Mining & Petroleum Gateway Panel

Report by the Mining & Petroleum Gateway Panel to accompany a Conditional Gateway Certificate for the Caroona Coal Project

July 7th 2014

Contact

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Executive Summary

The Mining & Petroleum Gateway Panel (the Gateway Panel) has determined an Application for a Gateway Certificate by Coal Mines Australia Pty Ltd (the Applicant) for its proposed Caroona Coal Project in the New England Northwest region of New South Wales. The Gateway Panel finds that the Application does not meet all of the Relevant Criteria and consequently issues the Applicant with a Conditional Gateway Certificate. This report provides both the opinions and the reasoning of the Panel.

The Caroona Coal Project proposes an underground coal mine within an 11,863 ha Project Boundary Area (PAA) that incorporates 2,215 ha protocol-verified Biophysical Strategic Agricultural Land (BSAL) as determined by the Applicant. A further 459 ha of NSW Government-mapped BSAL has also been identified in the project area but it has not been protocol-verified as the Applicant has been unable to access the land. The Applicant states that 30 ha of verified BSAL will be used for temporary infrastructure associated with ventilation and gas drainage.

Proposed underground longwall mining within the Project Area is predicted to result in subsidence of 8,500 ha of the PAA and cause direct subsidence impacts to 2103 ha of applicant-verified BSAL. The direct impacts resulting from subsidence associated with the longwall coal mining are predicted to include surface cracking of ten to 100mm (with isolated cracks to 300mm) and depressions in the land surface ranging from 1,600 to 3,100 mm.

Subsidence impacts on the agricultural productivity of the soil will range from changes to soil water drainage, increased surface water ponding and potential inundation of subsoil layers with associated physical and chemical degradation issues. Mining induced land surface changes will result in localised, short-term disruptions to land use practices, infrastructure and access, and may produce impediments to long term agricultural practices.

The lack of site-specific data and analysis of the likely behaviour of the surface overlying the long wall panels provided by the Applicant is a hindrance to the Panel's assessment and level of certainty with respect to mining impacts related on BSAL within and adjoining the PAA.

It is recommended that in future evaluation of the impacts of subsidence, the applicant apply a diligent approach to the assessment of existing site conditions, and that this be compared to all predicted impacts of subsidence on the landsurface, rural activities and infrastructure, for the short term as well as the Project life and beyond.

With respect to 'highly productive' aquifers it has been predicted by the applicant that 27 private bores located in the Gunnedah – Oxley Basin MDB (Spring Ridge) groundwater source will have impacts greater than minimal harm (2m). Of concern to the Panel is the potential cumulative impact on the 'highly productive' Upper Namoi alluvial aquifer (Gunnedah Formation). The preliminary groundwater modelling results show the predicted impacts to be less than the minimal harm criteria in the NSW Aquifer Impact Policy. The Panel requires that more site studies and detailed modelling be carried out to improve the certainty of any predictions. The current level of work is not sufficient for the Panel to be confident in the predictions.

With regard to verified BSAL, it is the opinion of the Gateway Panel that:

- Verification of the extent of BSAL within the PAA is incomplete. Further soil sampling and reassessment of initial soil sampling results is required.

- The Project would have direct and significant impacts on the agricultural productivity of verified BSAL within the PAA. The impacts on BSAL may be in localised areas but the information available on the site-specific changes in land surface, soil water movement and subsoil inundation is not sufficiently detailed to be exact about the specific areas that will be affected.
- The Project would have significant indirect impacts on groundwater levels. Some impacts upon groundwater will extend beyond the mine life of 30 years.
- Indirect impacts on potential BSAL adjacent to the PAA are considered to be potentially significant based upon information contained in the application.

With regard to Critical Industry Clusters (CIC):

- There are no CICs designated in the New England North West Strategic Land Use Plan.

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1 Purpose and Methodology

In accordance with the *Section 17H(2)(b), Part 4AA Mining and Petroleum Development on Strategic Agricultural Land, State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (the Mining SEPP), this report states the Mining & Petroleum Gateway Panel's (the Gateway Panel) reasons for the opinions expressed in the Gateway Certificate issued on this day to the Caroona Coal Project.

1.1 Terms of Reference

The Mining SEPP provides the Gateway Panel's Terms of Reference.

The Gateway Panel must determine an Application and issue a Gateway Certificate in accordance with *Section 17H* of the Mining SEPP.

Section 17H(4) provides the following *relevant criteria* for the Gateway Panel's determination and recommendations.

> *(a) in relation to biophysical strategic agricultural land- that the proposed development will not significantly reduce the agricultural productivity of any biophysical strategic agricultural land, based on a consideration of the following:*
>
> > *(i) any impacts on the land through surface area disturbance and subsidence,*
> >
> > *(ii) any impacts on soil fertility, effective rooting depth or soil drainage,*
> >
> > *(iii) increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH,*
> >
> > *(iv) any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy),*
> >
> > *(v) any fragmentation of agricultural land uses,*
> >
> > *(vi) any reduction in the area of biophysical strategic agricultural land,*
>
> *(b) in relation to critical industry cluster land-that the proposed development will not have a significant impact on the relevant critical industry based on a consideration of the following:*
>
> > *(i) any impacts on the land through surface area disturbance and subsidence,*
> >
> > *(ii) reduced access to, or impacts on, water resources and agricultural resources,*
> >
> > *(iii) reduced access to support services and infrastructure,*
> >
> > *(iv) reduced access to transport routes,*
> >
> > *(v) the loss of scenic and landscape values.*

Section 17H(5) states that in *forming an opinion as to whether a proposed development meets the relevant criteria, the Gateway Panel is to have regard to:*

(a) the duration of any impact referred to in subclause (4), and

(b) any proposed avoidance, mitigation, offset or rehabilitation measures in respect of any such impact.

1.2 Methodology

1.2.1 The Gateway Panel

The Gateway Panel that evaluated this Gateway Application is as follows.

Associate Professor Brett Whelan, Chairperson – agricultural discipline;
Dr Ian Lavering – mining discipline; and,
Mr George Gates – hydrogeology discipline.

1.2.2 Gateway Panel meetings

The Gateway Panel has held the following meetings in relation to this Application.

- On 19th May 2014 in Sydney, to consider the information included in the application
- On 24th June 2014 in Sydney, following receipt of Referring Agency advice.

1.2.3 Meetings with the applicant or third parties

The Gateway Panel did not hold any formal or information discussions in relation to this Gateway Application with either the Applicant or any stakeholder who may have an interest in this Project.

1.2.4 Referrals

In accordance with Section 17G of the Mining SEPP, this Gateway Application was referred to the Commonwealth Independent Expert Scientific Committee (IESC) and the NSW Minister for Primary Industries.

On 15 May 2014, the Gateway Panel received advice from the Commonwealth Independent Expert Scientific Committee (IESC, 2014). The Gateway Panel received advice from the Minister for Natural Resources, Lands and Water on 17 June 2014.

1.2.5 Document review

The Gateway Panel has reviewed the following documentation provided by the applicant as their initial submission for the panel to assess.

Australian Groundwater & Environmental Consultants Pty Ltd, 2014. *Caroona Coal Project Study Plan, Project No G1634*.

Coal Mines Australia Pty Ltd (CMAL), 2014. *Caroona Coal Project Application for Gateway Certificate – Technical Overview.*

Caroona Local Newspaper Advertisements, (11Feb2014). *PDF as provided in the applicant's initial submission.*

Gateway Schedule of Lands, *PDF as provided in the applicant's initial submission*.

HydroSimulations, 2014. *Caroona Coal Project Gateway Application – Appendix C, Preliminary Groundwater Assessment,* 140p

La Tierra, 2014a. *Caroona Coal Project Application for Gateway Certificate, Agricultural Impact Assessment*, 87p.

La Tierra, 2014b. *Caroona Coal Project Application for Gateway Certificate Agricultural Impact Assessment, Appendix A*, 70p

McKenzie Soil Management Pty Ltd (MSM), 2014a. *Caroona Coal Project Gateway Application – Appendix B, Agricultural Resource Assessment*, 48p

McKenzie Soil Management Pty Ltd (MSM), 2014b. *Caroona Coal Project Gateway Application – Appendix B, Agricultural Resource Assessment, (Appendices 1-10)*

McKenzie Soil Management Pty Ltd (MSM), 2014c. *Caroona Coal Project Gateway Application – Appendix B, Agricultural Resource Assessment, (Attachments A to E).*

McKenzie Soil Management Pty Ltd (MSM), 2014d. *Caroona Coal Project Gateway Application – Appendix B, Agricultural Resource Assessment, (Maps 1-14).*

Mine Subsidence Engineering Consultants (MSEC), 2014a. *Caroona Coal Project Gateway Application – Appendix D, Subsidence Predictions and Impact Assessment*, pp 0-57 & App. A-C

Mine Subsidence Engineering Consultants (MSEC), 2014b. *Caroona Coal Project Gateway Application – Appendix D, Subsidence Predictions and Impact Assessment*, Appx D, Drawings Part 1.

Mine Subsidence Engineering Consultants (MSEC), 2014c. *Caroona Coal Project Gateway Application – Appendix D, Subsidence Predictions and Impact Assessment*, Appx D, Drawings Part 2.

Mine Subsidence Engineering Consultants (MSEC), 2014d. *Caroona Coal Project Gateway Application – Appendix D, Subsidence Predictions and Impact Assessment*, Appx D, Drawings Part 3.

Mine Subsidence Engineering Consultants (MSEC), 2014e. *Caroona Coal Project Gateway Application – Appendix D, Subsidence Predictions and Impact Assessment*, Appx D, Drawings Part 4.

The Gateway Panel has also reviewed the following Referral Agency advice relevant to this Application.

IESC, 2014. *Advice to the decision maker on coal mining project, ISEC 2014-047: Caroona Coal Project – new development.* Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, Department of Environment, Canberra, 14 May 2014.

Minister for Natural Resources, Lands and Water, 2014. *Including covering letter; Attachment A: Advice on the Gateway application: Caroona Coal Project; Technical assessment by the NSW Office of Water for the Minister for the Natural Resources, Lands and Water*, 17 June 2014.

The Gateway Panel has reviewed the following publications relevant to Gateway Applications.

DP&I, 2012a. *New England North West Strategic Land Use Plan.* State of New South Wales through the Department of Planning & Infrastructure, September 2012.

DP&I, 2013 *Strategic Regional Land Use Policy, Guideline for Gateway Applicants, Fact Sheet, (the Guideline).* State of New South Wales through the Department of Planning & Infrastructure, September 2013.

DPI, 2013 *Agricultural Impact Statement technical notes: A companion to the Agricultural Impact Statement guideline.* State of New South Wales through the Department of Primary Industries, April 2013.

NSW Government, 2007 *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007, Part 4AA Mining and Petroleum Development on Strategic Agricultural Land (the Mining SEPP)*. NSW Legislation, State of New South Wales, 2007.

OEH and OAS&FS, 2013. *Interim protocol for site verification and mapping of biophysical strategic agricultural land (BSAL).* State of New South Wales through the Office of Environment & Heritage and the Office of Agricultural Sustainability & Food Security.

With specific regard to its assessment of BSAL verification and potential mining and groundwater-related impacts, the Gateway Panel has, through its own enquiry, also considered the following publications.

Barnett B, Townley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A and Boronkay A, 2012. *Australian groundwater modeling guidelines*, National Water Commission report, June 2012.

DTIRIS, 2012. *NSW Aquifer Interference Policy, NSW Government policy for the licensing and assessment of aquifer interference activities.* Department of Primary Industries, NSW Office of Water (NOW), State of New South Wales through Department of Trade and Investment, Regional Infrastructure and Services.

Isbell R., (2002). *The Australian Soil Classification*, Revised Edition CSIRO, Melbourne.

Lechner, AM, Baumgartl T, Matthew P and Glenn V, (2014). *The impact of underground longwall mining on prime agricultural land: a review and research agenda*, Land Degrad. Develop., doi: 10.1002/ldr.2303.

McNally G. and Evans R., 2007. *Impacts of Longwall Mining on Surface Water and Groundwater, Southern Coalfields, NSW.* Report by eWater CRC for NSW Department of Environment and Climate Change.

National Committee on Soil and Terrain (NCST), 2009. *Australian Soil and Land Survey Field Handbook* Third Edition. CSIRO Publishing, Collingwood.

