



Office of
Environment
& Heritage

Your reference: 11/18834
Our reference: DOC13/17728; FIL12/10400
Contact: David Paull, 4908 6837

Mr Clay Preshaw
Acting Team Leader, Mining Projects
Department of Planning and Infrastructure
GPO Box 39
SYDNEY NSW 2001

Attention: Carl Dumpleton

Dear Mr Preshaw

RE: OEH SUBMISSION FOR THE WALLARAH 2 COAL PROJECT (SSD_4974)

I refer to your letter dated 22 April 2013 seeking comment by the Office of Environment and Heritage (OEH) on the Wallarah 2 Coal Project, a proposed State Significant Development (SSD_4974). OEH notes that this project has been determined a 'Controlled Action' (EPBC 2012/6388) under the Australian Government *Environmental Protection and Biodiversity Conservation Act 1999* and that matters identified under the supplementary Director General Requirements are to be assessed pursuant to the *Environmental Planning and Assessment Act 1979* (EP&A Act).

OEH notes that the proposal will include the following features; an underground longwall mine, coal handling and storage facilities, rail loop and loading infrastructure, an underground entry and ventilation shafts, gas and water management facilities, maintenance facilities and administration buildings. OEH provides advice in relation to threatened biodiversity, heritage, flooding and surface water management and environmental impacts resulting from subsidence.

OEH has previously provided an adequacy review (31 October 2012) to the Department of Planning and Infrastructure prior to exhibition of the Environmental Impact Statement (EIS) and notes that many of the issues raised at this stage of the assessment process have not been adequately resolved in the exhibited EIS. Detailed comments on the exhibited EIS are provided in **Attachment 1**. Recommendations for additional information that is required for this project to be fully assessed are provided below:

1. In order to prevent permanent damage to sensitive groundwater aquifers, surface water systems threatened ecological communities and the habitat of threatened species, the proponent redesign the longwall layout so as to preventing longwalls being extracted directly under Little Jilliby Creek, Myrtle Creek, Armstrong Creek and Jilliby Creek or within their angle of draw.
2. The detailed Biodiversity Management Plan be provided to OEH prior to development approval, outlining the final details of the mitigating actions.
3. A finalised Biodiversity Offset Package final offset strategy detailing the amount of biodiversity credits to be retired, the quantum of the proposed offset package and the conservation mechanism to be implemented prior to development approval.
4. The extent of impact in the PMF needs to be included in the assessment so that appropriate management measures for this residual risk are included as part of the assessment process prior to development approval.

5. The proponent work with Wyong Shire Council to identify the properties and update controls in areas impacted by the proposed development prior to development approval.
6. The results of the Wyong River Catchment Flood Study should be compared to the Wallarah 2 flood study for consistency in results, as Wallarah 2 falls fully within the boundary of the Wyong River Catchment Flood Study.

OEH will reconsider the development proposal in the light of the above concerns being addressed, and if appropriate, provide recommend conditions of approval.

If you require any further information regarding this matter please contact David Paull, Regional Biodiversity Conservation Officer, on 4908 6837.

Yours sincerely



26 JUN 2013

RICHARD BATH
Head - Hunter Planning Unit
Regional Operations

Enclosure: Attachment 1

ATTACHMENT 1

OEH review of the Wallarah 2 Coal Project (SSD_4974) in relation to threatened biodiversity, heritage, flooding and surface water management and environmental impacts resulting from subsidence.

SUBSIDENCE AND AQUATIC ECOLOGY

Introduction

As in the adequacy review for this project, the EIS remains inadequate in a number of areas and has failed to take account of previous comments made by OEH on this proposal. The most obvious demonstration of this failure is that no changes to the mine layout have been undertaken to address concerns related to the impacts of the proposed mine on significant natural features, including 3rd order and above streams, important groundwater aquifers (and their linkage to significant stream networks), groundwater dependent ecosystems (GDEs), protected/threatened species and Jilliby State Conservation Area (SCA). OEH believes that there are significant risks associated with the proposed mine layout and that these risks have been understated and inadequately dealt with in the EIS.

The major deficiencies in the EIS that OEH has identified are:

- inadequate protection to Little Jilliby Jilliby Creek, the major stream within Jilliby State Conservation Area
- demonstrably inadequate survey and description of environmental assets at risk within Jilliby State Conservation Area, particularly the 3rd order sections of Little Jilliby Jilliby Creek above the proposed longwalls
- no mitigation strategy or commitment to rehabilitation of Little Jilliby Jilliby Creek within Jilliby SCA if impacted (or any other 3rd order or above stream over the project area)
- inadequate assessment of impacts and presentation of monitoring data from existing and past mining operations (e.g. Springvale Colliery, West Wallsend Colliery, Mandalong, Awaba, Chain Valley, Dendrobium Colliery) to inform risk and provide support for future mining, often with wider longwalls than those utilised in many neighbouring mines where impacts have been identified.
- highly speculative and untested assumptions that impacts will be lower at Wallarah 2 than in other mining domains
- inadequate assessment of potential stream impacts given approximately 13.7 kilometres of 3rd order or above streams have predicted upsidence > 100 mm (approximately 19.6 kilometres of 3rd order or above streams are predicted to experience upsidence > 60 mm) and approximately 10 kilometres of 3rd order or above streams have predicted closure > 200 mm (approximately 12 kilometres of 3rd order or above streams are predicted to experience valley closure > 100 mm)
- inadequate treatment of faults identified within exploration boreholes, some of which are very close to the major 3rd order streams within the Project Area
- unsubstantiated conjecture that alluvium within streams will prevent or mitigate impacts. This is compounded by limited mapping of stream features (pools, rockbars, exposed bedrock, boulder fields and alluvium depth) throughout the majority of the mining domain
- the use of ill-defined, unquantified and misleading terminology (e.g. ephemeral) to describe third order streams
- limited gauging data for 3rd order and above streams (excepting Jilliby Jilliby Creek and Wyong River) above the proposal. This will hinder any assessment of impact (e.g. loss of water) in the majority of 3rd order streams above the proposal

