that individual properties are no worse off following subsidence (see Appendix J). It is anticipated that Property Management Plans will be prepared as part of the Extraction Plan process. In this process, the supporting flood analysis will take account of any changes to the predicted rainfall intensities and the resulting changes in flood level predictions pre and post mining. In the course of preparing Property Management Plans, there will be an opportunity to provide flood affected dwellings with additional protection in anticipation of future climate change effects.

Flood Impacts

The flood modeling undertaken to date should be considered as indicative, rather than definitive, of the flood levels and degree of impact within the area that will be affected by subsidence. Flooding is considered in more detail in Appendix J.

Figure 6.2, shows an enlarged section of Figure 6.4 from the *Flood Impact Assessment*, shows the additional areas (shaded pink) that are predicted to be flooded in a 1% annual exceedance probability (AEP) flood. There will flooding impacts on a handful of dwellings and several local roads will be untrafficable for longer than pre-mining and more frequently.

Several options for flood mitigation are canvassed in the EA:

- For dwellings: raising on location; constructing levees; and voluntary purchase; negotiation will be essential for each option;
- For roads: raising the roads, which appear to be feasible options in the three instances anticipated.
- In the Hue Hue Catchment improvement of the hydraulic capacity of the flow channel has the potential to lead to geomorphic changes in the long term, and is not favoured.

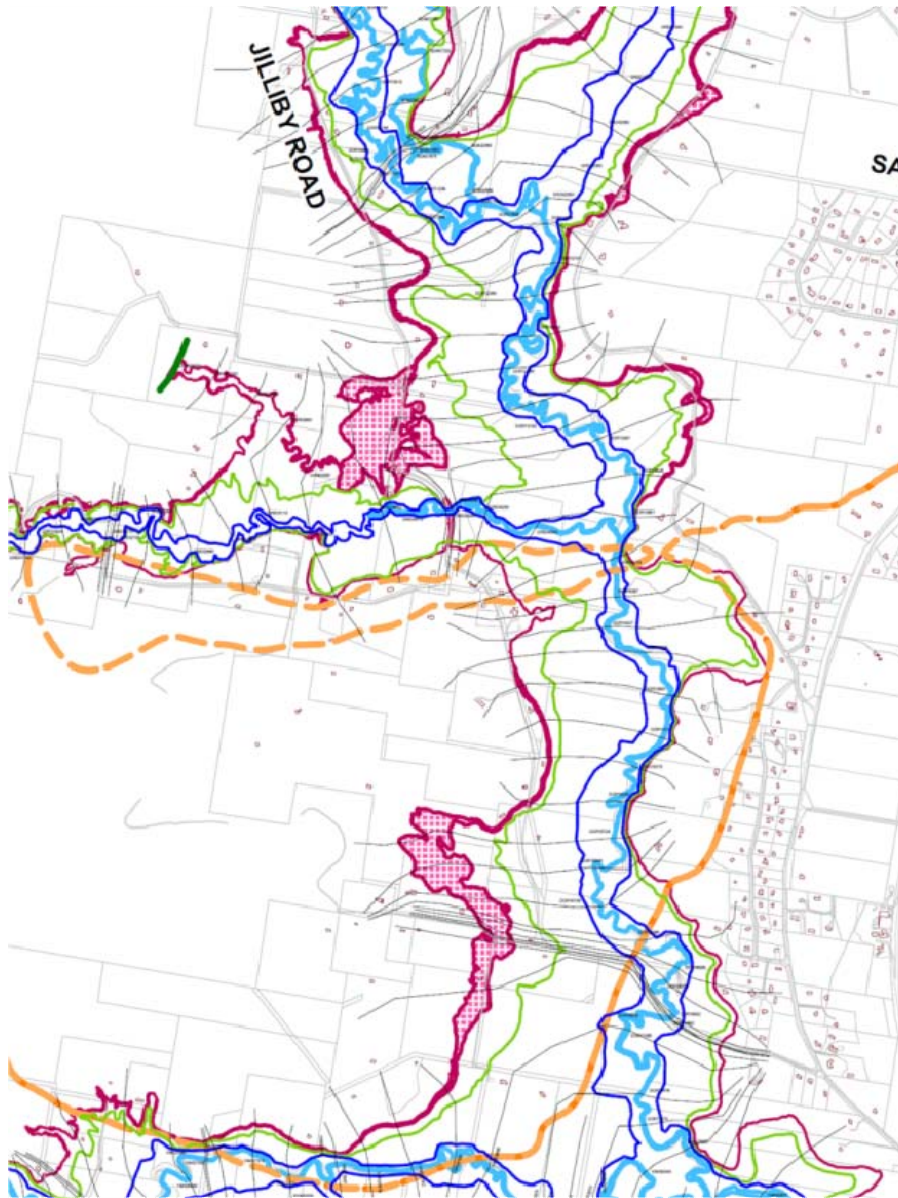


Figure 6.2 Predicted increase in flood extent as a result of subsidence

The Commission concludes that:

- The hydrologic and hydraulic models provide an adequate indication of the nature and extent of flooding on the existing landform and the impacts on flood behaviour as a result of subsidence.
- Climate change is likely to increase the frequency of larger floods, regardless of any subsidence as a result of mining.
- The options for mitigating the flood related impacts of subsidence on dwellings and roads would involve proven methods. Details of the precise works will be defined in the course of the Extraction Plan process.

- There is already in place a well established mechanism supported by legislation and administered by the Mine Subsidence Board for managing the impacts of mining on residential structures.

6.4. GEOMORPHOLOGY

Subsidence will cause localised changes to water courses, by altering the slope of the channel and creating sites for ponding. These will result in localised changes to drainage sensitive ecosystems. The EA does not enter into detailed mapping of these changes.

The impact on geomorphology is discussed fully in Appendix H. As considered above (Ch 5: Subsidence) confirmation of subsidence predictions will be necessary for reliable predictions of impacts on geomorphology at this localised scale. Destabilisation of riparian vegetation could lead to localised stream bank erosion and channel instability. The EA outlines generic proposals for monitoring and rehabilitation. In the case of ponding within the alluvial sections of creeks impacts can be mitigated by use of drainage conduits.

Subsidence impacts on the V-shaped valleys in the hilly uplands have been discussed elsewhere (Section 6.2 and Chapter 4).

The Commission concludes that:

- The assessment of the likely subsidence impacts on the upland creeks is a function of the mine layout presented in the EA. Site specific impacts cannot be ruled out but these are likely to be sparsely distributed and of a very localised nature.
- Any ponding that occurs as a result of subsidence on upland streams is likely to introduce a new habitat and lead to some localised change in the ecology.
- Further attention needs to be given to options for remedial works that might be undertaken in the headwater creeks if subsidence does create ponding or cracking occurs in isolated locations where rock bars occur in the creek bed.
- Ponding within the alluvial sections of the creeks can be readily and successfully mitigated by construction of drainage conduits (trenching, buried agricultural drains etc).
- The EA outlines generic proposals for monitoring and rehabilitation of subsidence within the sections of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek that run through the alluvial zone.

6.5. SURFACE WATER QUALITY

Some limited baseline monitoring in the EA indicates that the waters of Hue Hue Creek, Little Jilliby Jilliby Creek, Jilliby Jilliby Creek, and the Wyong River are far from pristine carrying evidence, for example, of faecal contamination. EA data indicate that the existing water quality does not comply with the default ANZECC guidelines for ecosystem protection in lowland rivers.

Better definition of the quality and impacts on Buttonderry and Wallarah Creeks will be important, since runoff from the two main surface facilities will enter these waters. In particular, impacts on Porters Creek Wetlands needs closer definition.

There is no serious attempt in the EA to characterise water quality in the steep headwaters creeks, notwithstanding the assertion that iron staining is unlikely to occur. In response to questioning from NOW and the Commission, the proponent commissioned further geochemical assessment which confirms there is negligible likelihood of iron staining impacts, no generation of highly anaerobic conditions and no generation of significantly acidic groundwaters containing high levels of iron, manganese, nickel or zinc.

The Commission concludes that:

- The water quality data collection and assessment is adequate to characterise the general characteristics of Jilliby Jilliby Creek and the Wyong River.
- The existing water quality data from Buttonderry Creek has not been used to establish water quality goals for site discharge from the Buttonderry Site and its associated effluent disposal area.
- The water quality data for Wallarah Creek has not been used to establish water quality goals for site discharge.
- Notwithstanding the geochemical analysis that was recently undertaken to assess the potential for iron staining, no effort has been made to sample water quality from upland tributaries where seeps and springs might exhibit low pH.

6.6. RECOMMENDATIONS ON SURFACE WATERS

The Commission recommends that:

1. As part of each Extraction Plan, the proponent should develop and implement a Surface Water Management Plan relating to the area that will be subject to subsidence. The plan should include the requirements listed in Schedule 2.
2. The Extraction Plans for longwalls that run under the steep rocky catchments should include contingency plans to manage any unexpected release of soluble oxidised metals due to fracturing of drainage lines. The contingency plans should canvass options such as not mining under these drainage lines, or to reduce mining dimensions such that fracturing is minimised.
3. Prior to commencement of extraction under the alluvial floodplain of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek, the relevant Extraction Plan should address measures to manage or mitigate any unwanted or unexpected effects of subsidence leading to the creation of new wetlands/depressions or increased potential for channel avulsion.
4. Property Management Plans should document the agreed flood mitigation measures for each dwelling as well as measures to mitigate any subsidence impacts on access along the driveways.

5. Any additional flood modelling necessary for the preparation of Property Management Plans should be based on updated calibration of the hydrologic and hydraulic models, use ALS data to characterise the land surface and take account of any updated subsidence predictions based on monitored subsidence in the W2CP area.

Schedule 2 – Surface Water Management Plan (SWMP)

The SWMP should :

1. Develop a program of flow and water quality monitoring to be undertaken on two small forested upland sub-catchments of comparable size, shape and aspect. One of these catchments is to be on a catchment that will not be affected by subsidence while the other is to be on one that will be affected. Continuous flow, salinity and pH monitoring should be undertaken for at least 5 years prior to undermining of the sub-catchment that will be subject to subsidence in order to provide an adequate baseline to detect any water quality changes such as pH that could be indicative of potential for iron staining.
2. Be linked to a Groundwater Management Plan, recognising the concern of stakeholders about loss of water from streams caused by leakage to deeper hard rock systems. This component of the plan should be developed in consultation with the NSW Office of Water.

7.0 ECOLOGY

7.1. INTRODUCTION

Types of impact

Ecological impacts assessed in the EA encompass flora, fauna and endangered ecological communities (EEC). The Commission considered ecology for three types of area (see Appendix K):

- Group-1 areas: subject to clearing and modification of lands for surface facilities at Tooheys Rd Buttonderry and the Western shaft ventilation sites;
- Group-2 areas: subject to mining subsidence that will alter landform, groundwater and surface waters; and
- Group-3 areas: not subject to impact from the proposal and intended to become habitat compensation zones.

In group-1 areas impacts are both direct through the removal of flora, and consequently habitat for fauna, and indirect through modification of drainage and runoff and the impact of these on the flora and fauna habitat.

In group-2 areas changes to both surface and ground waters have significant ecological impacts. A further subdivision of these areas into the alluvial Yarramalong and Dooralong valleys and the forested hills of the Wyong State Forest and the Jilliby Conservation Area is warranted. Subsidence is unlikely to fundamentally change the general pattern of water behaviour in the Yarramalong/Dooralong 'flooded' alluvial geomorphology. The serious impacts resulting from mining under 'U-shaped' valleys having rocky floors deeply incised into plateaux, a problem encountered elsewhere in NSW, are not foreseen in these alluvial valleys. But the EA nevertheless acknowledges that some cracking of creek beds may be expected in the steep 'V-shaped' valleys in the hilly forested regions in the western areas above the proposed mine.

In group-3 areas, where no impacts from mining are predicted, an accurate understanding of the ecology and its value is needed to ensure the offset proposed for ecology destroyed in group-1 and group-2 areas will be an adequate compensation.

Methodology

In group-1 areas the EA study³⁸ undertook detailed assessment of existing flora and fauna and predicted impacts to establish ecological values.³⁹ As this land is owned by the proponent, access for comprehensive ecological study was unhindered.