NSW Government, 2006. *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2006.* NSW Legislation, State of New South Wales, 2006.

Pineda, J. A. and Sheng, Daichao, 2013. *Subsidence : An Overview of Causes, Risks and Future Developments for Coal Seam Gas Production*. *Report Submitted to The Office of the NSW Chief Scientist and Engineer* As *Part of the Review of Coal Seam Gas Activities in NSW.* ARC Centre of Excellence for Geotechnical Science and Engineering, The University of Newcastle Australia, 31 July 2013.

1.2.6 Field inspection

The Gateway Panel did not conduct a field inspection for the assessment of this Gateway Application.

2 The Proposed Project

Coal Mines Australia Pty Ltd (CMAL), a subsidiary of BHP Billiton, is the proponent for the Caroona Coal Project (the Project) within Exploration Licence (EL) 6505. The EL is located in the Gunnedah Basin of New South Wales (NSW), approximately 14 kilometres north-west of the township of Quirindi (Figure 1). The Project proposed by CMAL is an underground mine which will involve longwall mining of coal and other associated mining activities.

The proponent of the Project is required to make a Gateway Application because:

- The Project is a proposed development specified in Clause 5 (Mining) of Schedule 1 to State Environmental Planning Policy (State and Regional Development) 2011 that a mining lease under the Mining Act 1992 is required to be issued to enable the development to be carried out because there is no current mining lease in relation to the proposed development; and,
- The proposed development is on land shown on the Strategic Agricultural Land (SAL) Map in the Mining SEPP to be Strategic Agricultural Land (SAL).

The Project is located on land subject to the New England and North West Strategic Regional Land Use Plan (DP&I, 2012a). Of the 34,400 hectares (ha) covered by EL6505, 11,863 ha have been submitted by the proponent as the Project Assessment Area (PAA) (La Tierra, 2014a).

The extent of EL6505, the PAA, the indicative underground mining layout and surface infrastructure placement is shown in Figure 2. The Project involves longwall mining in the Hoskissons Seam on Doona Ridge and Nicholas Ridge (Figure 2) with production of approximately 260 million tonnes (Mt) of run-of-mine (ROM) coal over the mine life of approximately 30 years. Within the Project underground mining area, the Hoskissons Seam has a thickness of between 8 to 16 metres (m) and a depth of cover of between 130 and 710 m (MSEC, 2014a). The mining operation will include the underground cutting of a total of 67 separate longwall panels (Figure 2) from the basal section of the seam. The panel heights will vary from 2.5 m (in designated subsidence controlled zones) to 4.5 m.

Other notable elements of the proposed project are as follows:

- production of up to approximately 10 million tonnes per annum (Mtpa) of saleable thermal coal;
- development and operation of a pit top mine infrastructure area, coal stockpile areas, coal handling infrastructure, bunded hydrocarbon tanks, associated infrastructure and access road on Doona Ridge;
- construction and operation of an event coal preparation plant (CPP) (up to 1 Mtpa ROM coal capacity) on Doona Ridge for washing of occasional high-ash ROM coal;
- construction and operation of a coal unloading facility on Doona Ridge to allow transportation of Nicholas Ridge ROM coal to Doona Ridge via rail for washing;
- co-disposal of fine and coarse rejects in an emplacement on Doona Ridge;
- development and operation of a separate infrastructure area comprising coal handling and stockpiles, administration and associated linear infrastructure on Nicholas Ridge;
- construction and operation of separate rail loops and spurs to connect to the Binnaway-Werris Creek Railway;

- emplacement of overburden, as well as infrastructure including such items as sumps, pumps, pipelines, water storages and other water management equipment and structures;
- ventilation surface infrastructure and gas drainage infrastructure - water and gas pipelines to connect the two infrastructure areas, the Doona and Nicholas Ridge areas;
- ongoing exploration activities within EL6505;
- ongoing surface monitoring and rehabilitation (including rehabilitation of mine related infrastructure areas and remediation of subsidence effects; and
- The construction and operation of facilities to support underground mining operations including (at least) personnel access to the underground mining area, ventilation facilities, workshop, offices and employee amenities, water and gas management facilities.

The Project would consist of two distinct mine construction phases, one initial phase commencing in Year 1 of the Project focused on Doona Ridge and taking approximately 3 years and a second phase in approximately Year 15 of the Project focused on Nicholas Ridge, with a duration of approximately 18 months.

Pre-mining gas extraction would be required by either vertical gas-drainage wells directly from the surface to the coal seam or via underground cross panel drilling and drainage of the gas through an underground collection system to infrastructure on the surface. Post-mining gas extraction would be undertaken by either vertical wells directly connecting the goaf to the surface or via underground drilling methods into the goaf.

The land within the PAA is primarily used for agricultural and rural residential purposes. The types of agricultural industries within and surrounding the PAA include beef cattle production and a mix of dryland and irrigated cropping (La Tierra, 2014a). A 23,500 head capacity, 1,390 ha cattle feedlot (Caroona Feedlot) is located to the south – west of the Doona State Forest within the PAA.

The Mining SEPP (New England and North West Region, Strategic Agricultural Land Map-Sheet STA_009) identifies a significant proportion of the land in EL6505 as potential Biophysical Strategic Agricultural Land (BSAL). An area of 3,423 ha is identified as potential BSAL within the PAA (Figure 3). Mackenzie Soil Management (MSM, 2104a-d) has provided the proponent with an Agricultural Resource Assessment report verifying the presence of 2,215 ha of BSAL within the PAA (Figure 4).

No equine or viticulture enterprises are located within the PAA or the surrounding locality.

Extraction of coal by longwall mining methods results in the vertical and horizontal movement of the land surface (subsidence impacts). Of the verified 2.215 ha BSAL, approximately 2,103 ha of BSAL (to the 20mm predicted subsidence contour) is predicted to experience subsidence impacts as a result of the Project (MSEC, 2014a). According to the proponent, subsidence control zones (SCZ) have been included in the pre-mine plan to minimize subsidence in the BSAL (MSEC, 2014a).

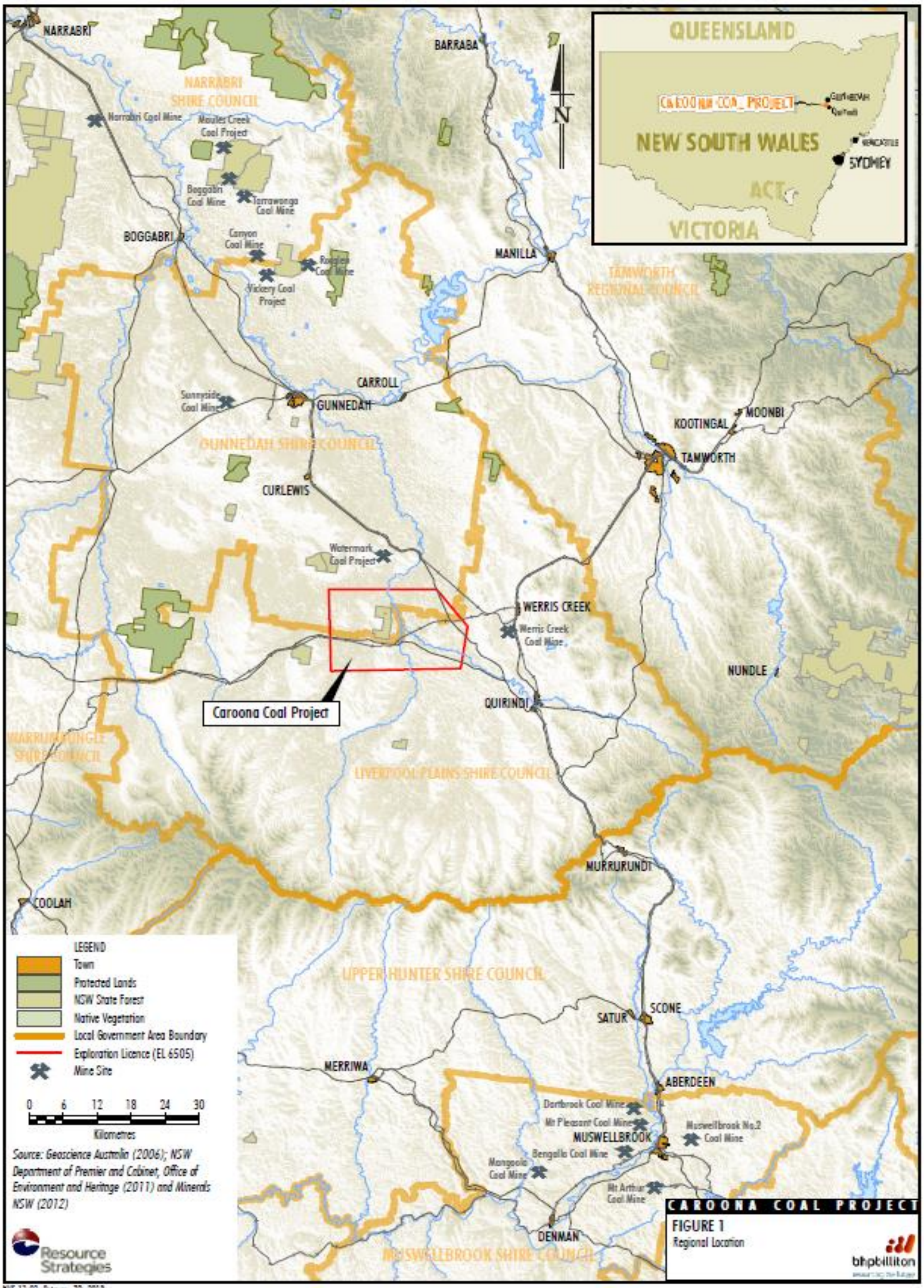

Figure 1. Project location within the region (CMAL, 2014).

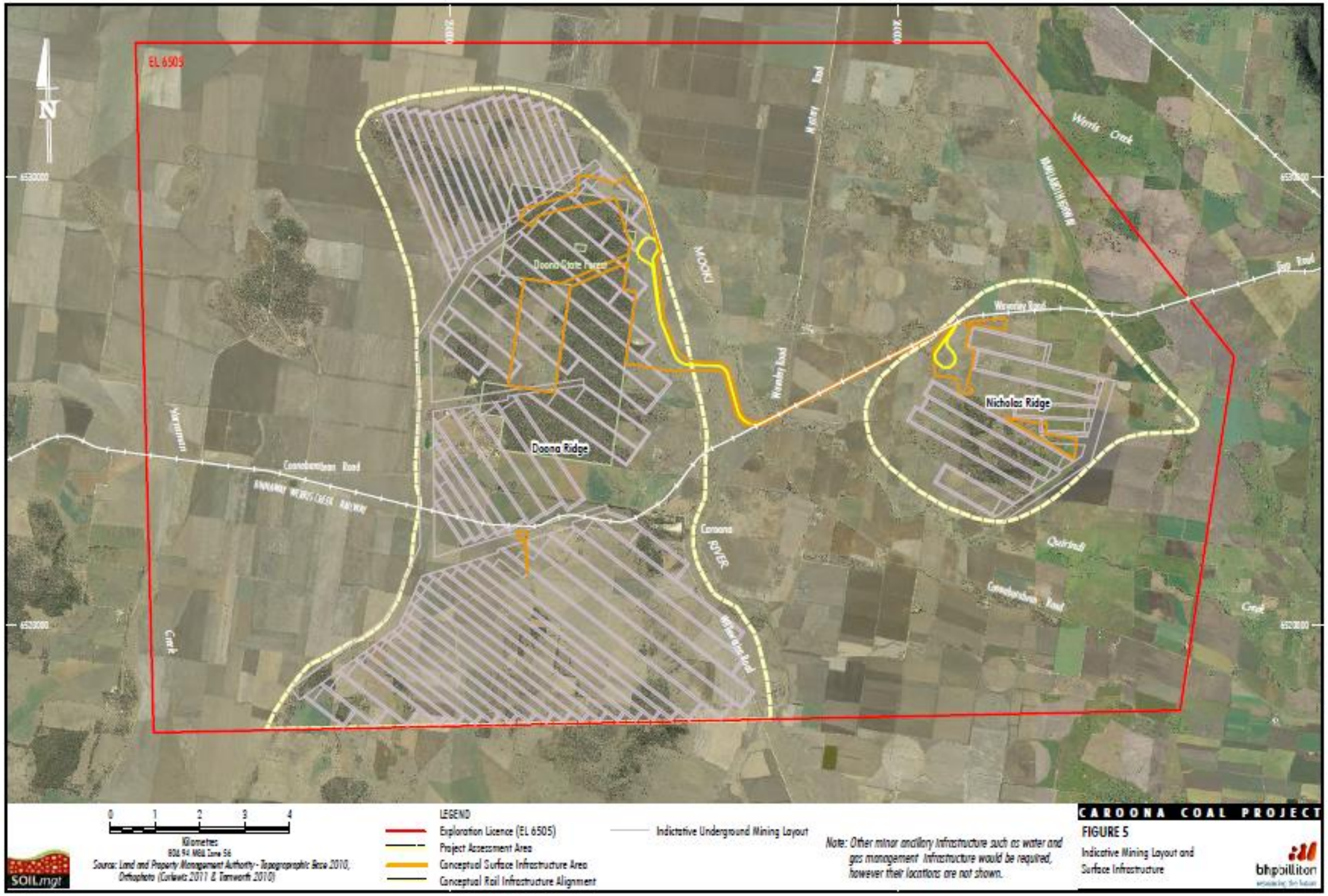

Figure 2. The extent of EL6505, the PAA, the indicative underground mining layout and the surface infrastructure placement (MSM, 2014a)