In group-2 areas the EA study⁴⁰ undertook targeted surveys coupled with review of previous studies of the area for regional context. As much of this land in the alluvial valleys is

³⁸ EA Appendix Q

³⁹ EA p13-1

privately owned and as consent for access was generally not forthcoming, there was an impediment to detailed survey work. Remote observations were used in lieu of access for some locations. In the wooded hills survey work was very limited and further work is needed before these areas are undermined beyond 15 years into the life of the mine.

In group-3 areas ecology was assessed by “predictive modelling accompanied by targeted survey” to assess “potential compensatory areas”.

The NSW and Commonwealth legislation governing rare and endangered species was generally followed in the EA survey (see Appendix K), but it is not clear in the EA the extent to which DECCW’s published survey guidelines were followed in the survey work to assess the suitability of offset land for compensation of predicted losses.

Areas of direct impact and potential offsets (groups 1 and 3)

Three EECs have been identified at the Tooheys Rd site and one at the Hue Hue Rd offset site. Of listed threatened flora, a total of ten species of orchids, trees, bushes and ferns were identified in the study area. Ten species of threatened fauna were recorded in the study area including bats, gliders, owls and frogs, and 142 trees with hollows, constituting habitat for some of endangered species were also identified. (Appendix K)

Vegetation clearing and construction activity on the Tooheys Rd site will constitute the main impact on ecology there. Areas of *Angophora inopina* and *Tetratheca juncea* will be cleared or disturbed. Impacts to the former have been determined as Controlled Action under the *EPBC Act*. The Squirrel Glider and the Wallum Froglet may be significantly impacted. Also a tree where a Powerful Owl is believed to be nesting will be carefully managed during construction.

Mitigation for group 1 areas

Offset lands offered for the 33 ha of vegetation to be cleared are 50 ha of dedicated land in the vicinity of Hue Hue Rd, 6 ha of *Angophora inopina* re-vegetation on the Tooheys Rd site and 12 ha of vegetation enhancement along Wallarah Creek on the Tooheys Rd site.

The proponent owns approximately 115 ha of forested land that will not be disturbed between Tooheys Rd and Buttonderry. There are also 318 ha of forested land within the development areas that will not be disturbed. Dedications are proposed to secure perpetuity.

Various other operational measures are intended for ecological management including development of a Management Control Plan, allowing fauna adequate opportunity to move during clearing, ensuring fauna and operations are appropriately separated on operational sites, salvage of hollow logs and debris, construction of artificial ponds and wetlands, enhancement of wild life corridors and provision of appropriate culverts under roads and rail

⁴⁰ EA Appendix R

line, control of feral animals and minimization of fragmentation of existing vegetation communities.

Areas of indirect impact (group 2) – alluvial valleys and forested slopes

Three species of threatened flora were identified from data bases in the alluvial valleys (bushes and trees) and none in the forested slopes. These ‘results’ are heavily qualified due to limited on-the-ground surveys undertaken, private-property-access limitations in the alluvial valleys and a minimal survey in the forested areas.

Threatened faunal species, including frogs, a quoll, owls, bats and birds, were identified. The frogs and bats appear to occur primarily in the wooded land with the avian species mainly in the open land of the alluvial valley floors. Several listed migratory wetland birds occur in the areas subject to subsidence.

Two key assumptions provide the basis for the EA assessment of ecological impact in the alluvial valleys, namely, that the semi-aquatic nature of the valley-floor environment will govern the types of extant flora and fauna and that the predicted subsidence will not essentially change this semi-aquatic nature although there will be local minor changes.

Based on its considerations of the impact of subsidence on groundwater and surface water (Chapters 5 and 6) the Commission has come to the conclusion that serious loss of water, or ‘drying out’ of these alluvial valleys due to mining-related subsidence is highly improbable.

The proponent argues for group-2 lands in the alluvial valleys that the vegetation groupings and fauna, including threatened frogs and other aquatic species, will be able to adapt to the modified water distribution in small wetlands and creeks induced by local changes to landforms as the longwall mining progresses. But the proponent has not studied whether this assumed adaptive capacity of the local ecology is likely to be realised in practice. While the Commission finds this reasoning plausible, it cannot agree that the conclusions are entirely adequate for adaptive management. Accordingly the Commission is recommending that further work be undertaken early in the mining process to better characterize the capacity of the ecology to adapt to the ‘moving’ aquatic environment in the alluvial valleys.

The situation in the creeks on the steeply sloping forested lands is rather different. As some cracking of rock beds in these creeks is likely, with significant local changes in water patterns and hence local ecology, further survey work is needed for an adequate assessment of the consequences of mining below.

The prediction of the consequences of mine subsidence in this area also needs refinement. While a completely comprehensive assessment for adaptive management purposes may be able to be delayed until mining moves closer to the area in 15 or more years’ time, better ecological information is needed. It will be important to allow an adequate period for the detailed ecological studies needed for adaptive management to handle these consequences

satisfactorily. Consequently the Commission considers that an approval for mining under the hilly terrain in the western part of the proposed area should be subject to conditions.

Mitigation for group-2 lands

The Commission accepts that it is not possible to predict local changes in the alluvial valleys in sufficient detail to be meaningful for comprehensive ecological assessment in advance of the commencement of mining. Adaptive management should be pursued as mining proceeds under an Extraction Plan. Mitigation measures for modified water courses and wetland can include drainage and channel modification measures as discussed in Ch 6: Surface water.

No mitigation is proposed in the EA for the steeply-sloping forested creeks except through a generalized management plan as part of the Subsidence component of the Extraction Plan. The Commission finds this unacceptable for unqualified approval of this area of the mine. A comprehensive study of ecology, in conjunction with a refinement of upsidence predictions for this area and a thorough risk assessment should be carried out before mining beneath this area.

The Commission recognises that there are access difficulties in surveying on private land in the alluvial valleys, but believes that with greater persistence and incentives the proponent's surveyors can gain better access than hitherto. Accessing the steeper forested land is a matter of logistics for the proponent and its consultants and the survey work in this area should be undertaken well before the advance of any mining underneath.

7.2. CONCLUSIONS

The Commission concludes that:

- On the directly-impacted group-1 lands there will be loss of threatened flora and fauna and EECs due to clearing and site works.
- Further work should be undertaken for a reliable assessment of the acceptability of the offsetting group-3 land proposed. In the event that the present group-3 areas held by the proponent prove inadequate in size or biodiversity for offset, other areas should be acquired or provided by the proponent by way of security into perpetuity.
- For indirectly-impacted group-2 lands under areas of mining subsidence the Commission accepts that surface water and groundwater is unlikely to be significantly affected in in the alluvial valleys. It therefore considers plausible the EA's claim that impacts on ecology are likely to be local and minor and that flora and fauna will adapt adequately for protection and conservation as the landforms slowly and progressively change due to subsidence with the advance of the longwalls.
- A better understanding of the capacity of the ecology to adapt to these changes in the alluvial valleys is needed for effective adaptive management and before mining advances substantially. Studies should be undertaken as soon as possible after the predictions of

subsidence impacts in this area can be validated and an adaptive Ecological Management Plan should be developed as part of the Extraction Plan. This should be implemented not later than one year after initial validation of subsidence predictions in the alluvial valleys.

- The Commission accepts as plausible that valley floor buckling and upsidence will occur but is likely to be less severe in the steeply sloping forested group-2 areas than in some other areas of NSW with different topography and geology.
- Considerable further ecological survey work is needed to adequately define the existing ecology and likely consequences of subsidence/upsidence, especially where damage to the rock floors of creeks is likely.
- While the Commission recognizes that this area is unlikely to be impacted for between fifteen and twenty years into the project, the assessment work needs to commence well in advance of that and at least three years before the underground mining advances to these areas.
- While the Commission is of the view that finding offsets for any damaged creek habitat in these steep streams may be possible in Wyong and neighbouring regions, a reasonable judgment cannot be made until there is a better understanding of the ecology of the area.
- A Ecological Management Plan within the Extraction Plan should be developed before mining is allowed under these hilly forested areas of the mining lease. Ideally this work should be completed three years out from longwalls undermining these areas to allow for any changes needed to the mine plan.

7.3. RECOMMENDATIONS

The Commission recommends that:

1. Before any clearing on the proposed surface sites, ecological surveys should be undertaken of sufficient intensity and to the satisfaction of DECCW so as to allow an adequate and appropriate area of offset land to be determined to compensate for ecological impacts caused by the provision of surface facilities.
2. Additional land(s) should be acquired or provided through security into perpetuity to make up for any deficiency in lands already held against ecological offset; the determination and offset provision should be to the satisfaction of DECCW.
3. A comprehensive Ecological Management Plan (EMP) for all lands liable to subsidence should be developed as part of the Extraction Plan. This plan should be in two parts as follows, and include the information listed in Schedule 4:
 - a) **Part A:** Hue Hue Creek and the alluvial floors of the Dooralong and Yarramalong Valleys; and
 - b) **Part B:** The steeply-sloping forested lands of the Wyong State Forest and the Jilliby Conservation Area.

Schedule 4 – Ecological Management Plan (EMP)

Part A of the EMP for the alluvial valleys should meet the following requirements:

1. Studies should be undertaken, to determine whether threatened or endangered water-dependent species can adequately adapt to the changes in surface and groundwaters resulting from progressive changes to landform ('advancing wave') caused by subsidence as longwall mining progresses;
2. To the extent EECs and threatened species cannot be adequately protected, offset lands are should be identified and protected in perpetuity;
3. An adaptive management component for the alluvial valleys should be developed as part of the EMP within the Extraction Plan considering the full suite of avoidance, mitigation and management approaches and, if adaptive management is an option, it should meet the test laid out in *Stoneco*⁴¹;
4. The plan should be finalized and implemented as soon as possible after the mining subsidence predictions for the area have been validated and not less than one year after that date;

Part B of the EMP for the steep forested areas should meet the following requirements:

Surveys for EECs and endangered species of flora and fauna should be undertaken:

1. The impacts of subsidence and upsidence in the creek beds in this terrain should be refined and comprehensively defined and mapped using the best predictive techniques available at the time of plan development;
2. The impacts of subsidence and upsidence on water quality should be assessed;
3. An adaptive management component for the steeply sloping forested lands should be developed as part of the EMP within the Extraction Plan considering the full suite of avoidance, mitigation and management approaches and, if adaptive management is an option, it should meet the test laid out in *Stoneco* (see above)
4. To the extent EECs and threatened species cannot be adequately protected, offset lands are should be identified and protected in perpetuity;

⁴¹ The NSW Land and Environment Court has recently defined adaptive management as:
„Adaptive management is a concept which is frequently invoked but less often implemented in practice. Adaptive management is not a “suck it and see”, trial and error approach to management, but it is an iterative approach involving explicit testing of the achievement of defined goals. Through feedback to the management process, the management procedures are changed in steps until monitoring shows that the desired outcome is obtained. The monitoring program has to be designed so that there is statistical confidence in the outcome□.
Newcastle and Hunter Valley Speleological Society Inc v. Upper Hunter Shire Council and Stoneco Pty Limited [2010] NSW LEC 48.

5. This component of the EMP planning should be finalized three (3) years before mining beneath the area commences, so as to allow adequate time for changes to the mining plan which may be necessary;
6. DG of Planning and DECCW should be advised five (5) years before mining is planned to reach the area;
7. This component of the EMP should be implemented before mining commences in the area.

Parts A and B of the EMP should meet the following requirements:

1. The EMP, including any survey work to be undertaken, should be developed:
 - a) In consultation with and to the satisfaction of DECCW;
 - b) Survey work should be at an acceptable intensity to identify occurrence of EECs and endangered species of flora and fauna; and
 - c) Should be adequate to identify action needed for protection to the satisfaction of DECCW;
2. The plan should endorsed by DECCW and in consultation with WSC; and
3. The plan should be reviewed biennially and re-endorsed by DECCW or, if DECCW is not prepared to re-endorse, changed to the satisfaction of DECCW.

8.0 ABORIGINAL HERITAGE

Scattered relics have been found at the Tooheys Road site and a number of axe-grinding groove sites have been identified within the Wyong Forest Study Area. Although the EA presents a disjointed commentary on aboriginal heritage, the Commission has received no submissions which suggest that the DECCW Guidelines were not followed. It is reported in the EA that consultation was undertaken with indigenous communities in accordance with DECCW *Interim Community Consultation Guidelines* and that the Darkinjung Local Aboriginal Land Council and the Guringai Tribal Link Aboriginal Corporation were engaged to undertake field work.

DECCW (2010a) assessed the potential impacts of the project on Aboriginal cultural heritage, and *agrees with the proponent's proposal to undertake a sub-surface investigation [at the Tooheys Road site] as an appropriate means of addressing a number of issues. The investigation should be undertaken before consideration is given to a project approval.* DECCW (2010a) stated that once these issues are resolved, and if the Commission recommends approval, *DECCW will assist by providing recommended conditions of approval for ACH matters.* DECCW raised no additional concerns.

DECCW's response does not address indigenous heritage in areas subjected to surface subsidence. The proponent has subsequently undertaken the test excavations (OzArk, 2010) involving a total of 60 excavation pits across four landforms and concluded that *there is a very low archaeological potential within the area investigated. While items of indigenous heritage (i.e. artifacts) are present, the distribution and nature of these items suggest a random 'background scatter', rather than the nearby presence of a site that would display intactness and complexity.*⁴² The Commission concurs.

A predictive model was developed for the Wyong Forest Study Area due to access difficulties. The model was tested in a portion of the Wyong Forest Study Area utilising input from indigenous communities. This identified four previously unrecorded Aboriginal axe-grinding groove sites, all of which were associated with creek beds. Two of the sites are outside of the mine subsidence zone. It was concluded from the predictive modelling and "ground truthing" of it that:

- Further indigenous sites are to be expected in the Wyong Forest Study Area but virtually no intact Aboriginal sites are to be expected in valley floor alluvial landforms.
- Axe-grinding will form the majority of sites that remain to be recorded in the Wyong Forest Study Area.

The EA states that axe grinding grooves found through the application of the predictive model are a common feature in the broader region and are representative of other sites previously recorded within the Study Area. It classifies both their scientific significance and

⁴² OzArk (2010), p3.

their public significance as *Low-Moderate*. Their cultural significance has been classified as *High* by the indigenous communities.

It is concluded in the EA that *based on their geological and landscape settings and the predicted range of subsidence effects, the individual axe-grinding sites along Myrtle Creek are likely to be at a generally low level of risk of damage.*⁴³ Based on its own analysis of conventional and non-conventional strain predictions, the Commission has some reservations about the accuracy of this impact prediction. However, this is not considered significant given that axe-grinding grooves are common features and none of the sites identified to date are of ‘special significance’. The Commission’s primary concern relates to identifying any sites of ‘special significance’⁴⁴ in a timely manner ahead of mining so as to afford them appropriate protection.

8.1. RECOMMENDATIONS

The Commission recommends that:

1. Mining should not be permitted beneath any area until an assessment of Indigenous heritage in that area has been undertaken in accordance with an Aboriginal Cultural Heritage Management Plan (ACHMP) prepared to address the requirements in Schedule 5 and to the satisfaction of DECCW.

Schedule 5 – Aboriginal Cultural Heritage Management Plan (ACHMP)

The ACHMP is to:

1. provide for the classification and management of all indigenous sites to be undertaken in consultation with DECCW and the relevant Aboriginal communities.
2. provide for the systematic identification of indigenous sites within the Wallarah 2 Project Area in consultation with the relevant Aboriginal communities at least 3 years ahead of the mine plan being approved in order to provide the opportunity to implement appropriate control measures.
3. be externally audited every three years for the duration of the project by a suitably qualified person appointed by the Department of Planning in consultation with the DECCW and relevant Aboriginal communities.

⁴³ EA, p14-27.

⁴⁴ This derives from *an assessment of a natural feature that determines the feature to be so special that it warrants a level of consideration (and possibly protection) well beyond that accorded to others of its kind. It may be based on a rigorous assessment of scientific importance, archaeological and cultural importance, uniqueness, meeting a statutory threshold or some other identifiable value or combination of values.* (DoP, 2009).

9.0 MAN MADE STRUCTURES

9.1. RANGE OF STRUCTURES

There is a large variety and number of man-made structures within the impact zone of the W2CP. These include residences, bridges, the F3 Freeway, local roads, water, gas & sewerage pipelines, electrical reticulation systems including 29 high voltage transmission towers, surface and underground telecommunication services, Jilliby School (250m north of Longwall 5S), farm structures, 375 farm dams, 13 registered bores, survey control marks, and tennis courts.

The Commission is aware that there is already in place a well established mechanism supported by legislation and administered by the Mine Subsidence Board for managing mining impacts on man-made structures and improvements. Furthermore, there is an extensive experience based on successfully managing subsidence impacts on many of the types of structures that occur within the W2CP Study Area.

PSM, in a report prepared for Wyong Shire Council SC has concluded that:

Based on the conclusion that the estimates of subsidence reported by the W2CP can generally be accepted as a reasonable interpretation of the effects of the proposed mine layout, we conclude that man made infrastructure such as the major dams, transfer systems including the Mardi to Mangrove pipeline, water treatments plants (sic), weirs and pipelines are unlikely to be adversely affected.⁴⁵

Against this background, the Commission has focused its attention on the more critical items specific to the Wallarah 2 proposal, being:

- Water Supply Infrastructure,
- Residences and farm structures, and
- Heritage

9.2. WATER SUPPLY INFRASTRUCTURE

The Mardi to Mangrove Creek Pipeline route marginally overlaps the general Study Area, south-west of Longwalls 1 SW and 2 SW, but is otherwise located outside of the general Study Area. The pipeline is in a declared Mine Subsidence District. The EA reports that the predicted movements along the proposed route have been provided to the pipeline designers and that the proponent has been advised that the current design can accommodate the predicted movements. Further consideration of the impact of subsidence on structures is provided in Appendix N.

⁴⁵ WSC (2010), PSM Report attachment, p11.

In its response to submissions on the EA, the proponent has advised further that⁴⁶:

- In assessing the potential impacts, it was conservatively assumed that all bedrock movements some 30 m below the alluvials at the site would be transferred from the bedrock to the surface and onto the pipeline itself.
- Additionally, it was conservatively assumed that the worst possible valley upsidence and closure movements would occur at the position of the pipeline.
- Nevertheless, the maximum predicted ground strains are well less than the tolerable limit of 1.5 mm/m for the pipeline.
- In reality, the dissipating effect of the alluvium should reduce the ground movements to a fraction of those predicted.

The Commission concurs with this conservative approach. It notes that mining in this area is not scheduled for some 15 to 20 years, by which time subsidence predictions will have been verified. Furthermore, subsidence movements should develop incrementally and the mine plan is amenable to modification (adaptive management).

Conclusions

The Commission concludes that:

- It is extremely unlikely that the Wallarah 2 proposal will impact on infrastructure associated with the Gosford-Wyong Water Supply Scheme.

9.3. RESIDENCES AND FARM STRUCTURES

The Wallarah 2 Study Area falls within the Hue Hue Mine Subsidence District and the Wyong Mine Subsidence District (MSD). The Hue Hue MSD was proclaimed in December 1985 and requires that mining induced ground movement effects on dwellings be limited to maximum ground strains of 3 mm/m, and maximum ground tilts of 4 mm/m. The Wyong MSD was proclaimed 1997. Initially, no specific ground movement limits applied, with structures longer than 30 m or structures on slabs being approved on their merits provided they were designed to withstand tilt and strain predictions provided by the then Department of Mineral Resources. Currently, houses are restricted to single storey and less than 30 m in length for brick-veneer construction.

At the time of compiling the EA, a total of 242 houses, 680 rural buildings and 98 swimming pools had been identified in the Study Area. Of the houses, 88 houses were located in the Hue Hue MSD and 154 in the Wyong MSD. The EA does not identify how many of these structures were constructed prior to the areas being declared Mine Subsidence Districts. Table 9.1 summarises the impact assessment for houses within the Study Area.

The EA states that:

⁴⁶ WACJV (2010b), p5-1 & 5-2

*Houses built in accordance with the Mine Subsidence District criteria should have appropriate levels of structural protection to mitigate the impacts of subsidence.*⁴⁷

This statement should not be interpreted to mean that all structures built in accordance with MSB guidelines will not be exposed to any structural damage. Further discussion of subsidence effects, impacts and consequences, and the subsidence impact assessment in the EA is provided in Appendix N.

The EA concludes that *the overall levels of movement for the houses across the Study Area would not be predicted to change significantly*. The Commission considers this conclusion to be reasonable provided that the longwall panel width and mining height do not change from that proposed in the EA.

Table 9.1 Assessed Impacts for Houses within the Wallarah 2 Study Area

Group	Repair Category			
	No Claim, or R0 - Adjustment	R1- Very Minor Repair, or R2 – Minor Repair	R3 – Substantial Repair, or R4 – Extensive Repair	R5 Rebuild R5
All houses (total of 242)	200 (83 %)	29 (12 %)	12 (5 %)	~1 (< 0.5 %)

The EA acknowledges that the overall level of movement predicted for houses in the Wallarah 2 Study Area is greater than that predicted to have occurred at houses overlying Tahmoor, Teralba, West Wallsend and West Cliff Collieries. Nevertheless, it concludes that *the higher proportion of impacts, however, would be expected to occur primarily at the lower end of the range, i.e. R0, R1 and R2.*⁴⁸

Appendix A of the EA states that there should not be any significant increase in the potential for impact on houses from downslope movements before concluding that:

*All houses within the Study Area are expected to remain safe, serviceable and repairable throughout the mining period, provided that they are in sound structural condition prior to mining. It should be noted, however, that the assessments indicate that the impact to approximately one house within the Study Area may be such that the cost of repair may exceed the cost of replacement.*⁴⁹

The EA concludes that 77% of the 680 rural buildings are predicted to experience curvatures similar to those experienced in the Southern Coalfield and that the observed levels of impact on the rural buildings structures in the Southern Coalfield should provide a reasonable guide to the overall levels of impact on the rural building structures. It does not quantify what these impacts are likely to be. The EA goes on to conclude that the remaining 23% of structures

⁴⁷ EA, p3-20.

⁴⁸ EA, Appendix A2, p120.

⁴⁹ EA, Appendix A2, p120.

will experience curvatures greater than those experienced in the Southern Coalfield. The general conclusion is then drawn that:

*It is expected therefore that all rural building structures within the Study Area would remain safe, serviceable and repairable during the mining period, provided that they are in sound existing condition.*⁵⁰

No indication is given of how this conclusion is arrived at for the 23% of structures predicted to experience curvatures greater than those in the Southern Coalfield.

Submissions

Concerns were raised in public submissions regarding subsidence related damage to housing, the inconvenience of moving whilst repairs are carried out, and the lengthy process and financial and emotional stress on families associated with obtaining compensation for damage. In responding to these submissions, the proponent has stated that:

*Houses located within the mine subsidence districts (MSDs) that have been built in accordance with the construction limitations set out for the MSD should not suffer any structural damage.*⁵¹

The Commission has reservations regarding this response given that Table 9.1 predicts that 17% of houses will require some form of repair. Unless the term *structural damage* in the proponent's response has a different meaning to *damage requiring repair*, it would appear that these 17% of houses had to have been constructed before the declaration of the Mine Subsidence Districts for the response to be accurate. The Commission is aware that some structures constructed to Mine Subsidence Board requirements in declared Mine Subsidence Districts have subsequently been damaged by subsidence, albeit of very minor nature in most instances.

The proponent has also responded that:

*...damage to housing, should it occur, will be minor and will not of itself require relocation of residents.*⁵²

This response also concerns the Commission regarding the meaning of the qualifier *will not of itself*. It does not provide assurance that the residents will not need to be relocated in order to undertake repairs.

The issue of the length of the process involved with obtaining compensation has not been addressed directly in the proponent's response. This issue is common to all declared Mine Subsidence Districts and relates to the time that it takes for subsidence movements to

⁵⁰ EA, Appendix A2, p103

⁵¹ WACJV (2010b), p2-10.

⁵² WACJV (2010b), p2-10.

effectively cease before repairs are carried out⁵³. Based on the subsidence profiles presented in the EA⁵⁴, this period of time is likely to extend to the extraction of at least one subsequent longwall panel in the Hue Hue MSD and to the extraction of two subsequent longwall panels in the Wyong MSD (the difference in time being due to differences in longwall panel width and mining height between the two MSDs).