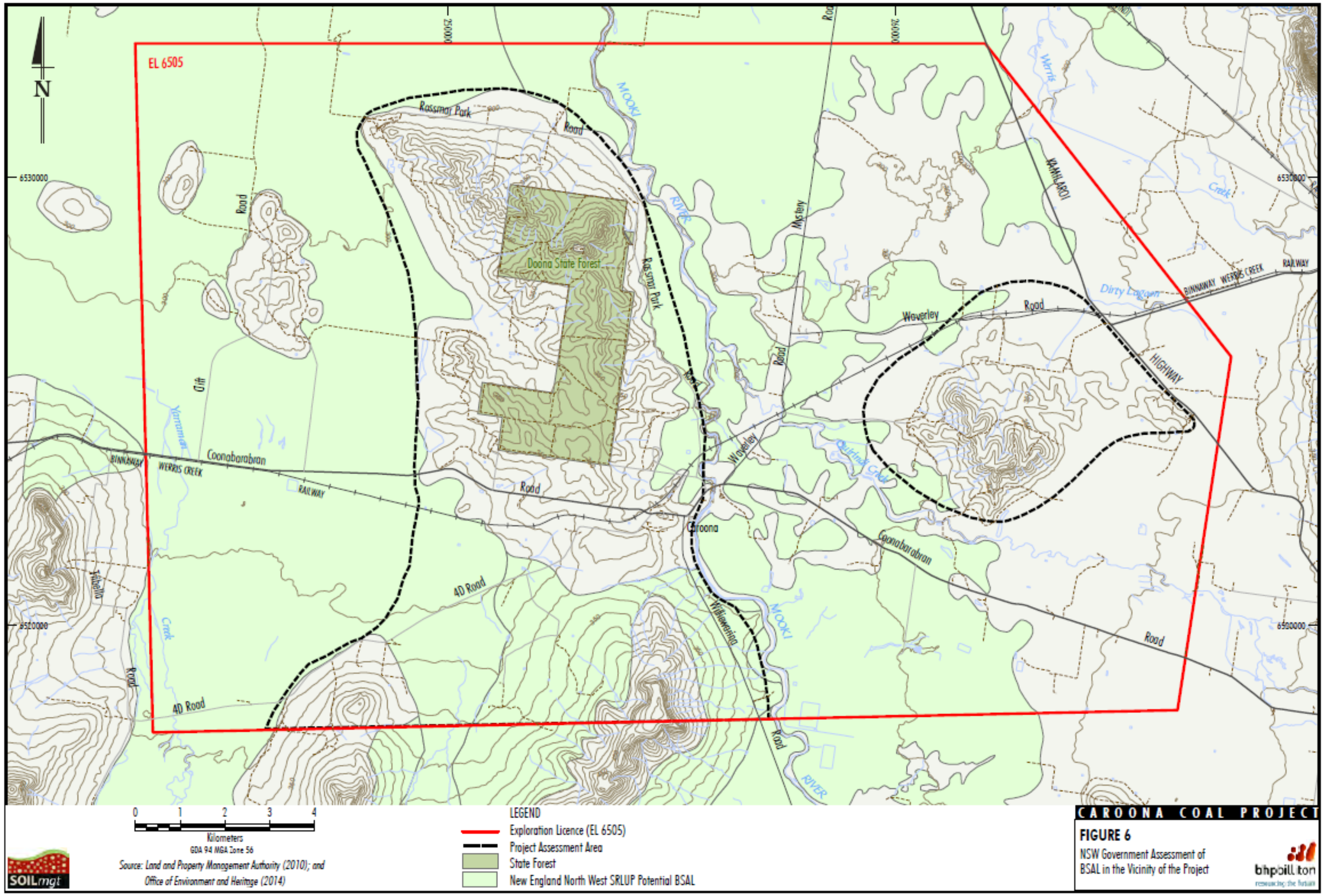

Figure 3. Location of potential BSAL in and surrounding the PAA (MSM, 2014a)

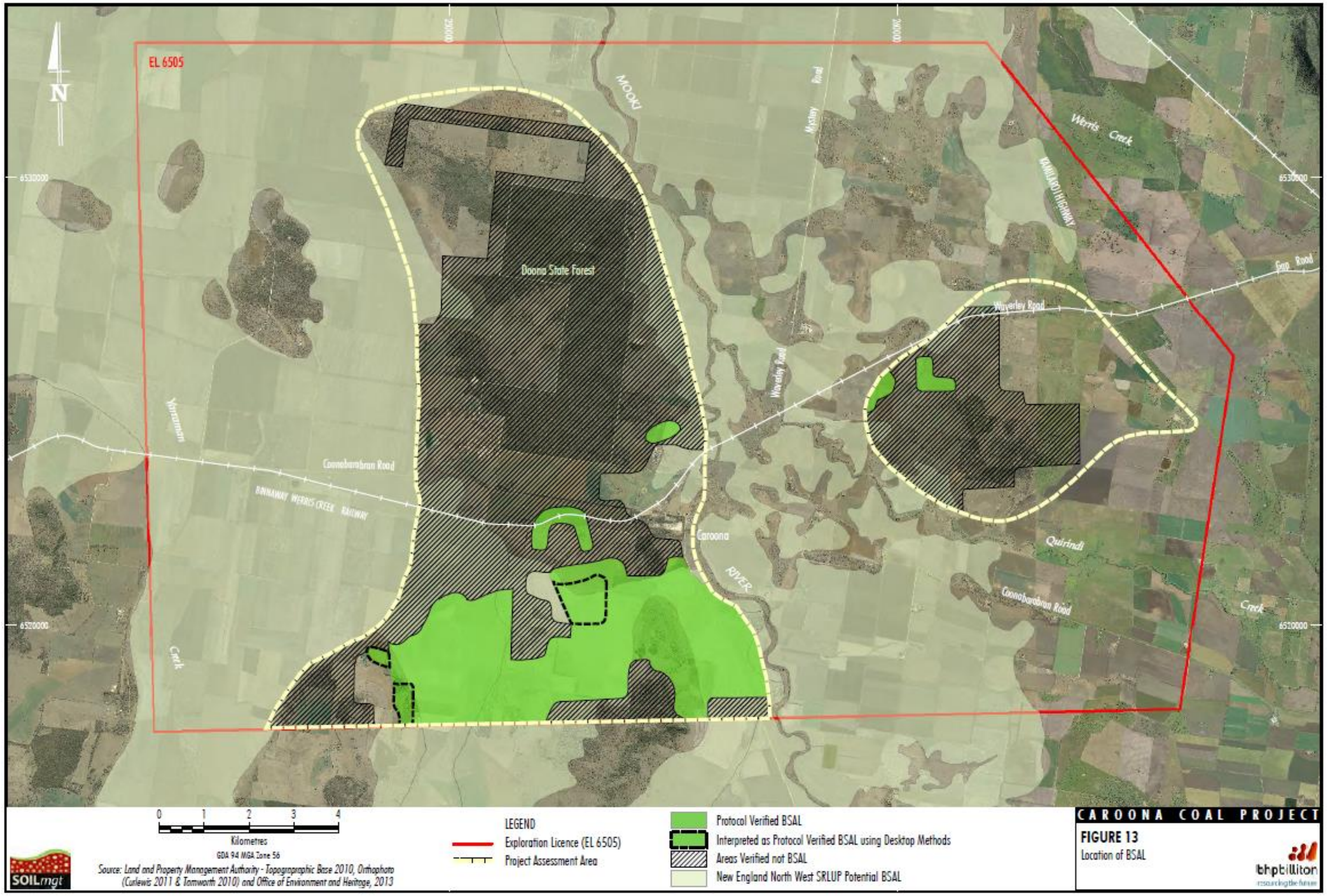

Figure 4. Location of verified BSAL in PAA relative to potential BSAL (MSM, 2014a)

3 Strategic Agricultural Land Verification

3.1 Biophysical Strategic Agricultural Land (BSAL) verification

For the identification of BSAL within the PAA the applicant applied the Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (OEH & OASFS, 2013). The soil and landscape verification was based on a soil survey incorporating chemical and physical assessments of 404 soil profile pits and subsequent soil landscape unit identification (MSM, 2014a).

According to La Tierra (2014a) there are 3,423 ha of potential BSAL the within the PAA as mapped by the NSW Government. MSM (2014a) verifies the presence of 2,215 ha of BSAL within the PAA comprising 2,069 ha confirmed by application of the BSAL verification process (OEH & OASFS, 2013) and 146 ha interpreted by a desktop method. The process employed for the desktop procedure has not been explicitly stated.

The 1207 ha discrepancy between the potential and verified BSAL is made up of 459 ha of potential BSAL that La Tierra (2014a) state has not been physically sampled and subjected to the BSAL verification process (OEH & OASFS, 2013) and the balance of 748 ha which MSM (2014a) contends fail to meet the verification criteria based predominantly on observed physical and chemical properties of the subsoil at the sampled locations.

The Gateway Panel notes La Tierra (2014a) states that most of the 459 ha of potential BSAL that has not been verified is likely to be located in the Alluvial soil landscape unit which elsewhere in the PAA was found to have subsoil characteristics (particularly soil salinity) that generally exceeded the relevant BSAL criteria during the physical soil survey (MSM, 2014a). The Gateway Panel believes that this generalisation should not be relied upon by the proponent to assess unsampled sites given the site-specific nature of soil property variability as evidenced in MSM (2014b-d). Every effort should be made to negotiate access to physically sample these areas and apply the BSAL verification protocol.

Where physical soil sampling remains unachievable, a desktop interpretation is acceptable for determination of the presence of BSAL but the process needs to be fully elucidated and include all available, relevant information. The Gateway Panel believes such information should include the remote electromagnetic survey information that MSM (2014a) state has been obtained by BHP Billiton across EL 6505 as part of the Project exploration program. As stated, this information has the potential to assist with the mapping of variability in key soil factors and soil landscape units. In particular, site calibration of the electromagnetic induction data is likely to be useful for mapping variation in subsoil salinity across the unsampled alluvial areas for use in the BSAL determination process.

Figure 5 shows the location of the individual soil pit sites within the PAA that were identified as possessing BSAL soil qualities by MSM (2014a) using the verification protocol. Based on the distance between sampling sites in the applied sampling scheme, MSM (2014a) states that individually isolated sites identified via the protocol do not meet the final BSAL requirement as they represent an area of less than 20 ha. Areas where two or more adjacent sites are identified as possessing BSAL soil qualities are verified as BSAL because together they represent the qualities in areas of land >20 ha. The Gateway Panel also notes that where the majority of sample sites in a dominant soil type (or a combination of the main soil types) within an identified soil landscape unit comply with the BSAL criteria, MSM (2014a) has correctly conferred BSAL dominant status on the whole soil landscape unit (refer Figure 4). Three soil landscape units, 'VO-LS', 'VO-MUS/V' and 'VO-MUS/CDF' in the southern part of Doona Ridge are thus considered to be BSAL dominant as >70% of the soil landscape units are comprised of a dominant soil type/s which met the BSAL criteria. MSM (2014a) lists the total area of these BSAL dominant soil landscape units as 2,040 ha.