DII (2010) submitted that:

- *The proponent has designed the mine layout in an attempt to limit subsidence movements in the Hue Hue MSD to within the limits ascribed to this MSD. No such limits have been ascribed and applied to the Wyong MSD.*
- *...the methods of predicting impacts to residential structures resulting from subsidence are still evolving. The Department's previous studies have identified significant inconsistencies between the predictions and actual observations of affected structures at other sites in NSW. The proponent's consultants have since adopted a new method for predicting subsidence on the residential structures within the application area. While I&I NSW MR supports in principle the general direction taken by this new method, it is yet to be tested.*
- *Again, management of potential subsidence impacts on dwellings should require an approach involving adaptive management.*

Wyong Shire Council submitted through a report prepared by PSM that:

Notwithstanding the requirement for an SMP, the Repair Classification system proposed in the EA (Table 6.1) is considered to be an appropriate tool for the task of assessing repairs to houses. Use of this system, or a similar approach may also be appropriate for other rural/farm/commercial buildings.⁵⁵

Conclusions

The Commission concludes that:

- The impact prediction methodology for houses relied upon in the EA is yet to be validated.
- There is already in place a well established mechanism supported by legislation and administered by the Mine Subsidence Board for managing the impacts on mining on residential structures.
- This mechanism is effective in not exposing residents to personal harm arising from mine subsidence and in maintaining and restoring structures to a condition equal to or better than their pre-mining state at no financial cost to owners.
- Houses constructed prior to the declaration of the site being in a Mine Subsidence District may be exposed to greater impacts.

⁵³ Repairs are delayed until residual subsidence movements are so small that they are not likely to impact the repairs.

⁵⁴ EA, p6-16 to p6-19, Figure 6.8 to Figure 6.11

⁵⁵ WSC (2010), PSM Report attachment, p39.

- The extent of impact to 23% of farm structures is yet to be quantified but is likely to be low if they are of flexible construction.
- These issues are of a nature and magnitude that should be able to be managed effectively through individual Property Plans as part of the Extraction Plan process.

9.4. HERITAGE

The EA reports that within the predicted subsidence area for W2CP there are no items that are listed in the Australian Heritage Data base and only two items listed in the Wyong Shire LEP 1991 as being of heritage significance. These later two are:

- Site 1 A brick and iron solo located south of Davenport Lane above longwall 2S
- Site 3 The Dwelling “Bangalow” which is located on the south-western corner of Longwall 5SW

Conventional subsidence predictions for these two sites listed are summarised in Table 9.2. Neither site is exposed to unconventional subsidence effects.

Table 9.2 Maximum Predicted Conventional Subsidence, Tilts and Curvatures for the Heritage Sites Resulting from the Extraction of the Proposed Longwalls

Location	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted Conventional Hogging Curvature (km ⁻¹)	Tensile Strain (mm/m)	Maximum Predicted Conventional Sagging Curvature (km ⁻¹)	Compressive Strain (mm/m)
Site 1	850	7.5	0.09	1.35	0.04	0.6
Site 3	650	7.5	0.08	1.20	< 0.01	< 0.15

The EA provides the following impact assessment for the two sites:

- Site 1 – The stability of the structure is unlikely to be affected by a tilt of 7.5 mm/m but it is possible that masonry walls could crack. The site may be impacted by the new extent of the 1:100 year flood zone, possibly registering an additional 0.4 depth of inundation beyond current inundation levels in a 1:100 year flood.
- Site 3 –If the predicted tilt eventuates, it is possible that some substantial remediation works may be required. Nevertheless, there is a probability of approximately 95% that none or only minor impacts will occur. The site may also be impacted by registering an additional 0.4 depth of inundation during 1:100 year flood event.

The EA proposes to address subsidence impacts at these two sites through the Archaeological and Cultural Heritage Management Plan in conjunction with the Subsidence Management Plan as part of the Extraction Plan process.

During field assessment, ERM (2000) identified 10 additional items of potential heritage significance within the predicted subsidence area having regard to changes to the Heritage

Act 1977. None of these appear to be so critical that they cannot be dealt with by a similar process.

Hence, the Commission concurs with the assessment of heritage sites and the manner in which it is proposed to manage mining related impacts if the W2CP proceeds.

Conclusions

The Commission concludes that:

- Subsidence impacts on heritage sites within the Study Area should be able to be managed effectively within acceptable limits through an Archaeological and Cultural Heritage Management Plan in conjunction with a Subsidence Management Plan as part of the Extraction Plan process.

10.0 NOISE

10.1. INTRODUCTION

Noise and mining

As an industrial activity using many different types of moving machinery, mining has the potential to generate significant environmental noise. In underground long-wall mining, as for this proposal, only a small amount of blasting is needed as most of the coal is removed from the seam by mechanical cutting and attrition. This is in contrast to open-cut mining, where noises are louder and generated in the open from non-fixed machinery and equipment.

Most of the industrial noise predicted to emit from this proposal originates in the surface activities at the Tooheys Road site for coal handling and the Buttonderry site for pit-head activities and ventilation. Additional noise is generated by rail transport from the mine to the Newcastle port for export, by traffic associated with both construction and operational activities and by the movement of employees and contractors by cars to and from the mine on a regular basis.

For most noise sources encountered in surface activities of a mine, proven techniques have been developed for mitigation of noise impacts. In general noise from fixed-position machinery can be mitigated by well-proven means, such as noise barriers, sound attenuators and silencers. The noise generation capacity of equipment used is well characterized for application in noise modelling. For moving equipment some mitigation of noise can be achieved by design of the engine exhaust systems and alarms. However, most mitigation for moving equipment relies on providing sound-absorbing barriers and optimizing vehicle movement. In the case of rail movement and loading, the design of track and rolling stock is important and ensuring locomotives have low noise ratings and are appropriately operated.

Noise impacts are readily monitored by noise measurement instruments used according to established protocols and as defined in legislative and industry standards. The sources of troublesome noise in an industrial complex can usually be identified by the measureable characteristics of the noise (sound pressure levels, frequency, etc.), allowing necessary corrective action to be quickly identified. Noise issues are further considered in Appendix L.

10.2. ASSESSMENT METHODOLOGY

Regulatory requirements

The NSW regulatory authority for environmental noise, DECCW, had established guidelines for noise assessment, the *Industrial Noise Policy* and the *Environmental Criteria for Road Traffic Noise*. There are two objectives in environmental noise control:

- Protection of amenity noise levels suitable to specific land uses, and
- Protection against intrusive noise.

In any situation the more stringent of the requirements or goals must be met.

An assessment in accordance with the guidelines involves identification of sensitive receptors (mostly houses), assessing the existing ambient noise levels, setting noise goals from DECCW guidelines, establishing noise emission levels for all equipment and operations in the project and modelling the predicted noise levels to assess compliance with the noise goals at the receptors under all types of weather conditions. Where compliance proves difficult, appropriate ameliorative measures must be designed to reduce the noise levels to the goals.

Modelling is carried out using a DECCW approved model which takes account of local meteorology and topography. Noise predictions are made for daytime, evening and night. Assessments are needed for both construction and operational phases of the project.

Regulatory control

If the project is approved and becomes operational, ongoing management will be generally achieved through an Extraction Plan, with a Noise Management Plan (NMP) as a component thereof. However, the operator will be required to hold an Environment Protection (EP) licence under the administrative control of DECCW. The Commission has therefore assumed that the management of noise issues would be carried out in accordance with the NMP and implemented generally through both the consent conditions and increasingly the through the EP licence into the life of the mine. The Commission notes that DECCW has the expertise, regulatory responsibility and capacity to manage the aspects of noise issues on an ongoing basis.

10.3. ASSESSMENT RESULTS

The proponent consultants have undertaken an assessment of the project generally in accordance with the DECCW requirements outlined above. A noise survey was carried out at a set of sensitive receptors around the Tooheys Rd and Buttonderry sites. This demonstrated that all receptors were influenced by traffic noise from the nearby Sydney-Newcastle freeway and other intersecting regional roads, most receptors being significantly influenced by traffic while a few are only influenced at background levels⁵⁶.

DECCW has accepted that the sensitive receptors are appropriate and that the limits are chosen in accordance with the policy.

Operational phase

The proponent claims to have demonstrated compliance with DECCW requirements for the operational phase of its activities⁵⁷. It used the DECCW approved ENM model for predictions and local meteorological information. This claim will be directly assessable by noise measurement in operation. DECCW will be able to exercise regulatory management of this requirement under any consent condition and an environment protection licence. See Appendix L for more information.

⁵⁶ EA p 11-23

⁵⁷ EA p 11-31

Stockpile configurations

A key consideration by the proponent of the Operational Phase in the assessment was the handling of coal from the mine through the raw coal surge or 'run of mine' (ROM) stock pile (50,000 tonne capacity); the crushing operation, and the product storage stockpile (250,000 tonne capacity). The configuration of this infrastructure affects both noise and air quality impacts, due to the use of bulldozers on the stockpiles.

The proponent's noise consultant considered 12 optional configurations ranging from a base case of three active dozers on the two stockpiles in the open to a configuration with a ROM bin for containment and a fully automated product stockpile with no dozers in operation. Two of the options considered involved fully enclosed ROM and product stockpiles, although the proponent demurred in its response to the Commission from the implied suggestions in the EA that the options involving covering of stockpiles were economically viable. The proponent preferred a configuration with no dozer on the ROM stockpile and one dozer on the product stockpile for project-assessment modelling, claiming *inter alia* that it "*provided a lower noise emission level than in most other cases*".⁵⁸

The Commission reviewed the modelling underlying this claim and, while it appears that cost may have played a role in the choice of options, it acknowledges that it is not aware of any other coal mining operation in Australia of this scale which covers stockpiles of this size. Nevertheless the Commission considers that fully automated stacking and recovery from these stockpiles, implied in several of the options, would be feasible at this scale of operation in the unlikely event that noise (and/or air) goals in the community cannot be met with the proponent's preferred configurations. If, for reasons the Commission cannot foresee, the noise and/or air goals cannot be met by fully removing the bulldozers from the stockpiles, then complete enclosure or covering of the coal handling, storage and loading operations would need to be applied.

The Commission notes that the Air Quality assessment (Section 11 below) has assumed two bulldozers on each of the ROM and Product stockpiles for the busiest day scenario, a combination apparently inconsistent with the proponent's preferred option above. This apparent anomaly has not been completely resolved, but the Commission considers the situation will be adequately managed through the performance-type conditions drafted.

Rail noise

Rail noise in the rail corridor between the Tooheys Rd loading site and the coal loaders at Port Newcastle has been briefly considered by the proponent. Noise modelling indicates that DECCW criteria could be met along sections of the track to Awaba, but progressive narrowing of the rail corridor as the track moves through urban areas to the port would make achievement of the noise goals increasingly difficult. The proponent notes that DECCW is

⁵⁸ EA p11-20f

progressively implementing Pollution Reduction Programs in respect of its licensing of track operations, as distinct from any licensing of the proposal.

The Commission has raised the issue of ‘wheel squeal’, the high pitched metallic whine of wheel flanges rubbing on rails, with both the proponent and DECCW, the latter indicating that its investigations into the phenomenon are ongoing. It has wider ramifications than this project, but could manifest itself at the Tooheys Rd site. It is not clear the extent to which the problem arises from the rolling stock, the track and/or both. The proponent advised that it is considering an option of purchasing two train sets, which could afford it the opportunity of greater control over rolling stock and scheduling (Appendix L).

The Commission notes that the configuration on the site will be used to maximum effect in minimising noise, for example, by loading to rail wagons in a ‘cutting’.

Construction phase

The proponent identified some potential problems at neighbouring premises during the construction phase. A Noise Management Plan with a construction component is proposed be developed to minimise impacts in a practical manner.

Traffic noise

There will be some exposure to minor impacts on residential receptors on Bushells Ridge Rd and Hue Hue Rd during construction.⁵⁹

10.4. AMELIORATION

The Commission is satisfied that a range of practical and proven measures is available to control noise at the project’s surface activities to achieve the DECCW goals for amenity and intrusive noise. Most of these measures have been proposed by the proponent in general terms⁶⁰ (Appendix L).

The Commission is confident that accurate monitoring and noise surveying can quickly identify whether compliance of the identified goals is being achieved in practice. Should further measures be needed, they are available (eg greater degrees of enclosure, further noise barriers, amelioration of fan noise, etc.) and will need to be installed. A Pollution Reduction Program attached to the EP licence would be the appropriate mechanism for achieving this.

If, in conjunction with air quality assessment, it becomes clear that the stockpiles with bulldozer movement of coal is causing compliance problems in operation, full mechanical stacking and reclaiming should be considered for achievement of the goals or a combination of this and coal receiving bins.