Beyond the BSAL dominant soil landscape units, four other clusters of BSAL sites (i.e. >20 ha) were identified (refer Figure 4). The total area of the four BSAL clusters is approximately 175 ha. Accordingly, 2,215 ha of protocol verified BSAL is considered to be located within the PAA.

The Gateway Panel notes that pit sites 21, 26, 31, 43 and 32 in the north east of the Doona Ridge section of the PAA are identified as individual BSAL locations. These points appear to bound an area that, while it includes landscape with slope >10%, also appears to include more than 20ha of landscape with <10% slope (Figure 6). Given there are no sample sites within the bounded area and that the sampling density around these locations, particularly along the north west and south east boundaries of the area is often greater than the '1 sample per 16 ha', the Gateway Panel believes that there is potential for verified BSAL (<20ha) in the area. Sampling at an increased spatial density is therefore warranted in this area.

MSM (2014a) applies the presence of mottling as a qualitative indicator of drainage condition for the BSAL verification process. The qualitative mottling data for the soil pits is recorded in MSM (2014c) for the soil profile layer in which the characteristic was observed. None of the terms suggested by NCST (2009) to describe the abundance, size or contrast of the mottling are presented. Mottling is required to be >10% ('common' in NCST terms) to be relevant to the BSAL verification process and also to be used as a descriptor in the ASC soil classification process (Isbell 2002). The Gateway Panel has assumed that given the presence/absence of mottling is recorded and used in the soil classification process to the Subgroup level (MSM, 2014b) that the mottling is >10% in all cases. Documentation following the NCST protocol would be preferable.

The upper depth of the layer in which mottling was observed has been translated as the 'depth to mottles' and then directly to the 'depth to waterlogged layer' in the BSAL Assessment Matrix (MSM, 2014b). The presence of mottling in the soil profile between 0 – 750 mm depth has then been applied as a quantitative criteria for determining soil drainage as 'poor or very poor', in the BSAL verification protocol.

The Gateway Panel suggests that this process alone is insufficient for fulfilling the drainage verification process. Firstly, the use of mottling as the dominant indicator of 'waterlogging depth' is contentious as 'mottling does not necessarily imply that oxidising and reducing conditions are currently occurring in the soil in most years' (Isbell 2002). Second, the NCST (2009) include the possibility that 'some horizons may be mottled' in the 'imperfectly drained' soil classification, which meets BSAL verification criteria. Third, the Gateway Panel notes that a depth criterion for mottling or waterlogging has not been established in the published verification protocol (OEH & OASFS, 2013), therefore setting the 0-750mm limit (equal to the criteria for depth to physical or chemical barrier) is subjective. Setting a critical depth equal to the depth criteria for soil pH and salinity (0 – 600mm) could be considered more appropriate. There are 41 sites in the PAA where mottling/waterlogging is identified in a soil layer that begins at 600mm depth and is also the only criterion preventing the site from being identified as BSAL. A number of these sites are adjacent to the area bounded by identified BSAL soil in the north east of Doona Ridge discussed above or may elsewhere form contiguous areas of BSAL >20ha. The Gateway Panel recommends the BSAL classification at these 41 sites be reassessed. Ideally, as stated in OEH & OASFS (2013), saturated hydraulic conductivity should be measured to determine internal drainage rates.

Soil pH (0 – 600mm) is another important property assessed in the BSAL verification process. The laboratory chemical analysis of the pit soil (MSM, 2014c) records soil pH in water and $CaCl_2$. The results from these two methods have different thresholds that can be applied in the BSAL verification process (OEH & OASFS, 2013). MSM (2014a) has applied the pH in $CaCl_2$ results in the verification process. However the Gateway Panel notes that there are at least 15 sites in the PAA where the soil pH value in $CaCl_2$ is the only criteria that fails the BSAL verification, but the soil pH in water results at these sites meet BSAL verification criteria. The Gateway Panel acknowledges that a number of these sites are already included in the identified BSAL through the landscape dominant soil unit assessment applied in MSM (2014a). However, reassessment of the individual sites that fall under this condition is recommended.

As stated by the proponent, protocol verified BSAL has been mapped along parts of the southern and south-eastern extents of Doona Ridge and it is reasonable to assume that these areas are contiguous with BSAL beyond the Project Assessment Area, generally in accordance with the NSW Government's potential BSAL mapping (Figure 3). The Gateway Panel agrees with this assessment linking the PAA to extensive areas of BSAL to the Southern and south eastern extents.

According to the NSW Government's potential BSAL mapping, areas to the west and east of Doona Ridge are also potential BSAL. The proponent has suggested that following the BSAL verification process, where the assessment suggests parts of the western and eastern margins of the Doona Ridge section of the Project Assessment Area are non-BSAL, it is likely that the land adjacent to the verified non-BSAL areas are subject to the same limitations that were observed in this survey (and hence are likely to be non-BSAL). The Gateway Panel suggests that given the issues raised above regarding reassessment of numerous pit sites, this assertion needs to be revisited and the links to potential BSAL bordering the PAA on the west and east boundaries be reassessed and the extent of adjoining BSAL on all borders correctly described as per the BSAL verification and mapping procedure (OEH & OASFS, 2013).

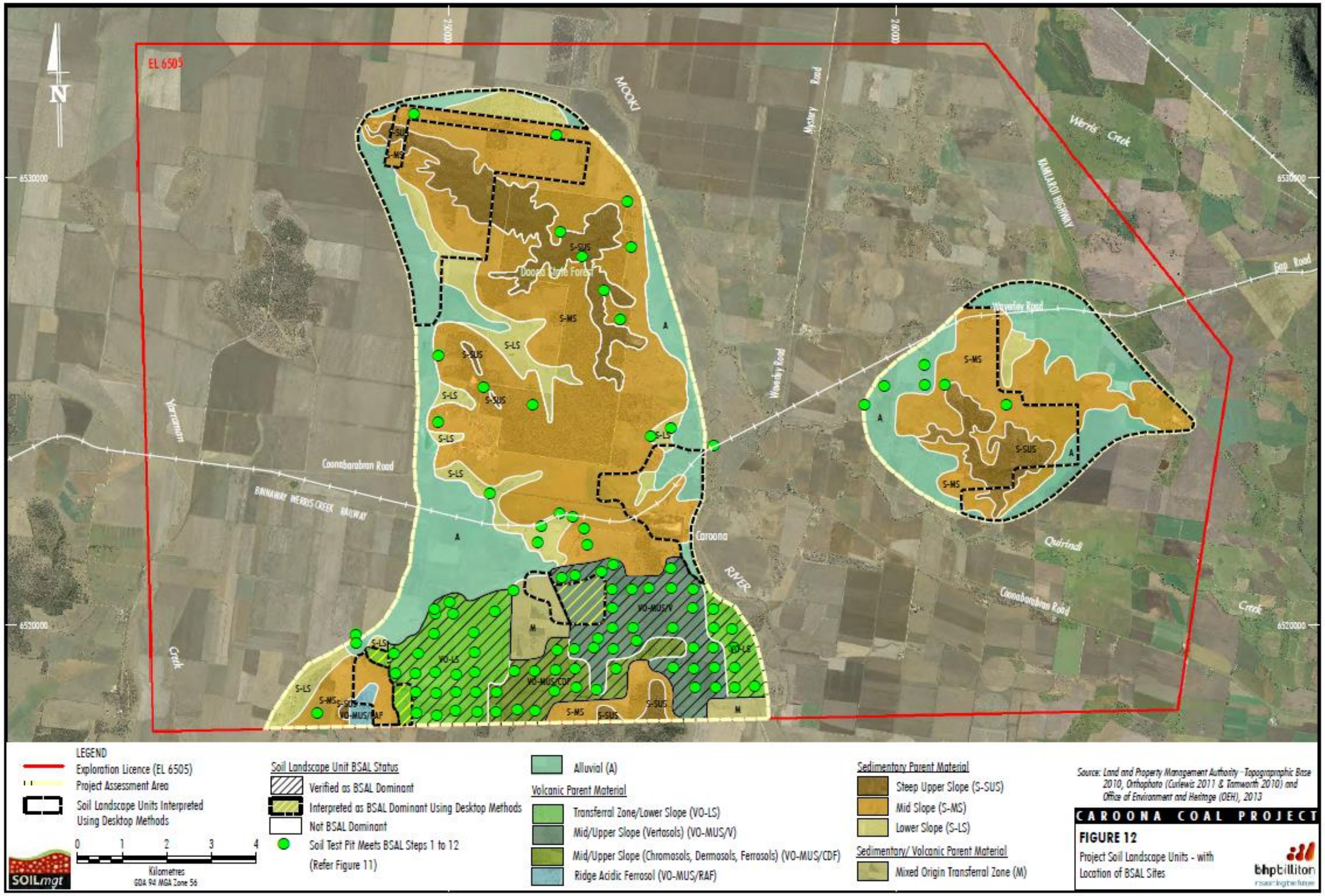

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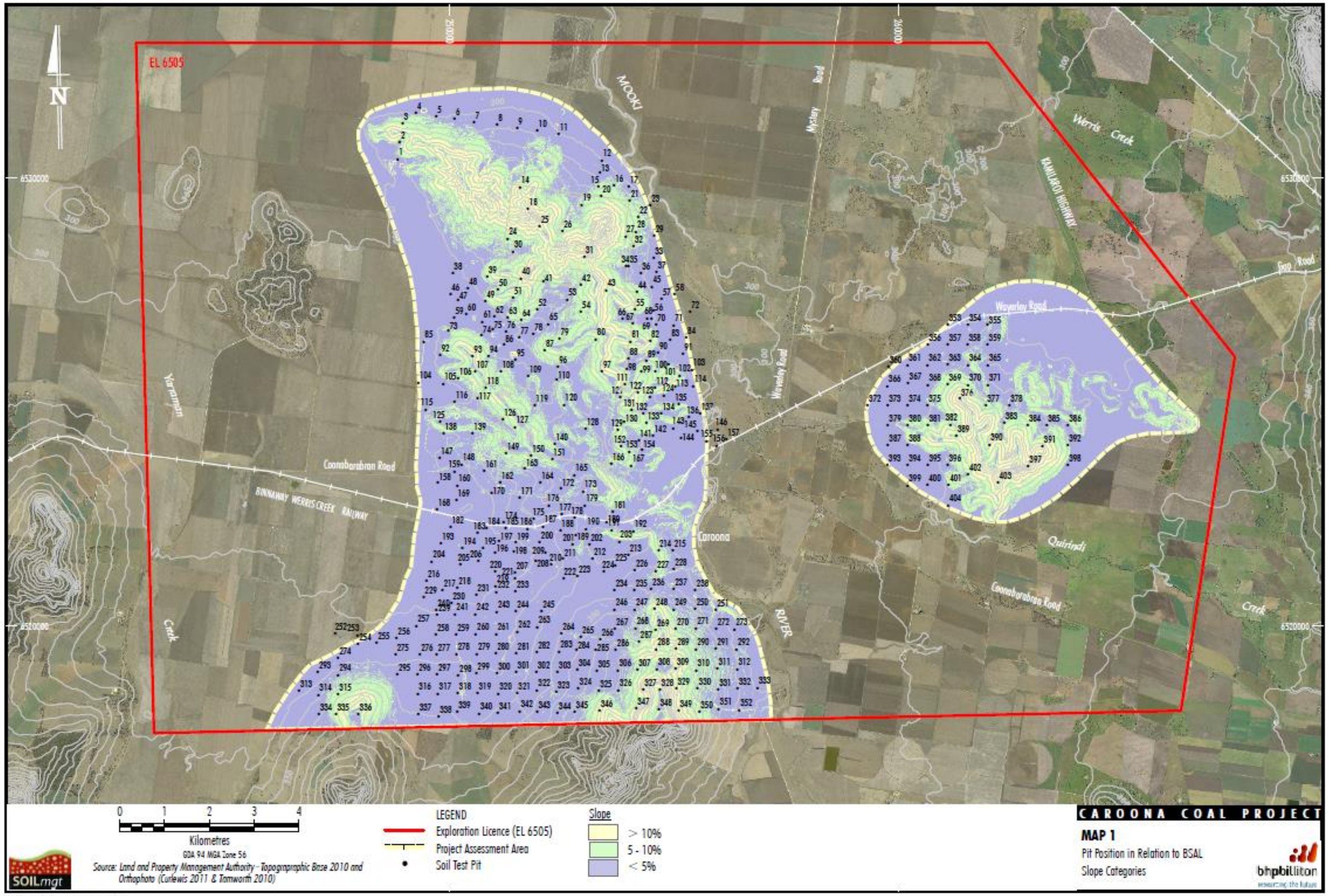
Figure 5. Soil landscape units and individual verified BSAL sites within the PAA (MSM, 2014a)



HVE-13-02 Gateway ARA Maps 201C

Figure 6. Individual soil pit numbers and location relative to landscape slope categories (MSM, 2014a)

3.2 Critical Industry Cluster (CIC)

There are no viticulture or equine industry businesses within or surrounding EL6505 (DP&I, 2012a).