⁵⁹ EA p 11-39

⁶⁰ EA pp 11-21f

10.5. CONCLUSIONS

The Commission is satisfied that noise impacts can be adequately managed from the surface operations of the proposal with appropriate conditions. The Commission considers DECCW is the appropriate body to ensure the noise goals are achieved.

Regular specified noise surveys should be undertaken to assess compliance with the EA modelling results. Should the goals adopted in the EA not be realised in practice, DECCW should specify Pollution Reduction Program for the purpose of achieving compliance.

The Commission's primary areas of concern are with:

- noise from bulldozers on the stock piles,
- noise from rail movements, including the 'wheel squeal' phenomenon, and
- noise in the rail corridor to the Port Newcastle coal loaders, noting that the proponent would not be the licensee for this component.

It is satisfied that engineering measures are available capable of meeting the goals.

The Commission considers that DECCW, the regulatory authority for environmental noise from mines and railways, is the appropriate and competent body to manage the achievement of noise goals through its EP licensing powers. Realisation of this outcome under Part 3A requires appropriate conditions attached to the Part 3A consent.

10.6. RECOMMENDATIONS

The Commission recommends that:

1. All plant and equipment shall deliver noise outcomes that are equal to or better than the noise outcomes identified in the EA.
2. A regular neighbourhood noise survey regime should be established and operated to the satisfaction of DECCW in accordance with consent and EP licence condition to ensure compliance with the project noise goals as defined in the EA.
3. A Noise Management Plan to minimise all noise impacts to the maximum extent feasible during construction should be developed to the satisfaction of DECCW before construction commences and implemented during the whole construction period; the plan should include regular noise surveys of sensitive locations.
4. If regular noise surveys indicate that any of the project noise goals are not being met, appropriate additional noise mitigation measures will be designed and installed to the satisfaction of DECCW, including such measures as:
 - a) Further enclosure of identified equipment generating excessive noise;
 - b) Provision and/or modification of equipment to enhance noise abatement;
 - c) Modification of stockpile management, including restricting the operation of dozers on its surface; and

- d) Design and provision of mechanical stacking and recovery equipment for stockpiles if noise abatement levels cannot be met after a reasonable period of operation using the proposed method of coal handling.
- 5. DECCW should further explore the impact of noise from coal train operations on the rail corridor (including ‘wheel squeal’) and at the Tooheys Road site. The proponent should contribute to this exploration.

11.0 AIR

11.1. INTRODUCTION

Air pollution related to coal mining

Underground mining as proposed for the Wallarah No 2 Mine, generates considerably less particulate air pollution than open-cut mining common in the Hunter Valley. The overburden is not exposed to the atmosphere as it breaks up and is emplaced; dust-generating activity occurring underground is shielded from entrainment by atmospheric winds.

The main sources of dust at the surface from operational underground mines are from conveyors, especially transfer points, from crushing and loading, raised by tracked and tyred vehicles working on stock piles, blown from stockpiles and roadways and dust discharged from ventilation shafts. Proven engineering measures are available to control these sources of dust.

Coal mining also contributes to pollution globally by the release of ‘greenhouse’ gases which contribute to global warming, both directly from the mining process and from the eventual combustion of the coal mined, albeit the latter may be in another jurisdiction or country.

Air quality is considered in more detail in Appendix M.

The impact of dust on the environment is usually assessed by two broad parameters:

- suspended particle concentrations, expressed as total suspended particulates (TSP) or particulate matter smaller than 10 micrometres (PM₁₀) or smaller than 2.5 micrometres (PM_{2.5}); and
- deposited particulate matter or ‘dust fall’, expressed as a deposition rate in terms grams per square metre per month.

The first broad parameter (suspended particulates as TSP, PM₁₀ and PM_{2.5}) is related to impacts on human respiratory health. PM₁₀ has been adopted for setting the recognized Australian goal since 1998 and it is a requirement to satisfy this goal under NSW assessment guidelines⁶¹. However, attention for health impacts since then has focused on the smaller PM_{2.5} fraction, for which there is a national advisory reporting standard. DECCW has not at this stage set a goal for PM_{2.5}. Sampling of air for these parameters is typically carried out over 24 hours at six-day intervals on a repeating cycle.

The second broad parameter (deposition or dust fall) is related to impacts on amenity. Dust fall, along with odour, is one of the most readily perceived forms of air pollution in the public domain. Dust fall is sampled on a monthly basis of continuous exposure. In the case of coal mining and handling, the black colour of the fallout and occasional large deposition rates caused by short-term, high-wind events tend to exacerbate the nuisance value.

⁶¹ DEC (2005) *Approved methods of the modelling of and assessment of air pollutants in New South Wales*,

Health and air pollution

It has long been recognized that air pollution can affect human health. However, relating specific air pollutants to health effects, in a society in which humans are subject to many health-adverse factors, is a complex task, requiring a wide range of medical and scientific skills.

Since 1994 the task of setting national air quality goals has been assigned by law to the National Environment Protection Council (NEPC). NEPC establishes 'goals' or 'standards' for environmental pollutants, each of which is formally termed a National Environment Protection Measure (NEPM). A NEPM for Air Quality was first established in Australia in 1998. This NEPM, as varied in 2003, sets the present national goal for PM₁₀ particulate matter, on which DECCW's air quality goals for NSW are based. The NEPM goal requires that a concentration of 50 µg/m³ (24-hour average) not be exceeded more than five times per year⁶². NEPC has been considering a NEPM for PM_{2.5} since 2000, but presently has only established an advisory reporting standard (25 µg/m³ (24-hour average) and 8 µg/m³ (annual average)) with a monitoring protocol.

In establishing NEPM goals and standards NEPC draws on leading medical, scientific and administrative expertise from across Australia. NEPC closely follows international and Australian medical and scientific research on pollutants and their associated risks of health impact.

In considering the various submissions related to health impacts of air pollutants in this assessing this proposal, including a submission from NSW Health, the Commission had given weight to the goals and standards from this established Australian standard-setting 'machinery' for integrating all aspects of health and air quality science and administrative practice. The NSW DECCW goals take account of the NEPMs established for the Australian environment.

Modelling air quality impacts

Modelling techniques for predicting the impact of air pollution from sources such as coal mines are well developed. DECCW requires that its *Approved Methods for the Modelling and Assessment of Air Pollutants (2005)* be used for assessing impacts. Several proven computer models are approved by DECCW, including the Ausplume package developed by the Victorian EPA over a 30-year period and used for this assessment.

The key inputs to air quality modelling in mining situations are:

- Local meteorology;
- Existing (background) local air quality;

⁶² Five occasions over the specified goal concentration are allowed to account for incidences such as bushfires and dust storms.

- Emission rates from the mining activities;

Local meteorology takes account of all weather conditions and the modelling data base usually comprises at least one typical year's full meteorological measurements at hourly intervals. Thus all the meteorological phenomena normally encountered at or near a site, including inversions, sea breezes, strong winds, etc., will be encompassed by this data.

Existing or background local air quality is obtained by regular monitoring (on a similar basis to the collection of meteorological data) at the site or at a regional site subject to similar levels of pollution. Provided this data is reasonably recent it will take into account existing sources of pollution and therefore represent the cumulative impact of a pollutant when the predicted concentration is added to the background concentration.

Emission rates are determined by measuring rates of pollutant emission from specific types of activity. These rates are difficult to determine for open fugitive sources such as dust generated by outdoor mining-related activities. A concerted study of this type of dust emission was undertaken by industry and government in the Hunter Valley in the 1980s. It corresponds generally to similar testing of open sources internationally.

The particulate size distributions from this work, critical parameters for predicting PM₁₀ and PM_{2.5} concentrations, indicated that only small fractions of mining-generated dusts fell within the fine (2.5 micrometre) range. This is anticipated theoretically, since these fine particles are mostly generated by condensation processes in the atmosphere. They are not usually formed in large amounts by the mechanical size-reduction processes in mining. Nevertheless the amount of data on particle size of mining dusts is more limited than for many other industrial processes, due to the difficulty of collecting the fugitive emissions.

The consultant has predicted emission sources as TSP and then applied this size distribution uniformly to all emission sources to predict TSP, PM₁₀ and PM_{2.5} concentrations in the environment. After reviewing other available data (Appendix M) the Commission cautiously accepted the size distribution the proponent has used for air modelling.

Given the methodology for determination, this third input to dispersion modelling, namely, the emission rate, represents the greatest uncertainty in any predictive assessment of air pollution from mining activities.

Methodology

Meteorological data from the Charmhaven sewage treatment works and the Buttonderry landfill were used for modelling of emissions from the Tooheys Rd and Buttonderry installations respectively. The Buttonderry data was also used for predictions of emissions of particulates and odour from the mine ventilation shaft.

Existing air quality data for total suspended particulates (TSP) and particulate matter smaller than 10 micrometres (PM₁₀) and deposition rates has been collected at the Tooheys Rd and Buttonderry sites over a period of nine years with some gaps. This data accounts for the

cumulative contributions from the central coast power stations and the nearby quarrying operation.

Emission rates have been calculated using the technique normally adopted for coal mine assessment with the size apportionment (PM_{10} and $PM_{2.5}$), as discussed above. Rates have been calculated for the construction period, a normal operating period and a high-activity operating period, a 'busy day' (described in the EA as a "peak rate of mining and processing"). In response to a Commission question the proponent has indicated that the 'busy day' day rate of operation would exceed the annual capacity of the mine by nearly five times. It only anticipates this rate of coal throughput occasionally.

Odour and particulate emission rates from the ventilation shaft have been calculated using measurements made at other local underground coal mines. Buttonderry meteorology has been applied at the ventilation shaft, where the discharge occurs.

These inputs have been applied in the Ausplume model to predict cumulative particulate concentrations and deposition rates at a set of sensitive receptors around the three proposed sites.

A major component to particulate emissions as calculated are due to the operation of bulldozers on the ROM stockpile and the storage or "product" stockpile (60% for normal operations and 66% for peak operations). US EPA emission factors have been used to determine emissions from bulldozers working on the coal stock piles.

The Commission considers that the methodology and inputs used are generally sound and provide essentially realistic predictions of the air quality impacts from the proposed operations. There appears to be a minor problem in estimating the major source of emission, namely from bulldozer operation (see Appendix M), but this only translates into an increase in predicted PM_{10} of about 10%, probably lower than the inherent measure of uncertainty due to the emission factors. Nevertheless, any margin of comfort in the predictions is thereby reduced.

11.2. AIR QUALITY ASSESSMENT (AS IN EA)

Suspended particles (TSP, PM_{10} and $PM_{2.5}$)

The modelled outcomes indicate compliance for TSP and PM_{10} with DECCW criteria at all selected sensitive receptors, mostly houses (Appendix M). Contributions from the Tooheys Rd site ranged from 1 to $10 \mu g/m^3$ PM_{10} (24-h) at the chosen receptors for normal operation and from 3 to $29 \mu g/m^3$ on a 'busy day'.

In response to Commission questions the consultant reworked the modelling presented in the EA to include background air quality. This further modelling, conducted and allowing for peak activity, has indicated only two values over the $50 \mu g/m^3$ PM_{10} 24-h maximum goal at one sensitive receptor. If an adjustment is made for the modified bulldozer emission factors discussed above, the situation is not changed. The NEPM goal allows five values above the

goal per year at any site. The proponent points out that these predicted values take no account of proposed measures of dust suppression such as stockpile watering.

Concentrations of PM_{2.5} were modelled in a similar manner to PM₁₀ in the Health Risk Assessment section of the EA. At the same receptors as above the maximum predicted concentrations from the project operations ranged generally from 0.5 to 2.6 µg/m³ PM_{2.5} 24-h, with a value of 4.3 at one receptor. These are well below the maximum value in the NEPC reporting goal of 25 µg/m³ PM_{2.5} 24-h. The annual contributions ranged from 0.01 to 0.11 µg/m³ PM_{2.5} annual average, contrasted to the NEPC reporting goal of 8 µg/m³ PM_{2.5} annual average.⁶³

The Commission considered the situation at the Port Waratah coal loader in metropolitan Newcastle in seeking a practical point of comparison of the likely outcome at Wyong. It is located less than a kilometer from the residential areas of Tighes Hill and Mayfield. It uses mechanical stacking and reclaiming equipment and an extensive water spraying system for dust suppression. The annual throughput capacity of coal is approximately 25 million tonnes and the exposed area of stacked and surface coal is approximately 21 Ha. This compares to a proposed throughput of 5 million tonnes per year at Tooheys Road, with an exposed surface of approximately 8 Ha. ANSTO have operated a PM_{2.5} monitor approximately 1.3 km from the Port Waratah loader since 1998. This has demonstrated a capability of operating within the NEPM 'reporting' standards for this pollutant.