4 Assessment of Mining Disturbances

The Gateway process requires that the potential impact on BSAL and/or a CIC is evaluated as either:

- A direct mining effect whereby part or all of BSAL or a CIC is either removed, worked upon or subsided, or
- An indirect mining effect whereby the state of either the surface water or sub-surface water is significantly altered by mining which then has a direct impact on BSAL and/or a CIC.

Therefore, the assessment of mining disturbance must consider both direct and indirect impacts as defined above, noting that the Applicant has commissioned studies on surface subsidence (MSEC, 2014a-d) and hydrogeological effects (HydroSimulations, 2014) due to the proposed mine.

4.1 Direct mining disturbances

The Project underground mining area has been located underneath the Doona Ridge and Nicholas Ridge Project Assessment Area to minimise impacts on the alluvial plains within EL 6505. The mine infrastructure area, coal handling and preparation and reject emplacement areas are proposed to be sited to avoid impacts on BSAL.

4.1.1 Removal or working upon verified BSAL

The applicant states that approximately 30 ha of verified BSAL will be used for temporary infrastructure associated with ventilation and gas drainage. The size of this predicted area should be assessed following further surveying and BSAL verification in the identified unsampled areas of the PAA and the reassessment of the BSAL status of sites from the current soil survey data.

4.1.2 Disturbance due to longwall mining subsidence

The Project will subside 8,500 ha of the PAA due to longwall mining. The applicant states that the project design has focused upon mining under the high ridge areas where the extent of impacts upon BSAL would be a minimum. The Agricultural Impact Assessment (La Tierra, 2014a) includes an assessment of the potential impacts of the Project on BSAL, including consideration of the relevant criteria in the Mining SEPP. La Tierra (2014a) notes that for the mining of any coal resource, the underground longwall mining method has lower-order potential impacts on agriculture than open cut mining.

According to La Tierra (2014a) the proposed underground longwall mining is predicted to cause the subsidence of 2,103 ha of verified BSAL. The predicted effects of subsidence on BSAL outlined by MSEC (2014a) vary across the seven mining areas in the PAA (as shown in Table 1) and include surface deformation with maximum vertical settling of 1,600 to 3,100 millimetres (mm) and surface cracking of ten to 100 mm, with isolated cracks to 300 mm. The applicant suggests that the impacts of subsidence would be less than these maximums.

Table 1. Predicted subsidence from long wall mining in the Caroona Project areas (MSEC, 2014a).

Location	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Area 1	3,100	70	3.0	3.0
Area 2A	3,100	65	2.5	2.5
Area 2B	1,600	40	1.5	1.5
Area 2S	3,000	30	0.50	0.50
Area 3	2,900	25	0.40	0.45
Area 4	2,750	20	0.25	0.35
Area 5	2,400	10	0.10	0.20

The predicted strains vary across the mining areas depending on the local depth of cover. The lowest strains are expected to occur in Areas 4 and 5 (i.e. the southern portion of Doona Ridge), where the depths of cover to the targeted coal seam are the greatest, having values typically between 1 mm/m and 2 mm/m. The highest strains are expected to occur in Areas 1 and 2A, where the depths of cover are the shallowest, with values typically between 10 mm/m and 20 mm/m, with some isolated strains greater than 20 mm/m.

The Gateway Panel notes that a wide range of subsidence impacts are common in NSW Coal mining activities, as noted by Pineda and Sheng (2013), and the modeled effects presented by the applicant are within the range that Pineda and Sheng (2013) identify.

The Gateway Panel considers that to improve the level of certainty in assessing the precise subsidence effects of the Project, it would have been advantageous if the applicant had provided site specific data on the nature and features of the stratigraphic units which the long wall mining process is likely to impact upon. Such features could include fracture patterns, faulting and geotechnical characteristics of the roof strata above the coal seam to be mined. Such information would be expected to be produced from the scientific surveying of EL6056 by the applicant.

The subsidence impacts are likely to be most notable where the coal seam is at its shallowest; along the northeast of the Nicholas Ridge and the inclusion of the additional information described above would improve the level of certainty in predicting the subsidence impacts throughout the region. The applicant's subsidence study provides minimal detail, as documented in Appendix A (attached).

La Tierra (2014a) has also assessed the potential impacts of subsidence on BSAL to include surface cracking and landform changes, changes to surface water drainage, changes to surface water resources, changes to groundwater resources and impacts to built features. MSEC (2014a) identify that subsidence may also result in changes in gradient of surface drainage features, both natural and manmade (such as contour banks). This may lead to ponding above longwall panels in some cases and cause accelerated scouring of drainage lines that traverse verified BSAL (MSEC, 2014a).

La Tierra (2014a) identifies that surface water ponding and subsequent prolonged submersion can reduce the chemical and physical fertility of soils. While surface water ponding is considered 'likely' in some locations, the applicant predicts that ponding will not occur on the presently verified BSAL in the PAA (La Tierra, 2014a). However, the potential for inundation of the subsoil of subsided soil is likely to be greatest where the depth to water table is shallowest. Hydrosolutions (2014) provides an interpolated watertable for the PAA, EL6505 and surrounds. Whilst this is a snapshot of a depth that varies with time, areas with a depth to watertable of between 2- 5m are identified within the presently verified BSAL, and surrounding locations in Areas 3 and 5 where the observation of high subsoil salinity (MSM, 2014a) resulted in the noncompliance with BSAL criteria. The Gateway Panel believes the potential for subsoil inundation in these areas requires greater investigation and documentation.

Subsidence-induced cracking in the root zone is predicted to mimic natural occurring fissures in the cracking clay soils and is considered likely to be beneficial to drainage in the non-reactive soils according to MSM (2014). However the potential for increased soil bulk density in the compression areas associated with the central zones of troughs above subsided panels (Bacon 2013) is not considered in the application. The Gateway Panel notes that the impact on the cracking clays may well be naturally reversible, but the impact on non-reactive soils will be site-specific and may be significant.

In summary the direct mining related impacts of the Caroona Project will result in some impacts on soil drainage, surface water ponding and potential inundation of subsoil with associated soil physical and chemical degradation issues. To assess what local or specific impacts might occur, in both the short and long term, all relevant data, collected from a range of geotechnical, geological and geophysical studies undertaken by the applicant to date, should be incorporated into a comprehensive evaluation of the impacts of subsidence and mining related activities on the PAA and its surrounds.

4.1.2 Duration of impacts, mitigation and rehabilitation measures

The Project proposes underground longwall coal mining methods in the Hoskissons Seam. The conceptual mine layout design indicates seven proposed 'Mining Areas' (Table 1). The estimated 2,103 ha of verified BSAL which is predicted to be subsided is predominantly located in Areas 4 and 5 and will be sequentially subsided over approximately 15 years (La Tierra, 2014). The plan for monitoring and remediation of subsidence and other mining impacts is outlined in CMAL (2014) and further detailed in MSM (2014a).

The applicant states that proposed mining activities will not cause the long-term or permanent fragmentation of agricultural land uses. La Tierra (204) note that for the period of active subsidence and any subsidence remediation it may be necessary to temporarily remove areas of cultivated BSAL from agricultural production or modify the type/methods of agricultural production. Grazing activities are predicted to continue with the aid of temporary fencing.

However, a recent comprehensive review of research into the impact of underground longwall mining on agricultural land (Lechner et. al, 2014), found that subsidence induced greater heterogeneity in local landscapes and soil conditions that can decrease agricultural productivity through altering the types of farming practices that can be undertaken.

The Gateway Panel notes that surface landforming and infilling works are proposed to remediate subsidence impacts on BSAL. The applied procedures (cut/fill) and the properties of any replacement soil would need to ensure that properties of BSAL are maintained. Detail to determine this outcome would be site-specific and is not supplied in the application. Comprehensive Property Subsidence Management Plans (PSMPs) will need to be developed for all properties regardless of BSAL status.

Subsidence effects are also expected to impact upon built features including houses, rural building structures, farm dams, groundwater bores, local roads, electrical infrastructure, telecommunications infrastructure, diesel tanks and gas infrastructure located above the proposed mining areas. The Caroona Feedlot infrastructure is located within the predicted subsidence area of the PAA. PSMPs will be required for such areas.

While it is considered unlikely that any long-term or permanent change to the agricultural operations across all of the verified BSAL in the project area will occur, the Gateway Panel cannot determine, from the data and analysis provided, precisely how limited or extensive (in time and space) any disturbances will be to land use patterns in the area of mining.

It is the Gateway Panel view that the uncertainty of the subsidence modelling and interpretation in the application would be reduced if the study incorporated more site-specific data that should be readily available to the applicant as a result of scientific and other investigations undertaken in the project area to date. The Gateway Panel considers that the lack of site data (surface geology and stratigraphy) in the applicant's subsidence study is a hindrance to assessment. The impacts of subsidence are considered potentially significant in a number of localised areas where mining will take place at the shallowest depths proposed, where the depth to the watertable is shallowest, or where geotechnical conditions are complex.

4.2 Indirect mining impacts

4.2.1 Impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)

This section should be read in conjunction with Appendix B (attached) which gives a detailed explanation of the Panels thoughts. The Gateway Panel notes that the proposed Project has water level impacts that exceed the Level 1 minimal impact considerations in the NSW Aquifer Interference Policy (AIP) for the 'highly productive' Gunnedah-Oxley Basin MDB (Spring Ridge) groundwater system. The preliminary groundwater model predicts that 27 privately owned bores will experience drawdowns that exceed the 2m minimal harm criteria. Mitigation measures have been put forward to manage this issue.

Whilst the preliminary groundwater model does not predict greater than level 1 impacts for the 'highly productive' Upper Namoi alluvium (Gunnedah Formation) the limited sensitivity analysis conducted to date shows that this is a possibility for parts of the alluvium. Considerable more work is required to demonstrate the risk of exceeding the minimal harm criteria in the Upper Namoi alluvium.

The Gateway Panel believes that the conceptualisation of the local and regional hydrogeology is reasonable and that the processes of groundwater flow from one water source to another are plausible within the limitations of a Gateway assessment.

The hydraulic connection between the mine and the Mooki River/Quirindi Creek is not demonstrated sufficiently and as such the Gateway Panel lacks confidence in the estimates of stream losses.

The MODFLOW-SURFACT software that was used for the ground flow modelling is considered appropriate. The model meets the Aquifer Interference Policy (AIP) requirement for a simple model and the calibration statistics are adequate for it to be used as a guide for assessing environmental impacts and mine inflows at this early stage in the planning process. The Gateway application could have been improved by a more extensive sensitivity analysis of model input parameters.

The Gateway Panel considers that the modelling results from the preliminary model should be interpreted as broad estimates only. The water level impacts are temporary but last for many decades after mining has ceased. The preliminary model does not include any climate change scenarios and this should be address in future modelling.

Subsidence induced fractures alter groundwater flow pathways and control much of the flow into underground mines. The approach adopted in the groundwater model to handle fracture zones associated with subsidence is consider appropriate for this early work. However more detailed investigations into the height of fracturing are required for an EIS, to determine the implications on surface and groundwater flow. Future modelling should include a sensitivity analysis on varying the density of fractures back to the ground surface.

CMAL state that there will be no reduction in beneficial uses of any groundwater source or the Mooki River. This conclusion however has not been demonstrated. Of particular interest to the Gateway Panel is any saline discharge to the Mooki River, both short and long term, post mining. The Panel cannot comment further with the limited information to hand.

CMAL have indicated that they will acquire the necessary groundwater and unregulated Mooki River access licences and abide by the rules in the relevant water sharing plans. They have not indicated however how they will mitigate the continuous take of water by the mine from the Mooki River when access restrictions are in place. This needs to be resolved so that ecological assets and other water user’s rights are not diminished.

Desktop studies have found two high priority groundwater dependant ecosystems (GDE) south west of the mine. The preliminary modelling results show that any impacts on water levels caused by the mine will be less than allowed in the AIP. This should be confirmed or otherwise by future modelling.

The Gateway Panel finds that there is considerable uncertainty in the water budget results and water level impacts using the preliminary groundwater flow model. The proponent has however provided a pathway forward to develop a more complex and robust transient groundwater flow model that will be used in the EIS assessment. This will incorporate temporal data and include the results from ongoing work that will better define the hydrogeological complexities of the lease areas. This more detailed model should provide results that have a higher degree of certainty.

5 Panel Assessment of Impacts on Strategic Agricultural Land

The Gateway Panel has assessed and determined the potential impacts of the Project on BSAL as follows (findings are summarised in Table 2). The Project will subside 8,500 ha of the PAA and cause direct impacts to 2103 ha of presently verified BSAL (to the 20mm predicted subsidence contour) due to subsidence from longwall mining. The effects are potentially significant in localised areas where mining will be at the shallowest depths, where the depth to the watertable is shallow or elsewhere where geotechnical conditions are complex.

Table 2. Summary of Gateway Panel determination of impacts on BSAL

17H(4)(a) BSAL	Determined Impact
(i) any impacts on the land through surface area disturbance and subsidence,	Potentially significant
(ii) any impacts on soil fertility, effective rooting depth or soil drainage,	Potentially significant
(iii) increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH,	Potentially significant
(iv) any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy),	Significant impact
(v) any fragmentation of agricultural land uses,	Potentially significant
(vi) any reduction in the area of biophysical strategic agricultural land.	Cannot be determined

5.1 Significance of the project's potential impacts on BSAL

5.1.1 Any impacts on the land through surface area disturbance and subsidence

The Project proposes to utilise approximately 30 ha of verified BSAL for temporary infrastructure associated with ventilation and gas drainage. Surface rehabilitation following utilisation will be required to rectify any temporary impacts.

Subsidence has the potential to create surface ponding and any significant periods of inundation would affect the chemical and physical fertility of affected soil, thereby impacting the agricultural productivity of verified BSAL. Subsidence of the magnitude expected from the Project, in areas where the depth to the water table is shallow, also poses a risk of subsoil inundation. Such areas are potentially present in the western section of the verified BSAL in the Doona Ridge PAA.

It is the Gateway Panel's opinion that impacts on the land through surface area disturbance will be significant in localised areas with potential to significantly impact upon the agricultural productivity of verified BSAL through surface ponding and subsoil inundation.

The panel cannot determine the significance of any impacts on agricultural productivity from potential BSAL within the PAA where the BSAL verification protocol (OEH & OASFS, 2013) has not been completed.

5.1.2 Any impacts on soil fertility, effective rooting depth or soil drainage

The potential for surface-water ponding and soil compaction in subsidence depressions, and subsoil inundation of BSAL where the depth to watertable is shallow, mean that the fertility, effective rooting depth and soil drainage may be significantly impacted in localised areas of presently verified BSAL soils.

The Gateway Panel finds the impacts on fertility, rooting depth and soil drainage should be minimal where BSAL is impacted by temporary mine infrastructure, providing thorough rehabilitation procedures are followed. The panel cannot determine the significance of any impacts on agricultural productivity from potential BSAL within the PAA where the BSAL verification protocol (OEH & OASFS, 2013) has not been completed.

5.1.3 Any increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH

It is the Gateway Panel's opinion that localised changes to slope may increase the heterogeneity of the landscape at the field level and produce a significant impact to agricultural production by altering the suitability and timing of farming practices. Localised surface-water ponding or subsoil inundation may significantly impact agricultural productivity through increases in soil salinity.

The proposed Project should not significantly reduce the agricultural productivity of BSAL due to increases in micro-relief, rock outcrop or significant changes to soil pH providing thorough subsidence rehabilitation procedures are followed. The panel cannot determine the significance of any impacts on agricultural productivity from potential BSAL within the PAA where the BSAL verification protocol (OEH & OASFS, 2013) has not been completed.

5.1.4 Any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)

The Gateway Panel concludes that the proposed Project has significant impacts to groundwater levels. The water level impacts exceed the Level 1 Minimal Impact Considerations in the NSW Aquifer Interference Policy for the 'highly productive' Gunnedah – Oxley Basin MDB (Spring Ridge) groundwater source. Mitigation measures have been put forward to manage this issue and they appear to be acceptable.

With respect to the 'highly productive' Upper Namoi alluvium (Gunnedah Formation) the groundwater modelling completed to date is not of sufficient detail or rigor for the Panel to be confident in the results. Whilst the preliminary groundwater model does not predict greater than level 1 impacts for the Gunnedah Formation, the limited sensitivity analysis shows that this is a possibility for parts of the alluvium. Considerable more work is required to demonstrate the risk of exceeding the minimal harm criteria in the Upper Namoi alluvium.

The long term impacts on aquifer and stream salinity have not been demonstrated to any significant degree.

No work has as yet been done on-site to establish the presence and value of groundwater dependent ecosystems or whether they will be impacted by mining.

5.1.5 Any fragmentation of agricultural land uses

The Gateway Panel finds the Project will certainly cause short-term fragmentation of agricultural land use on verified BSAL during the period of active subsidence and subsidence rehabilitation. The potential for longer-term fragmentation due to localised changes that impact the applicability of particular farming practices or suitability of the land for specific crops will be site-specific and difficult to assess from the information provided.

Of further concern to the Gateway Panel is land use on BSAL outside the PAA that might be directly impacted by the proposed Project via groundwater impacts on irrigation and crop production.

The panel cannot determine the significance of any impacts on agricultural productivity from potential BSAL within the PAA where the BSAL verification protocol (OEH & OASFS, 2013) has not been completed.

5.1.6 Any reduction in the area of BSAL

Any reduction in area of BSAL due to the Project cannot be determined by the Gateway Panel because the BSAL verification has not been completed across the entire PAA. Identified issues with the application of the verification process also restrict this assessment. The potential success of local remediation and mitigation measures for the impacts of subsidence on BSAL status are also difficult for the Gateway Panel to assess from the information supplied.

6 Conditional Gateway Certificate

The Gateway Application for the Caroona Coal Project proposes underground longwall coal mining within EL 65055. The Project Assessment Area (PPA) of 11,863ha incorporates 2,215 hectares of applicant-verified BSAL and 459 hectares of Potential BSAL (as mapped by the NSW Government) which has not been verified.

It is the opinion of the Gateway Panel that;

- the Project would have direct and significant impacts on the agricultural productivity of verified BSAL within the Project Boundary area;
- the Project would have indirect and significant impacts on the agricultural productivity of verified BSAL within the Project Boundary area;
- the Project would have indirect impacts on potential BSAL adjacent to the Project Boundary area have been assessed and are potentially significant with respect to the impacts upon groundwater.

Appendix A – Project Information Related to Subsidence Impacts

The Technical Summary for the application lists the following data as having been acquired over the project area. It should provide sufficient detail to improve the subsidence interpretation presented in the Gateway application by MSEC (2014a-e):

BHP Billiton's exploration program was undertaken from 2006 to 2012. Exploration activities included (CMA, 2014a):

- drilling of 346 boreholes;
- airborne magnetometer survey;
- 2-Dimensional and 3-Dimensional seismic surveys; and
- ground magnetic surveys.

Such data would improve the level of detail over that present in the application and would have avoided the following notable omission. The surface geology data provided by one section of the applicant (HydroSimulations, 2014: reproduced here as Figure A1) shows a major fault and consequent subsidence of the major target coal-bearing sequence along the northeast part of Nicholas Ridge.

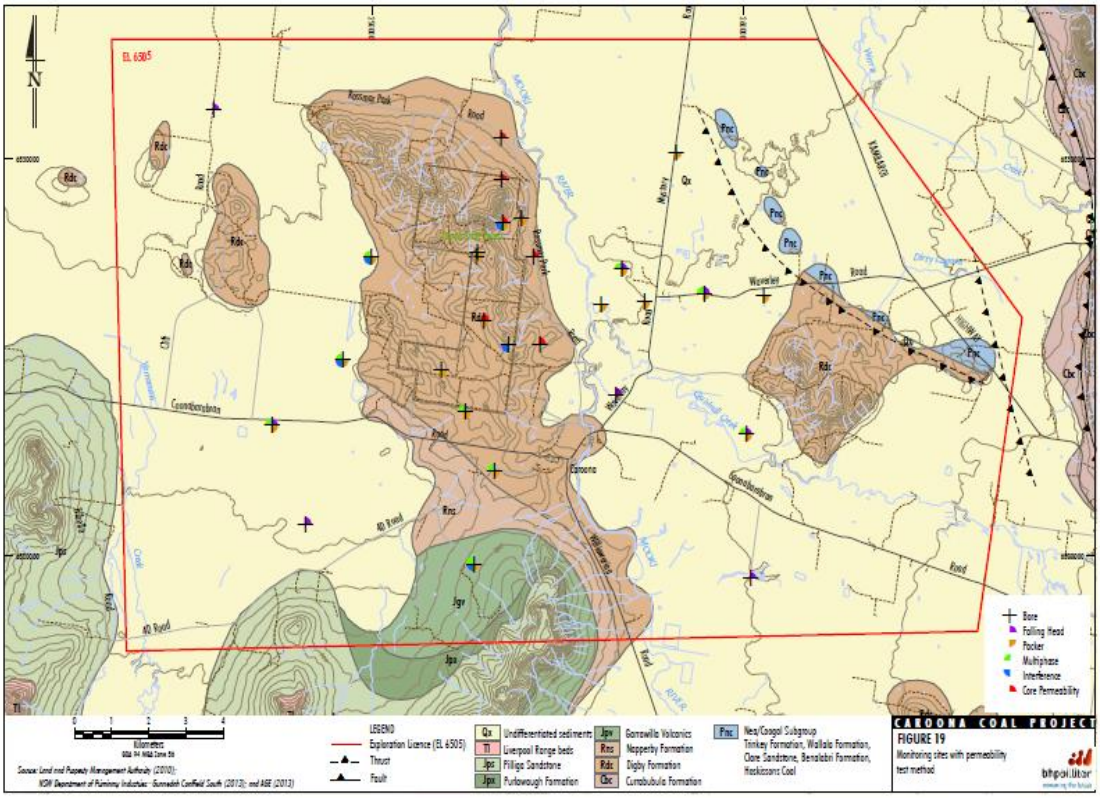


Figure A1. The surface geology, topographic contours of the project area and surrounding regions (HydroSimulations 2014). Included in the above map is a major geological fault along the northeast margin of the Nicholas Ridge.

The subsidence study (MSEC 2014a-e) omits this fault, or any similar relevant subsurface data acquired by the applicant, from this and other relevant cross-sections (Figure A2). The fault on the geological surface map (Figure A1) overlies at least the first two long wall panels of the cross section but is not evident in the applicant's subsidence cross section (Figure A3) which shows subsidence across these and other panels. The Gateway Panel notes that the stratigraphic sequence overlying the coal to be mined and each of the units will have a different response to strain, stress and fracturing induced by mine excavation.

The Gateway Panel considers that the applicant has sufficient information to assess the likely response of the sequence to the mining process – this would result in some greater degree of complexity in the pattern of surficial subsidence-related features than the applicant has outlined. The pattern of subsidence and cracking on the land surface would impact upon soil drainage and ponding of surface water. Ponding of surface water may result in the development of additional near surface salt build-up in the soil profile - as was noted in the soil survey sampling undertaken for BSAL identification.