Given this practical comparison, the Commission considers on the basis of modelling that the likely PM_{2.5} goal should be achievable in the neighbourhood of the Tooheys Rd surface facilities.

Dust fall or deposition

Modelled increases in deposition rates are small. The goal is not exceeded at any receptors. This of course takes no account of the added nuisance value of the dust fallout being predominantly black coal compared to the 'grayish' fallout normally encountered in urban areas or in the vicinity of most open-cut mines (mainly overburden). However, even applying a factor of two to the results would not suggest a significant problem.

The proponent has responded to a Commission question on the impact of 'high-wind events' on short term fallout. The additional modelling indicates that, if the worst possible combination of high-wind conditions persisted throughout the year with no suppression, clearly a very conservative and unrealistic assumption, the fallout predictions would still be within DECCW guidelines.

⁶³ EA Appendix M, p.9.

Odour

Modelling of the impact of emissions of odorous mine gas from the upcast ventilation shaft at the Buttonderry site indicates a very low potential for nuisance at sensitive receptors. The predicted values readily comply with the DECCW criterion for odour impact.

The control mechanism is essentially one of dispersion. In the unlikely event that odour from this source emerges as an issue in operation the problem could be addressed by additional measures to increase the degree of dispersion, such as the retrofit of a vertical stack as mentioned in the EA⁶⁴

Greenhouse

Using DECCW approved factors for estimating greenhouse gas emissions from the operations in Australia of this proposal, the EA estimates that the emissions would be approximately 0.2% of net Australian greenhouse gas emissions based on 2008 information. It further estimates, by a simple comparative method, that this might contribute 0.000328 oC to global warming. While these figures represent extremely small contributions to global warming the proponent acknowledges that “it is the cumulative effects that pose a threat to ESD (viz environmentally sustainable development) principles.”⁶⁵

The Commission is, of course, aware of calls from some in the community for export of coal to be halted or constrained on the grounds of reducing carbon emissions to the atmosphere in order to limit global warming. The whole issue of Australia’s response to global warming is being actively debated at national and state level. A clear path ahead for the nation is yet to be defined. The Planning and Assessment Commission does not consider it to be within its mandate or within its terms of reference for this assessment to enter this debate. Accordingly it has proceeded on the basis of making an assessment within the existing national and state guidelines for export.

11.3. MITIGATION

Measures

A range of feasible and proven measures to mitigate dust emissions from the mining and coal handling operations have been proposed:

- Enclosure of conveyors on three sides to control blow off during high-wind conditions;
- Enclosure of crushing and screening equipment and capture of dust so generated;
- Enclosure of the rail loading facility;
- Watering of stockpiles;
- Regular sweeping of roadways and hard surfaces to remove dust accumulation; and
- Adaptive management for adverse meteorological conditions.

⁶⁴ EA Appendix L, p.30.

⁶⁵ EA Appendix L, p.26-30.

The consultant has conservatively made no allowance for these measures in predicting air quality in the environs. In other words, the actual air quality will be less than predicted with the measures in place.

The Commission has estimated a peak watering rate of about 1.8 ML/day may be required for effective wetting of the stock piles with an annual average need of about 150 ML/year. Should the make of water from the mine not eventuate by year 5, then treated sewage effluent could be used from the nearby Charmhaven sewage treatment plant, with disinfection of the water to an appropriate standard.

Monitoring of key parameters, TSP, PM₁₀, PM_{2.5} and deposition rates, around the Tooheys Rd facility will provide adequate and reliable feedback on the performance of the facilities against the predicted concentrations. Monitoring requirements should be specified in the consent and should be statutorily administered by DECCW.

In developing the monitoring network required, the Commission urges DECCW and the proponent to consider requiring two PM_{2.5} monitors at locations on opposite sides of the Tooheys Rd site, preferably NW and SE, with a meteorological station at one of the monitoring sites. This will allow the contributions of PM_{2.5} directly attributable to this surface operation can be determined. Alternative methods of source identification should also be explored (Appendix M).

The Commission is confident it will be possible to make practical engineering adjustments throughout the life of the mine should problems of compliance with ambient goals or satisfying amenity become apparent after startup or during the life of the mine. Some of the measures which are available include:

- Increasing the rates of watering of stockpiles and thereby the moisture content of the coal;
- Applying proprietary dust-suppression materials to enhance the effectiveness of stockpile watering in promoting ‘crusting’ of the stockpile surfaces and reducing dust emissions;
- Reducing or restricting the access of tracked and tyred vehicles to stockpile surfaces by increasing the extent of automated stacking and reclaiming; and,
- If dust becomes a significant problem, contrary to the Commission’s expectation, requiring that all coal to be handled mechanically and by excluding tracked or tyred vehicles from the stock pile surfaces except for an environmental and/or safety emergency, such as a coal stock pile fire, and
- If all other measures fail, covering the stockpiles and/or requiring coal to be handled through bins.

The Commission recommends that there should be no transport of coal to or from the site by road vehicles at any time, except in an environmental or safety emergency and that this should be with the approval of the Director General of Planning.

Management

If the project is approved and becomes operational, ongoing management will be generally achieved through an Extraction Plan, with an Air Quality Management Plan (AQMP) as a component thereof. However, the operator will be required to hold an Environment Protection (EP) licence under the administrative control of DECCW. The Commission has therefore assumed that the management of air quality issues would be carried out in accordance with the AQMP and implemented generally through both the consent conditions and increasingly the through the EP licence into the life of the mine. The Commission notes that DECCW has both the expertise, regulatory responsibility and capacity to manage the aspects of air quality issues on an ongoing basis.

The proponent has committed to an adaptive management system based on real-time monitoring to manage dust emissions during high-wind events (eg the notorious ‘southerly buster’). A purely responsive approach is inadequate. A predictive system, tapping into the excellent meteorological predictive services available, is essential to ensure success in mitigating any ‘blow off’ impacts. The details of such measures can be worked out with DECCW and the Bureau of Meteorology based on experience with other NSW coal loaders.

DECCW should also be encouraged to develop with the proponent a monitoring mechanism to assess the amenity impact of occasional high-wind events, to which the standard deposition measurements are relatively insensitive.

There have been many concerns expressed about health impacts. As discussed above, it is not anticipated that the fine fraction of dust, which has the greatest impact on respiratory health, is likely to be a problem around this project. However, in the event that PM_{2.5} concentrations are higher than the very low values predicted as in the EA’s Health Risk Assessment⁶⁶ or exceed the national standard to be decided in the near future by NEPC, application of a suite of the above measures through a Pollution Reduction Program can be readily administered through the EP Licence the proponent will be obliged to hold.

Concerns have also been raised in respect of emissions on a peak operating day. The proponent has responded to Commission questioning arguing that the busiest day scenarios would only be likely to occur for short periods (eg one day) each month⁶⁷. The Commission considers this difficult to regulate effectively. It considers the comprehensive air quality monitoring network recommended is a better method of discerning a problem than placing an unworkable operating condition on the proposal.

⁶⁶ EA Appendix M, *Health Risk Assessment*, Table 4, p9.

⁶⁷ Proponent response to PAC questions.

11.4. CONCLUSIONS

The Commission concludes that:

- Modelling of ambient air quality impacts have been carried out by the proponent in the EA in accordance with accepted and proven techniques;
- Air quality modelling indicates that goals as set by DECCW and NEPC for TSP, PM₁₀ and deposition will be comfortably met in normal operating conditions, as expected for a mainly underground mining operation;
- Due to uncertainties in prediction, primarily in the emission factor data used, a comprehensive air-quality monitoring network should be used to ensure air quality goals and a satisfactory amenity are achieved; to this end DECCW should require a corrective program through its statutory (licensing and PRP) powers;
- When a PM_{2.5} goal is established at national and/or state level, the equivalent should also be met at monitoring locations acceptable to DECCW and, in the unlikely event that this goal is difficult to achieve in operation, DECCW should require a corrective program at the proponent's surface facilities through its statutory (licensing and PRP) powers in operation;
- In response to the many submissions raising health impacts, the Commission has decided to follow the established national mechanisms for establishing health-based goals through NEPC for air pollutants at both national level and the NSW level of government (the latter being derivative in respect of setting health-related goals). These processes ensure that an appropriate balance of the medical and air quality science and other factors such as risk assessment are considered and robustly weighed in setting air quality goals.
- DECCW is urged to develop with the proponent a better method of assessing short-term amenity impacts caused by high-wind events than currently offered by the monthly-averaged particle deposition rates.
- Adequate engineering measures are available to deal with air quality problems likely to be encountered in the project;
- There should be no transport of coal from the project by road except as approved in response to emergencies;
- The ventilation arrangements can be modified to increase the degree of dispersion in the unlikely event there is an odour problem from this source.

11.5. RECOMMENDATIONS

The Commission recommends that:

1. All measures for control of air pollution shall deliver air quality outcomes that are equal to or better than the air quality outcomes identified in the EA and that correspond to best practice or the application of best available technology economically achievable.

2. The proponent should develop and implement an Air Quality Management Plan to ensure air quality goals are achieved and a satisfactory amenity is achieved in the neighbourhood. This should include the requirements listed in Schedule 3.

Schedule 3 – Air Quality Management Plan (AQMP)

The AQMP should include the following requirements:

1. Monitoring and management arrangements that:
 - d) Establish a comprehensive monitoring network for TSP, PM₁₀, PM_{2.5} and deposition;
 - e) Ensure the monitoring network has the capacity to apportion the component of emissions from the proponent's surface operations using a combination of dual synchronized monitors and meteorological instruments, supplemented by elemental or chemical methods of source apportionment as appropriate; and
 - f) Establish a predictive management system for high-wind events.
2. The proponent should ensure that there is compliance with an appropriate local equivalent of the PM_{2.5} goal, when this is finalised nationally and at State level, using its licensing mechanism to enforce a Pollution Reduction Program should this be necessary.
3. The Proponent should develop, in conjunction with DECCW, a monitoring system for detecting any adverse short-term amenity impacts resulting from high-wind events.
4. All air quality management measures should be included in the Air Quality Management Plan of the Extraction Management Plan and be incorporated into the Environment Protection Licence issues under the Protection of the Environment Operations Act 1997. The AQMP and Licence conditions (after the first Licence review period) should be comprehensively and periodically reviewed.

12.0 SURFACE FACILITIES WATER MANAGEMENT

12.1. OVERVIEW

The proposal involves two surface facilities:

- The Buttonderry Site located on the western side of Hue Hue Road immediately south of Council's Buttonderry Waste Management Facility. This facility, which will contain an administrative office and amenities for mine workers, will occupy an area of approximately 10 ha within a land holding of about 68 ha. This site will provide facilities for 210 mine workers and 40 office employees.
- The Tooheys Road Site which is bounded by the Sydney-Newcastle Freeway to the west and the Newcastle Motorway Link Road to the south. The company landholding for this site covers about 193 ha which will contain coal stockpile facilities, a rail loop and coal loading facilities. Apart from the rail loop, the active operational area including water holding and pollution control dams is about 33 ha. There will be 50 workers at this site.

Each site is proposed to have a separate integrated water management system that is designed to make the site self sufficient for water after about Year 5 of the mine production – once sufficient groundwater inflow occurs to the mine workings.

A detailed consideration of site water management issues is at Appendix I.

12.2. WATER MANAGEMENT ISSUES

Issues

Essentially, the proposed water management systems at both sites rely on a single main storage at each site (subdivided into three in the case of the Tooheys Road Site). Water from all sources (surface runoff, mine water and excess treated sewage effluent) will be directed into the main storage dam and water will be drawn from this source for all purposes (longwall operations, dust suppression, fire fighting and potable supply). The water management arrangements and the associated water balance analysis raise a number of issues identified in submissions and in the course of this review:

- Over its life, the mine is predicted to produce a net surplus of water. However, during construction and for the first 5 years of operations, additional water will be required. The EA indicates a number of options for supply including treated effluent from a sewage treatment plant at Charmhaven (about 2 km from the site) and potable supply by tanker.
- The proposal includes a modular reverse osmosis (RO) plant (3 units each capable of treating 1 ML/day). Details provided in the EA are limited.