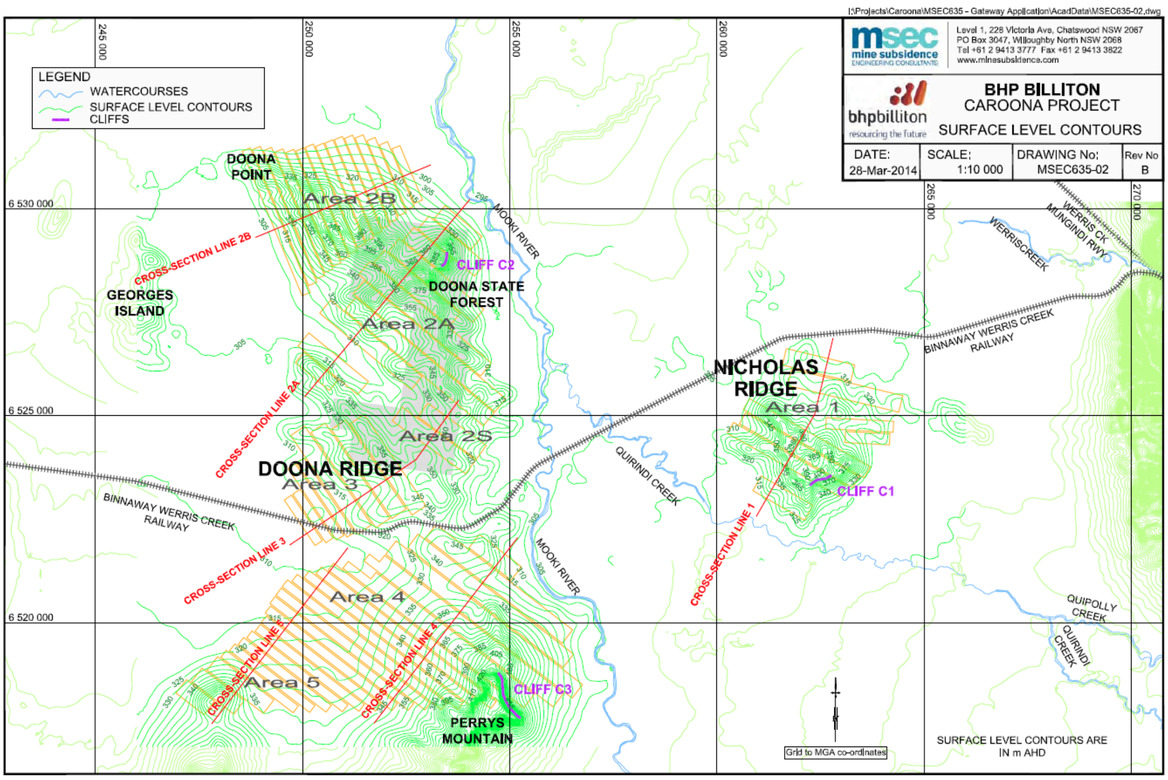


Figure A2. Location map of subsidence cross sections in the project area including Cross-section 1 which crosses the location of a major fault (arrowed) on the Nicholas Ridge (MSEC 2014b).

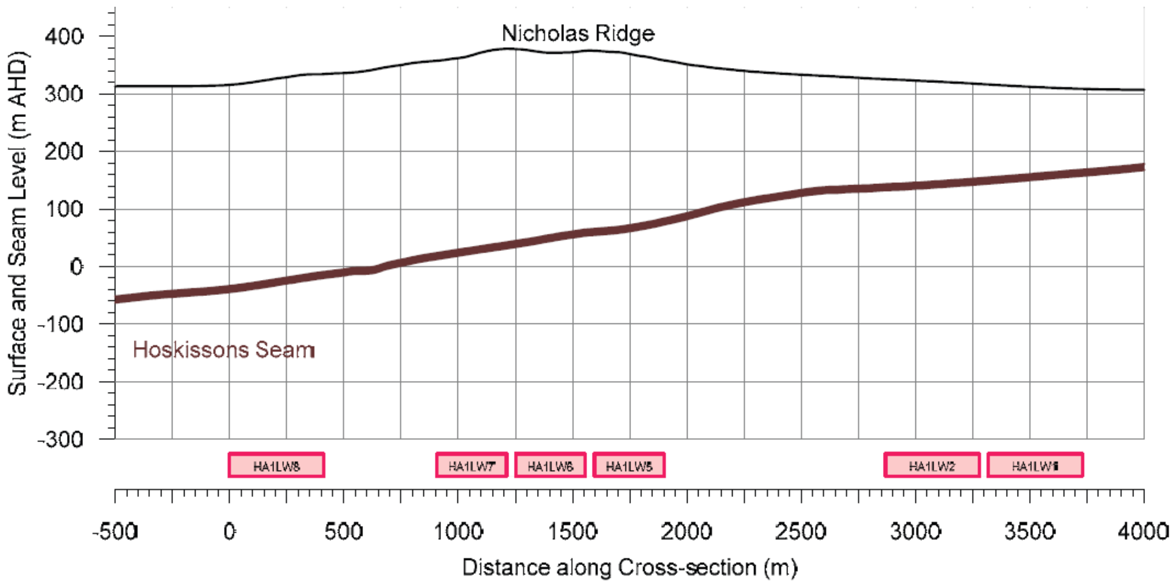


Figure A3. Cross-section 1 of the applicants' subsidence study (MSEC 2014a) which omits the major geological fault present in this region on the surface geology map reproduced from Hydrosimulations (2014). The fault would affect the subsurface in the right third of the cross section.

Appendix B – Groundwater Assessment

Hydrogeology

The proponent, CMAL, has made an application for a Gateway Certificate for the Caroona Coal Project (EL6505) which lies within the Upper Namoi Catchment. The assessment herein is a preliminary assessment made ahead of the regular planning process which requires a full Environmental Impact Assessment (EIS) and contains more detailed information.

The basic geology at or near EL6505 consists of outcropping Quaternary alluvial sediments and sedimentary rocks of Triassic to Jurassic age. Permian strata, which contains the target Hoskissons coal seam, occurs in subcrop (200-600m depth). Tertiary Basalts occur 30km to the south on the Liverpool Ranges

The highly productive groundwater sources in the vicinity of the proposed mine include the:

- Upper Namoi alluvium (Gunnedah Formation);
- Gunnedah-Oxley Spring Ridge sandstone; and the
- Liverpool Range basalt.

The importance of the 'highly productive' alluvial groundwater resources to irrigators on the Liverpool Plains cannot be overstated. Groundwater extraction for irrigation purposes commenced in the 1960s and developed steadily from that time onwards. Because of the importance of the resource the NSW government undertook exploration drilling into the alluvium (from late 1970s to 1990s) and set up an extensive network of water level monitoring bores. The resource was made sustainable with the gazettal of the Upper and Lower Namoi Groundwater Sharing Plan in November 2006 which resulted in a 56% reduction in groundwater entitlements.

Other 'less productive' groundwater sources are located within Permian, Triassic and Jurassic rocks but are not the principal concern of the Gateway Panel. Aquifers within these rocks are low yielding and generally contain brackish water.

Groundwater Data and Conceptual Model

There is an extensive data set, both spatially and temporally (31 years), of water level measurements in the alluvium, from NSW government monitoring bores. In addition a total of 68 monitoring bores at 32 sites have been constructed by CMAL across EL6505. Data includes both continuous time series and manual water level readings.

Groundwater level data for both the sedimentary rocks and Liverpool Range basalts is much more limited. As a result groundwater gradients between formations are not well understood. The historic data that is available mostly comes from information held within Department Primary Industry (DPI) data bases and is not consistent in time. Completion of the bore census work and ongoing monitoring of bores is essential to improve the data set.

Groundwater quality data is limited to pH and estimates of salinity, calculated from electrical conductivity readings. Full chemical analyses such as anions, cations, trace metals and nutrients have not been presented.

The Gateway Panel believes that the conceptualisation of the local and regional hydrogeology is reasonable and that the processes of groundwater flow from one water source to another are plausible within the limitations of a Gateway assessment. The Gateway Panel stresses the need in any future work to utilise:

- Detailed site geology from the coal exploration drilling program (to locate faults, sheer zones, volcanic intrusions etc.);
- full chemical analysis in all bores to better understand potential mixing of groundwaters under a mining scenario; and
- stable isotopes to estimate the age of groundwaters and hence flow velocities, likely recharge rates and natural mixing patterns.

The hydraulic connection with the Mooki River/Quirindi Creek is not demonstrated sufficiently and as such the Panel lacks confidence in the estimates of stream losses. More work is required to demonstrate the voracity of estimated stream losses that the proposed mine may cause.

Some geological faults are shown in AGE (2014; Fig 5.2) but have not been represented in the modelling or their effects on groundwater flow discussed. The Gateway Panel agrees with the IESC (2014) that the flow dynamics of faults and their influence on the hydrogeological system should be investigated and the results included in future modelling. Likewise the potential for subsidence fractures to extend higher into overlying Triassic and Jurassic strata needs further investigation.

The Gateway Panel questions whether full use has been made of hydrogeological information gathered during the coal investigation drilling program and the spatially variably hydraulic parameters in the DPI Upper Namoi groundwater flow model.

Groundwater Flow Model

The MODFLOW-SURFACT software that was used is considered appropriate. The proponent has used a lower resolution basic modelling approach and has stated that a more detailed peer reviewed model will be developed for the EIS. The Gateway Panel agrees that the model meets the Aquifer Interference Policy (AIP) requirement for a simple model and the calibration statistics are adequate for it to be used as a guide for assessing environmental impacts and mine inflows at this early stage in the planning process. The NOW (2014) comments agree that the model as developed is fit for purpose.

The Gateway Panel notes that the preliminary model is calibrated in steady state mode and will likely produce transient predictions of moderate to low confidence. Conversely, when a transient calibration is completed for the EIS, this upgraded model may be expected to have a higher level of confidence.

Advice on model uncertainty is critical in understanding how useful a model is and any limitations it may have. An uncertainty analysis has not been carried out on the preliminary model. A detailed uncertainty analysis is required by the Panel for subsequent modelling of the Caroona Coal Project to test the conceptual model and provide a range of answers rather than a single deterministic answer.

The Gateway Panel considers that the modelling results from the preliminary model should be interpreted as broad estimates only.

The Gateway Panel's appraisal of the model and comments from IESC (2014) and NOW (2014) has highlighted the following:

- The hydraulic parameters used in the preliminary groundwater model, particularly vertical hydraulic conductivity, are lower than other estimates within the region (IESC, 2014). Future work should demonstrate an appropriate range of hydraulic conductivities to be used in modelling and constrain calibrated values within reasonable ranges. Results from tests on site should be afforded greater weight than other studies in the Namoi Valley.
- The Jurassic Pilliga sandstone unit should be modelled as a separate layer. This is the 'highly productive' aquifer within the Jurassic sequence of rocks and impacts on this water source will rightly come under scrutiny.
- The hydraulic connection between alluvial groundwater and stream flow in the vicinity of the mine is uncertain. Predicted stream losses (0.7ML/day), due to mining, are therefore also uncertain. Both NOW (2014) and IESC (2014) have similar concerns.
- The predicted drawdown impacts on the potentiometric surface in the alluvial Gunnedah formation is less than the minimal harm AIP criteria of 2m for the base case model. The limited sensitivity analysis conducted to date shows that when the vertical hydraulic conductivity of layers 4 to 9 are increased by one order of magnitude, the 2m criteria is exceeded in some local areas (HydroSimulations, 2014; Fig E1). The predictive model sensitivity analysis needs more work and a more rigorous assessment. The NOW (2014) and IESC (2014) have similar concerns about requiring a more detailed parameter sensitivity analysis.
- There are concerns with how the stream flow routing cells have been used to represent streams across the model domain (IESC, 2014). The Panel supports the IESC recommendation to use field data to inform the relative contributions to streamflow from runoff/interflow and baseflow at various locations within the catchment. This also fits with the NOW (2014) recommendation requiring a calibrated transient model that provides some capability for well-defined stream leakage properties.
- The no flow boundary on the western edge of the model appears to be influencing predicted drawdowns in layers 5 to 9.
- The estimation of cumulative groundwater level impacts by adding the modelling predictions from the neighbouring Watermark project to the CMAL predictions is considered satisfactory for a gateway assessment. It would have been more useful to the Panel if the location of the 1m drawdown contour for the Gunnedah formation had been presented, so it could be compared to the 1m drawdown prediction for the neighbouring Watermark Coal project.
- The preliminary model does not include any climate change scenarios. Future models should address this issue.
- The visual comparison of predicted water levels compared with measured water levels shows that the head calibration is best for the alluvium and worst for the sedimentary rocks and Basalts. In some areas the differences are significant (20 to 50m).
- The base case groundwater model shows the maximum drawdown for the Hoskissons Seam to be substantial in both area and in depth. Also the residual recovery area is still significant after 280 years post mining i.e. large areas have 2-10m still to recover (HydoSimulations, 2014; Fig.40 Layer 8).