- Notwithstanding the intent to make the sites self sufficient in water, there will be occasions when discharge occurs. There is limited detail in the EA on how this will meet appropriate receiving water quality goals.
- While Porters Creek Wetland is located outside the area that is proposed to be undermined, stormwater discharge from the Buttonderry site and any runoff from the effluent disposal area for the site will drain to Buttonderry Creek which drains to the wetlands. Accordingly, the potential impact of the project on the wetlands is an important consideration.
- Although the main storage dams at each site are claimed to be designed to capture the runoff from a 72 hour, 100 year ARI storm, the effectiveness of these dams in controlling discharge has not been demonstrated.
- The proposed integration of different sources of water into a single system is heavily reliant on sufficient treatment capacity to adequately treat water before it is utilised or discharged. There is significant potential for:
 - Cross contamination into the potable supply from excess treated sewage effluent during wet weather. Excess effluent could be discharged into the storage dams at each site from which the potable supply is taken;
 - Elevated salt levels in the storage dam as a result of discharge of mine water into the main storage dam at the Tooheys Road site. Whilst it is acknowledged that the proposed dam will be divided into three separate cells, there is the potential to discharge some mine water to the environment in wet weather after mixing with stormwater.
- More consideration of the method of disposal of treated sewage effluent or the requirement for storage of effluent in wet weather is needed.
- The water balance analysis is questionable:
 - The analysis only applies to an average rainfall year and the assumed runoff characteristics of the sites are not stated and justified.
 - While it is predicted that the mine will be fully self sufficient for water from the underground workings after Year 5, the situations that might arise during initial construction and the first 5 years of mining have not been adequately assessed.
 - The amount of ground water inflow from mine workings predicted at Year 5 may not be realised.
 - There is a significant discrepancy between the predicted groundwater inflow to the mine in Year 20 as identified in the *Groundwater Assessment* (about 880 ML/year) and that accounted for in the water balance for the Tooheys Road site (475 ML/year).

The Commission is concerned that, while the integrated water management concept is intended to make the mine self sufficient for water in the medium to long term, unintentional consequences are an increased risk of discharge of water of unacceptable quality.

Observations

The Commission's observations on particular aspects of the proposed water management arrangements are at Appendix I. Specific matters reviewed in detail there include:

- Quantity and quality of groundwater inflow to the underground workings;
- The capability of the proposed RO plant to treat water generated by the proposal;
- Problems in disposing of waste brine from the RO plant to the goaf areas of underground mining;
- Uncertainty as whether there will be an eventual surplus or deficit of water from the proposal and how a deficiency or surplus will be managed. A surplus could become an environmental flow with adequate treatment, and a deficit could be made up with sewage effluent from the municipal system treated to a suitable level;
- The possibility of uncontrolled discharges of effluent from the surface sites to surface waters and groundwaters;
- Uncertainties in the design of the stormwater management systems at the Buttonderry and Tooheys Road sites in terms of assessment of rainfall events, the degree of runoff assumed and the sizing of holding capacity to avoid uncontrolled discharges;
- Uncertainties in the treatment systems proposed for sewage and other effluent at both sites and availability of suitable land for disposal or any effluent, including either by irrigation and/or incorporation into the coal product.

12.3. CONCLUSIONS

The Commission concludes that:

- The proposals for managing water on each of the two surface facility sites would have been clearer for assessment purposes had more detail been provided.
- The existing proposals for site water management carry a risk of adverse off-site impacts as a result of uncontrolled discharge of water of an unacceptable quality for the receiving waters. These risks can and should be significantly mitigated by managing the flow and water quality characteristics of each water stream separately.
- Because the indirect potable reuse of treated sewage effluent will raise a significant number of health and regulatory issues, the Commission recommends that separate systems be developed to manage effluent and other waster sources.

12.4. RECOMMENDATIONS

The Commission recommends that:

1. Prior to commencement of construction, separate Surface Facilities Water Management Plans should be prepared for the Buttonderry site and the Tooheys Road site. These plans should be prepared in consultation with DECCW and Wyong Shire Council and should be to the satisfaction of the Director General of the Department of Planning. The plans should specifically address the issues identified in Schedule 6.
2. In consultation with DECCW, appropriate water quality criteria should be developed for each body of receiving water based on procedures for assessing local specific criteria as set out in ANZECC 2000 for the protection of downstream ecosystems. Separate assessments should be prepared for Wallarah Creek and Buttonderry Creek to reflect the different aquatic and riparian conditions of each creek and the ultimate receiving waters (Budgewoi Lake and the Porters Creek Wetlands respectively).

Schedule 6 – Surface Facilities Water Management Plan (SFWMP)

The SFWMP should meet the following requirements:

1. Site specific detailed analysis should be undertaken to demonstrate how the required water quality will be achieved for all site discharge. The analysis should include water balance modelling using daily climate data for a period of at least 25 years.
2. Serious consideration should be given to maintaining separate water management systems for mine water, surface runoff and treated effluent.
3. The water management facilities should be designed and managed so as to achieve uncontrolled discharge with probability of no more than one event in 5 years. The design and supporting analysis to be undertaken to the satisfaction of the Director General of the Department of Planning.
4. Detailed proposals should be prepared for water supply for each site during construction and initial mine operations. These proposals should include anticipated volumes required for sources of different quality (potable, treated sewage effluent and any other) and details of how the water is to be imported to the site (pipeline or tanker). In the case of any proposed pipeline, details of the proposed route should be provided. The water supply proposals should include details of how water would be managed on site in the event of wet or dry years.
5. The SFWMP should include a detailed program for monitoring water quality in the receiving waters upstream and downstream of each site and in any discharge from the site. The plan should include appropriate trigger levels and contingency actions to be taken in the event that discharge water quality fails to meet requirements.
6. Site investigations should be undertaken to characterise area to be used for disposal of effluent from each site in accordance with the DECC guidelines *Environmental Guidelines: Use of Effluent by Irrigation* (2004). The effluent disposal scheme (including method of irrigation and capacity of wet weather storage) should be designed and operated in accordance with the guidelines including measures to control public access. A detailed management, monitoring and contingency management plan should be prepared.

7. Firm proposals should be developed for provision of potable water for staff use including detailed analysis of the volume and reliability of supply available from roof runoff and measures to supplement the supply as necessary.

13.0 TRANSPORT

13.1. ROAD TRAFFIC

The EA states that construction of the Tooheys Road facility would generate 250 return vehicle trips per day (16% rigid and articulated heavy vehicles) over the 16 month construction period. Construction of the Buttonderry Road facility would generate 145 return vehicle trips per day (21% rigid and articulated heavy vehicles) over the 24 month construction period. At Year 10 of the project, the construction of the Western Shaft facility would generate 45 return vehicle trips per day (22% rigid and articulated heavy vehicles). All of these construction-related trips would occur between 5am and 7pm during daylight saving periods and between 6am and 5pm during non-daylight saving periods.

During operation, vehicle trips will be split over three shifts, starting at 7am, 3pm and 11pm. At the Tooheys Road site, the number of return vehicle trips per day generated by these shifts will be 15, 3 and 2 respectively. At the Buttonderry Road site, the shifts will generate 100, 80 and 80 return vehicle trips per day respectively. 20 additional return vehicle trips per day to the Buttonderry Road site will occur for the 9am-5pm administration shift.

The traffic study in the EA concluded that all intersections other than the F3 Freeway/Sparks Road intersection would operate with acceptable levels of performance throughout the life of the project. The study argued that since traffic signals have already been installed at the western end of the F3 Freeway/Sparks Road intersection, no further work is necessary to address this.

Wyang Shire Council raised concerns that the traffic study did not adequately consider the additional traffic from planned residential and commercial precincts in the vicinity of the site. The RTA raised concerns that the F3 Freeway/Sparks Road interchange had been incorrectly treated as a single intersection (it is in fact two separate intersections).

In response to these concerns, the proponent prepared a revised Traffic Impact Study in September 2010. This study indicated that although three intersections in the vicinity of the site will operate with unacceptable performance by 2024, the reduced performance is only attributable to the project for one intersection – the eastern intersection of the F3 Freeway/Sparks Road interchange. The proponent suggests that this intersection should be upgraded to a two-lane roundabout in order to simplify conflicts, reduce vehicle speeds and provide clearer indication of drivers' right of way.

The RTA's independent analysis of this intersection confirmed the reduction in performance as a result of the project. However, the RTA suggested that traffic signals would be the appropriate response and requested a contribution from the proponent to bring forward the upgrade of this intersection to 2012. The Commission agrees with the RTA recommendation.

The proponent proposes to upgrade Brothers Forest Road, Tooheys Road and Hue Hue Road at various points. Although the Commission is satisfied that these upgrades are appropriate,

insufficient detail on these upgrades has been provided in the EA. Therefore, the Commission recommends that detailed upgrade/realignment specifications for these roads be prepared and approved prior to the commencement of construction. The Commission also recommends that the proponent prepare a Road Condition Report, Traffic Management Plan and Workplace Travel Plan as part of its pre-construction activities.

13.2. RAIL TRAFFIC

Up to six (6) return rail trips will be made between the Tooheys Road site and Port of Newcastle each day during the operation of the project. The EA did not address the capacity of the rail network to absorb this additional traffic, but the proponent provided a supplementary rail study in September 2010 in light of additional data provided by RailCorp.

The study demonstrated that up to six return rail trips can be run between the project site and the Port of Newcastle, with significant spare capacity that can be used as a contingency. The Commission considers this to be a reasonable assessment but supports RailCorp's right to review train paths and future infrastructure requirements with the proponent over the life of the project.

The Commission acknowledges that growth in passenger, coal and intermodal rail traffic is likely to occur in the future. Since it is difficult to anticipate the extent of this growth, the Commission recommends that the proponent be required to participate in any future review of the rail corridor's capacity undertaken by Transport NSW, and make an appropriate contribution to the funding of this review and its outcomes.

The Commission also recommends that the proponent meet all installation and maintenance costs associated with the new crossover and turnout with the Main North rail corridor.

13.3. RECOMMENDATIONS

The Commission recommends that:

1. The Proponent should bear all costs associated with the installation and maintenance of the new crossover and turnout with the Main North rail corridor.
2. The Proponent should not transport any coal off site by public road, except during emergencies and with the written approval of the Director-General of the Department of Planning.
3. The Proponent should monitor the amount of coal and coal reject transported from the site each year, and report the results of this monitoring on its website every six months.
4. Prior to the commencement of construction, the Proponent should submit a Road Condition Report to the Director-General of the Department of Planning. The Road Condition Report must include:
 - a) an assessment of the pre-construction condition of all roads used to access the Buttonderry, Tooheys Road and Western Shaft sites,

- b) a program for periodic review of the condition of these roads during construction and operation in consultation with the RTA and Wyong Council, and
 - c) procedures for quantifying the role of the project in any road damage and repairing this damage.
- 5. Prior to the commencement of construction, the proponent should submit a Traffic Management Plan for the project to the Director-General of the Department of Planning. This plan must be prepared in consultation with the RTA and Wyong Council. This Plan must describe the traffic management structures and procedures to be put in place during the delivery of major components and equipment to the project sites, the closure or partial closure of roads, and the construction of the rail spur crossings over Tooheys Road.
- 6. Prior to the commencement of construction, the Proponent provide evidence of an agreement with the RTA regarding a contribution to the upgrade of the eastern intersection of the Sparks Road/F3 Freeway interchange. This must include evidence of the RTA's satisfaction with the terms of the agreement.
- 7. If Transport NSW undertakes a review of the Main North rail corridor's capacity at any stage during the construction and operation of the project, the Proponent:
 - a) make an appropriate contribution to the funding of this review,
 - b) participate in this review, and
 - c) implement the recommendations of this review to the satisfaction of the Director-General.

14.0 VISUAL

The Commission considers the potential for adverse visual impact from the Buttonderry site to be low. The site is surrounded by vegetation which screens the site from rural properties to the west and south of the site. A natural rise along the southern boundary also reduces the visibility of the site from these properties. The site can be viewed sporadically by travellers along Hue Hue Road, however this visibility will be reduced by the proposed landscaping and earthworks.

Furthermore, the design of the administrative building is consistent with the adjacent waste management facility and the light industrial uses proposed for the adjacent Wyong Employment Zone land. The Commission recommends that the proposed landscaping be formalised through a Landscape Management Plan prior to the commencement of construction.

The Tooheys Road site has greater potential for visual impact because it is the main operational site for the project. Site facilities will include two coal stockpiles, conveyors, rail loaders and rail bridges. The most visually prominent structures on the site will be the coal stockpiles and associated conveyors.

It is likely that the Tooheys Road site will be visible from the tallest buildings (up to 21 metres high) in the Warnervale Town Centre. However, the Town Centre is over three kilometres from the site, and the Commission believes that the distance separating these buildings from the site will ameliorate its visual impact.

Some residences along Bushells Ridge Road have a direct line of sight to the Tooheys Road site are less than three kilometres from the site. The landscaping proposed by the proponent will eventually screen the site from these residences and users of the F3 Freeway. However, whilst this landscaping is being established, some recourse for these property owners is appropriate. The Commission recommends that the proponent be required to provide additional landscaping measures on request from residents with direct line of the sight within 2 kilometres of the site.

To ensure that the coal stockpiles do not cause unacceptable visual impacts, it is recommended that their volume be limited to 250000 t (product stockpile) and 50000 t (raw coal stockpile). The proponent may be permitted to exceed these limits in an emergency or if it can be demonstrated to the satisfaction of the Director-General that the additional screening provided by the proposed landscaping has taken effect.

The Western Shaft will be located within Wyong State Forest and will require minimal above ground structures. No specific conditions addressing the visual impact of the Western Shaft are recommended. The project sites will not have an adverse cumulative visual impact, as they are separated spatially and visually by a number of other land uses.

14.1. RECOMMENDATIONS

The Commission recommends:

1. Prior to the commencement of construction, the proponent shall submit a Landscape Management Plan to the Director-General of the Department of Planning. The Landscape Management Plan does not apply to any areas that form part of the project's offset strategy, which must be managed separately. The Landscape Management Plan must include:
 - a) detailed plans and plant species schedules for landscaping at the Tooheys Road and Buttonderry sites,
 - b) a program for the monitoring and ongoing maintenance of landscaping for the life of the project.
2. Upon receiving a written request from an owner of privately-owned land with direct views to the Tooheys Road site from a residence within two (2) kilometres of the Tooheys Road site, the proponent shall implement reasonable and feasible additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, and to the satisfaction of the Director-General of the Department of Planning.

If, within 3 months of receiving this request, the proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General of the Department of Planning for resolution.
3. The Proponent shall minimise light spill and the off-site lighting impacts of surface works and ensure that all external lighting associated with the project complies with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting.

15.0 SOCIO-ECONOMIC

The proponent states that the construction of the project would cost \$613.5 million and operational expenditure would average \$130.8 million per year. The project would employ at least 800 workers during construction and 300 workers during operation.

The Commission believes that the socio-economic benefits of this expenditure and employment have been somewhat overstated in the Environmental Assessment. The Commission also agrees with several submissions that the socio-economic costs associated with the environmental impact of the project have been somewhat understated.

However, the socio-economic benefits of the project are large enough that these inaccuracies do not affect the overall socio-economic outcome. Without the inclusion of the social benefits of employment, the net benefit of the project as indicated by the Gillespie Economics analysis in the EA is \$854m. The implication is that the externalities omitted from or undervalued by that analysis would need to be in excess of \$854m for the overall finding of the economic assessment to be reversed. A review of the water and ecology chapters of the EA and with reference to environmental valuation studies performed for similar cases in NSW indicates that this is highly unlikely.

The internal net benefits from mining are large in comparison to the likely externalities of the project. Hence, their explicit inclusion in the cost-benefit analysis is unlikely to effect the overall conclusion that the mine will provide an improvement in the well-being of the population. Their exclusion from the analysis provides little risk to the validity of that decision.

15.1. COMMUNITY ENHANCEMENT PLAN (CEP)

The majority of the socio-economic benefits of the proposal will be felt at the regional scale, whereas the majority of the socio-economic costs will be felt at a local scale. Although some aspects of these costs have been addressed by the Commission's other recommendations, the Commission supports the proponent's proposal for a Community Enhancement Program (CEP) to ensure that local residents also derive direct socio-economic benefits from the project.

It has been suggested that the CEP include four elements: a community trust to establish and manage community projects; local environment and biodiversity management projects; work-ready training initiatives; and contributions to community infrastructure identified in Wyong Council's Management Plan. The Commission believes that these suggestions are appropriate, but recommends that final details of the contributions be negotiated with the Director-General of the Department of Planning.

In order to ensure that the CEP is implemented, the Commission believes that it should be enshrined in the conditions of approval. This can occur either as a direct condition requiring

the preparation of a detailed CEP prior to the commencement of construction, or as a condition requiring the proponent to enter into a Voluntary Planning Agreement.

The proponent proposes to implement the CEP through a Voluntary Planning Agreement, however few details have been provided in the Environmental Assessment regarding the timing, funding and procedures for the CEP. This is problematic for the Minister because section 93I of the *Environmental Planning and Assessment Act 1979* only allows the Minister to require a planning agreement to be entered into as a condition of consent, if that agreement is in the terms of an offer made by the developer. At present, the developer has not made an offer that contains enough detail to satisfy the Commission that the CEP will properly compensate neighbours for the impact of the project.

Rather than require a CEP through a VPA, any approval should require the preparation of a CEP prior to the commencement of construction. What is being sought is some mitigation of the impacts of the project on its immediate neighbours rather than the cost of regional infrastructure upgrades that are required as a result of the project. The CEP should identify directly affected landowners that will be consulted on the terms of the CEP, and provide evidence of their involvement. It should identify specific initiatives that will be funded through the CEP, their timing and cost, and procedures for reviewing the CEP.

The Commission believes that the socio-economic impact of the project is acceptable provided that the conditions recommended in this report are imposed. These conditions will reduce the impact of the project on socially-valued elements (such as ecology, air, water, visual amenity and heritage) and thus its social cost.

15.2. RECOMMENDATIONS

The Commission recommends that any approval conditions require that:

1. Prior to the commencement of construction, the Proponent shall submit a Community Enhancement Program (CEP) to the Director-General to fund (or provide in kind) community infrastructure and services in the locality of the project. The CEP must:
 - a) identify directly affected landowners that will be consulted on the terms of the CEP
 - b) be prepared in consultation with those directly affected landowners and Wyong Council, and provide evidence of their involvement
 - c) identify specific initiatives that will be funded by the proponent, and the timing and costs for those initiatives, and
 - d) detail procedures for the review of the CEP throughout the life of the project.
2. Any approval should make provision for the establishment of a Community Consultative Committee.

16.0 RISK ASSESSMENT

The EA reports that the risk assessment process commenced at the project inception in 1966, with the latest risk assessment carried out in October 2009 including the final Environmental Assessment Requirements (EARs) issued by the Director-General of the Department of Planning. It also reports that there have been more than 12 separate mine plans and numerous additional variations during project planning, with several revisions being the result of environmental investigations.⁶⁸ The EA goes on to state that:

*Given that the risk assessment process has been ongoing for 13 years, many of the issues have already been resolved. Mitigation strategies in all areas are well advanced. This enables the risk assessments to be continually reviewed and modified accordingly.*⁶⁹

This is consistent with the submission of UMFA (2010) that:

*The benefits of adjusting the mine plan was to eliminate flood impacts from almost all of Yarramalong Valley and to reduce the risk of changes to the alignment of Little Jilliby Jilliby Creek as well as overall impacts in the Dooralong Valley and Hue Hue Creek.*⁷⁰

The Commission accepts that progressive modifications to the mine over the past 13 years, illustrated in Figure 2.2, have been an important component of risk management. However, it considers that there are deficiencies in the process, a number of which have been identified in submissions.

ACA (2010) has noted the Director-General's Requirements include *a comprehensive risk assessment of the potential environmental impacts of the project, identifying key issues for further assessment*. It has submitted that:

*W2CP modelling has failed to demonstrate any evidence of comprehensive risk assessment of key issues – the overall impacts from physical subsidence damage to unconfined and coal seam aquifers, shallow groundwater aquifers, depressurisation and associated water regimes, high conductivity of water flow, fugitive drainage and connectivity flow.....*⁷¹

Mr Wayne McCauley submitted that:

⁶⁸ EA, pES-7.

⁶⁹ EA, p5-4.

⁷⁰ UMFA (2010), p22.

⁷¹ ACA (2010), p8.

*AS 4360 recommends that representatives of all stakeholders be involved in the risk assessment process, this has not been done and thus the risk assessment should be rejected.*⁷²

During its public submission to the Commission, the Total Environment Centre submitted a report prepared on its behalf by the Institute for Sustainable Futures at the University of Technology Sydney. This report is also critical of the level of stakeholder engagement in the Wallarah 2 risk assessment process and the degree to which it accords with Australian Standard *AS/NZS 4360:2004 – Risk Management – Principles and Guidelines*.

The Commission considers that these points have merit. Although in response to other public submissions⁷³, the proponent maintains that the risk assessment was undertaken in accordance with *AS/NZS 4360:2004*, the Commission does not fully concur.

Wyong Shire Council submitted via a report it commissioned from Earth Systems that:

*The Proponent's risk assessment appears to be based on the results of the EA, and some important risks have been discounted in light of the findings of the EA.*⁷⁴

The Commission also considers that this point has merit.

The Commission has reservations concerning the following statements in the EA:

- *The assessment of impacts has been undertaken within a transparent risk assessment framework which provides confidence that all potential impacts have been identified and have been pro-actively managed and resolved.*⁷⁵
- *For the W2CP Project, the current risk assessments have not resulted in any high scores because control measures have been incorporated in to the design of the project.*⁷⁶

AS/NZS 4360:2004 was superseded in November 2009 by *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines* although the two standards are virtually the same in respect of how risk assessment should be undertaken. *NSW Mining Design Guidelines MDG1010 Risk Management Handbook for the Mining Industry* and *MDG1014 Guide to Reviewing a Risk Assessment of Mine Equipment and Operations*, both published in 1997, present complementary information on risk management. A basic premise of both standards is that a risk assessment team should be comprised of a team with appropriately varied and relevant experience for risk identification. *MDG1014* cautions against unwarranted optimism, stating:

⁷² Submission of Mr Wayne McCauley, responded to in WACJV (2010b), p2-66.

⁷³ WACJV (2010b), p2-71 and p2-73.

⁷⁴ WSC (2010), Attachment 1, p95.

⁷⁵ EA, pES-2.

⁷⁶ EA, p5-6.

There is a tendency for a risk analyst to view optimistically either the safeguards which exist or proposed by the operating organisation, or proposed as a result of the risk study identifying a need for improvement of safety.

This is an insidious trap which can catch not only members of the organisation itself but also “independent” consultants. A consultant who works closely with the client (as is very desirable) finds himself or herself unconsciously becoming a member of the clients “team”, and viewing the proposals through the client’s eyes. Further, no consultant wants to admit to a client an inability to define adequate safeguards. (It is necessary for a risk consultant to ask himself or herself frequently “Is this a balanced view, looked at from the outside?”).

Against this background, the Commission is concerned that the risk assessment team for the W2CP EA was comprised only of those company representatives and consultants engaged in compiling the EA. The team did not include any external stakeholders or specialists. Hence, the team effectively assessed its own scenarios, which could account for why *the current risk assessments have not resulted in any high scores because control measures have been incorporated in to the design of the project.*

The Commission notes that the Wyong Strategic Review placed the onus on *relevant government agencies in consultation with affected mining companies, representative bodies and the community* to develop and implement a rigorous, standardized risk assessment process. Nevertheless, it considers that a more robust risk assessment process on the part of the proponent was warranted and is likely to have identified and addressed many of the issues and uncertainties identified by the Commission. This deficiency has had to be addressed through the Commission assessment process and recommended conditions of approval should the Wallarah 2 proposal be approved.

Conclusions

The Commission concludes that:

- The risk assessment of the EA undertaken by the proponent is deficient in respect of the Australian Standard for risk management and would have benefited from engagement with a broader range of stakeholders and technical specialists.
- Deficiencies in the risk assessment process have been adequately addressed for current purposes through the Commission process by means of submissions and the Commission seeking additional information from the proponent, undertaking its own assessments and framing recommended conditions of approval should the proposal be approved by government.
- Risk assessment needs to form part of the Extraction Plan process for this project.
- The need identified in the Wyong Strategic Review for government to develop and implement a rigorous, standardized risk assessment process for EAs is outstanding and warranted.

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