- Model layers 2(Gunnedah Fm/Regolith), 3(Liverpool Range Basalts) and 4 (Jurassic Formations) represent the 'highly productive' aquifers but only layer 4 (Jurassic Formations) triggers the minimal impact criteria of greater than 2m. This occurs at 27 privately owned bore sites.
- The deeper Permian and Triassic rocks (Model layers 5 to 9) will experience the most significant groundwater impacts, with predicted water take up to 2,300 ML/year and drawdowns in nearby privately owned bores up to 186 m. These are the 'less productive' groundwater sources.

Notwithstanding the above comments the model has many of characteristics of a Class 2 model under the National Modelling Guidelines (Barnett et. al, 2012) and as such can be used for broad prediction purposes.

The proponent has provided a pathway for developing a more complex groundwater flow model as required by the AIP for an EIS. The Panel believes that the development of the more complex model should include:

- Using time variant input data e.g. stream flow, rainfall, ET, pumping data etc.;
- Distributed input parameters to the extent practical (T,Sy,Ss, River leakance);
- Improved hydrogeological knowledge on faulting, and the effects of subsidence fracturing on groundwater flow;
- Calibration of both Steady State and Transient models;
- A more rigorous assessment of cumulative impacts by including the neighbouring Watermark development in the model;
- A detailed sensitivity analysis for the predictive model, including varying boundary conditions; and
- A detailed uncertainty analyses so the reader can gauge the likelihood of a particular outcome.

These modifications would more accurately represent the conceptual hydrogeology of the mine area and surrounds. A more complex model will still have a high degree of variability of predicted model outcomes. It is important therefore that future model reports discuss predicted outcome uncertainty so that the community and approval authority have a total picture on risk to water assets.

Subsidence

The potential impacts to water resources as a result of the predicted subsidence are not well quantified (IESC, 2014). According to the IESC they could include:

- Increased permeability, connectivity and potential for leakage between streams, alluvium and hard rock hydrogeological units;
- Surface cracking, ponding, changes to stream morphology, streambed scouring and increases in areas subject to flooding. As a result, water quality may be reduced, including an increased sediment load. Direct subsidence-induced impacts to the Mooki River and Quirindi Creek are unlikely, but there are likely impacts to smaller drainage channels in their respective catchments; and
- Potential structural damage to water infrastructure.

NOW (2014) state that surface fractures caused by subsidence could present a risk that surface flows may enter the mine void and that this risk has not been defined.

The Panel is of the opinion that the generic approach adopted in the groundwater model to handle fracture zones associated with subsidence is appropriate for this early work. However more detailed investigations into the height of fracturing are required for an EIS to determine the implications on surface and groundwater flow. Future modelling should include a sensitivity analysis on varying the density of fractures back to the ground surface.

Water quality

Seventeen sampling events have been conducted between June 2008 and March 2013 (AGE, 2014). Samples were collected from 51 bores screened across five different formations. Estimates of total dissolved solids are made from electrical conductivity readings, pH values are also provided.

Detailed chemical analyses including major anions, major cations, minor ions, trace elements and nutrients are noted in the documentation but not presented or discussed. This important information could throw more light on the groundwater flow process, particularly when coupled with age dating of the groundwaters, also not reported. The Panel requires that full chemical analysis of all groundwaters be included in future reports.

CMAL state that there will be no reduction in beneficial uses of any groundwater source or the Mooki River. This conclusion however has not been demonstrated. Of particular interest to the Panel is any saline discharge to the Mooki River, both short and long term, post mining.

Other potential water quality impacts that require further consideration are:

- The effects of the emplacement of CPP rejects materials (on verified non- BSAL land) on runoff water quality; and
- The risk of increased dryland salinity caused by water ponding on low slopes as a result of subsidence.

Surface Water

The Panel notes the IESC (2014) statement:

"The Caroona Coal Project is expected to induce a loss of baseflow to the Mooki River of up to 0.7 ML/day, primarily between Caroona and Breeza. This reduction is about one third of the low flow (70th percentile) in the Mooki River at Breeza. As such, there is likely to be an increased duration and/or frequency of no flow periods at and downstream of Breeza. The loss of baseflow could be as high as 0.9 ML/day when considered in a cumulative sense with the neighbouring Shenhua Watermark Project. Impacts to ecological assets and surface water users as a result of the modelled reduction in baseflow to the Mooki River have not been presented".

Presumably CMAL will acquire the necessary Unregulated Mooki River access licences and abide by the low flow rules in the water sharing plan. They have not indicated however how they will mitigate the continuous take of water by the mine from the Mooki River when access restrictions are in place. This needs to be resolved so that ecological assets and other water user's rights are not diminished.

A detailed water balance needs to be included in any future studies to determine whether there is a need to discharge waste water during the life of the mine.

As stated previously the Panel finds that the work on the river-groundwater exchange quantities needs a more rigorous assessment. The reach between Caroona and Breeza needs to be assessed for spatial and temporal variation in losing and gaining stream flows.

Water sharing Plan Rules

The Gateway application shows an understanding of the relevant water sharing plan (WSP) rules with respect to holding appropriate annual entitlements in affected surface water and groundwater sources. Predictions have been made on the number of unit shares needed to account for water taken from surface water sources, alluvial sources, porous rock and fractured rock sources on an annual basis. CMAL already have some access licences and have stated that they are prepared to acquire the necessary shares through the trading market. It appears that there are sufficient shares in the various affected water sources for the company to acquire the necessary licences. Alternatively water may be available in some water sources through a controlled allocation order.

The Panel is aware that the daily flow rules within a WSP can be more restrictive during times of drought than the annual limitations. This is particularly the case for Unregulated River Access Licences. Known commonly as daily flow restrictions or the cease to pump rule, it is generally invoked when the river flow falls below a specified flow. CMAL has not indicated what they will do in the event of a daily flow restriction order being made on the Mooki River, for which they require a water licence to account for their take.

Contrary to what is stated in the application, groundwater trading from Upper Namoi zone 8 to other zones is not permitted (apart from Zone 10). The proponent needs to revisit their proposal to transfer share component from zone 8 to other zones.

Aquifer Interference Policy (AIP) Requirements

Table 1 below provides the Panel's assessment against individual AIP requirements

TABLE 1. ASSESSMENT AGAINST AIP REQUIREMENTS

Requirement	Assessment	Recommendation
1. Estimates of all quantities of water that are likely to be taken from any water source on an annual basis during and following cessation of the activity	The water budget work was undertaken using a simple calibrated steady state model and an un-calibrated transient model. The results whilst adequate at this early stage of planning are broad in nature. For an EIS the proponent needs to develop a more robust and detailed groundwater flow model that will more accurately depict groundwater flow conditions.	Using a transient 3D groundwater flow model re-calculate the volumes of water to be taken from each water source. Provide this information in the EIS together with all assumptions made and data used. Include information on: • A strategy for accounting for any water taken beyond the life of the operation; • Quantification of any uncertainties in the groundwater modelling; and • A plan for monitoring actual water take and how any changes from the predictions will be accounted for with water licences.
2. A strategy for obtaining appropriate water licenses for the maximum predicted annual take	The proponent already holds some groundwater entitlements. CMAL has indicated that all necessary water entitlements will be acquired through the trading market or by transfer of water entitlements CMAL already held.	The proponent should demonstrate how the proposed water transfers will work within the Upper and Lower Namoi Groundwater trading rules.

Requirement	Assessment	Recommendation
3. Establishment of baseline groundwater conditions including groundwater depth, quality, and flow based on sampling of all existing bores in the area, any existing monitoring bores and any new monitoring bores that may be required under an authorization issues under the Mining Act 1992 or Petroleum (onshore) Act 1991	More work is required to establish baseline groundwater conditions. In particular the following is inadequately defined: • Potential effects of geological faulting on groundwater flows; • The interaction between surface and groundwater; • The detailed hydrochemistry of groundwaters in each modelled layer; • The age of groundwaters in each modelled layer; and • Groundwater levels in Permian, Triassic and Jurassic rocks within the predicted zone of impact.	Undertake more studies to establish baseline groundwater conditions. Including: • Determining the likely effects of geological faulting on groundwater flow; • Determining the interaction between surface water and groundwater; • Establishing the hydrochemistry of the groundwater in each modelled layer; • Determine the age of groundwater in each modelled layer; and • Ensure that sufficient water level and water quality monitoring is undertaken in all major rock units affected by the impacts of mining.
4. A strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans	Other than holding the appropriate annual licence volumes in affected water sources the proponent has not demonstrated how they would abide by Water Sharing Plan daily flow rules.	The proponent should provide: A strategy for mitigating the impacts of mine water take from the Mooki River during periods of restricted access, such as droughts.
5. Estimates of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right.	Basic landholder rights include extracting water for stock and domestic uses. A water licence is not required for this type of extraction in water sharing plan areas. Impacts are similar to 6 below.	Same as 6 below.
6. Estimates of potential water level, quality or pressure drawdown impacts on nearby licenced water users in connected groundwater and surface water sources	Current estimates are based on a preliminary groundwater flow model. The model gives broad results only. The results are satisfactory for the Gateway assessment but need to be upgraded for an EIS. The Panel recognises the limitations of the work to date. Current water level monitoring is inadequate for the NSW Murray Darling Basin Porous Rock groundwater sources.	Using a calibrated transient 3D model re-calculate the impacts on nearby licenced water users. This updated modelling and reporting should: • Capture the hydrogeological complexity of the site; • Use temporal input data; • Have distributed input parameters; • Quantify any uncertainties in the groundwater/surface water connection; • Trial a range of model boundaries to establish a preferred boundary type; • Establish the cumulative impact of operating in parallel with the neighbouring Watermark project; and • Extend the network of monitoring bores to monitor potential impacts on water users in the NSW Murray Darling Basin Porous Rock groundwater sources.
7. Estimates of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems	No site studies have been undertaken. Reference has been made to published data.	Undertake a detailed assessment including field studies, on the potential impacts of mining on groundwater dependent ecosystems and report on mitigating options as necessary.

Requirement	Assessment	Recommendation
8. Estimates of potential for increased saline or contaminated water inflows to aquifers and highly connected river systems	CMAL has stated that there will be no change in beneficial use of any aquifer or the Mooki River as a consequence of mining. Some hydochemical work has been done to determine baseline groundwater quality, but full chemical analyses have not been presented.	Undertake studies to better characterise the hydrochemistry of each model layer and predict changes in water quality in both the alluvial aquifers and surface streams, if any. Determine the effects of: • the emplacement of CPP rejects materials on runoff water quality; and • The risk of increased dryland salinity caused by water ponding as a result of subsidence.
9. Estimates of potential to cause or enhance hydraulic connection between aquifers	The subsidence report outlines the possible extent of fracturing above the underground mining site. This work will be refined for the EIS. The current groundwater model does not handle fracturing from the coal seams back to the surface.	Undertake more detailed work on the height of fracturing above longwalls. As appropriate, include in future groundwater modelling, subsidence fracturing that extends to the ground surface and discuss the results in a sensitivity/ uncertainty analysis.
10. Estimates of the potential for river bank stability, or high wall instability or failure to occur.	Not considered to be a risk to water resources.	NA
11. Outline of the method for disposing of extracted water (in the case of coal seam gas activities.	NA	NA

In undertaking this assessment the Panel has considered all comments from the IESC (2014) and NOW (2014). The Gateway documentation could have been improved by a more extensive sensitivity analysis of model input parameters and more refined scales on the drawdown and recovery maps.

All forward undertakings by the proponent should match or better the recommendations outlined above.

References

Australian Groundwater & Environmental Consultants Pty Ltd (AGE), 2014. *Caroona Coal Project Study Plan, Project No G1634.*

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