- no baseline water level monitoring of the vast majority of GDEs over the proposed mine plan
- inadequate survey methods for fish and limited fish and aquatic or semi-aquatic vertebrate surveys in all 3rd order streams within the Project Area
- limited description of groundwater discharge areas or quantification of groundwater contributions to stream flows and the effect lowering of groundwater aquifer levels will have on these discharge areas and stream flows
- exceedingly long timeframes suggested for recovery of groundwater aquifers (500 years) compared to the relatively short life of the mine (30 years). Due to these long timeframes, any mistakes in calculations of recovery or unexpected adverse groundwater aquifer outcomes are unlikely to be addressed by the mining company responsible
- extremely limited groundwater information from nearby mines (e.g. Mandalong mine) included to identify the potential magnitude of the vertical leakage and pressure losses within overlying or underlying strata
- inadequate consideration of vertical leakage and pressure losses from other areas of longwall mining in NSW to help inform risks of the current proposal (e.g. Dendrobium Mine)
- uncertainty about the actual volumes and quality (compared to predictions) of treated mine water to be discharged to Wallarah Creek. Any new licensed discharge into Wallarah Creek should not lead to major degradation of the streams ecosystem
- inadequate investigations of reuse options for the treated water in the EIS
- inadequate assessment of the potential for super-saline waste products to migrate into the surrounding groundwater aquifer(s)
- inadequate assessment of where the current coal seam aquifer(s) discharge and whether it has the potential to be intersected by the streams/lakes of the Central Coast floodplain. As a result, the ultimate environmental fate of the supersaturated salt solution for the project remains uncertain.

Jilliby State Conservation Area

Jilliby SCA (12159 ha) is located in the Lakes Area of the Central Coast – Hunter Range Region, approximately 13 kilometres west of Wyong. Jilliby SCA was identified as an icon forest area in the NSW Comprehensive Regional Assessment process, and after being at the heart of a high profile environmental debate the reserve was created on 1 July 2003 through enactment of the *National Park Estate (Reservations) Act 2003*. Jilliby SCA was created from four portions of former State Forest, but because of the known coal reserves underlying the area the reservation for Jilliby State Conservation Area was restricted to a depth of 50 metres. Jilliby SCA provides an almost continuous link between Watagans National Park in the north and Brisbane Water NP in the south, and features predominantly wet sclerophyll forests (shrubby and grassy subformations) of the Coastal Dissected Plateau biogeographic subregion. The major creekline within Jilliby SCA is Little Jilliby Creek which reaches 3rd order under the Strahler categorization above the proposed Wallarah 2 longwalls. Little Jilliby Creek becomes a 4th order stream under the Strahler categorization downstream of Calmans Gully.

Subsidence predictions identify a high level of risk (fracturing and diversion of flow) to Little Jilliby Creek. No mitigation strategy or commitment to rehabilitation of Little Jilliby Creek within the SCA has been made by the proponent. While OEHL does not object to the extraction of the coal resource underlying Jilliby SCA, OEHL does not accept the unnecessary damage to the most important stream within Jilliby SCA (i.e. Little Jilliby Creek). Loss of flow in this stream (as is likely given subsidence predictions) would have a significant impact on the fauna of the area, including a number of recorded threatened frog species. The likely magnitude of such impacts will have a direct and adverse impact on the conservation values of the SCA.

OEH note that there has been no surveys undertaken in the vast majority of Little Jilliby Jilliby Creek within the SCA and the boulder fields, rockbars, bedrock and other features of this stream have not been mapped. One spot measurement of water quality appears to have been made in the first and second order drainage lines of Little Jilliby Jilliby Creek but this does not appear to have been extended to the third order section of Little Jilliby Jilliby Creek overlying the proposed longwalls. In fact, the EIS almost completely ignores the 3rd Order sections of Little Jilliby Jilliby Creek in its description of current state or risk of impact from the mine plan. No aquatic (fish or macroinvertebrates) fauna surveys have been conducted in Little Jilliby Jilliby Creek within the SCA. Further, there has been no monitoring of flows within Little Jilliby Jilliby Creek to assess the potential consequences of loss of flow and aquatic habitat within Little Jilliby Jilliby Creek.

Given the potential for damage to Little Jilliby Jilliby Creek, OEH revisited these areas in December 2012 to gain an appreciation of the current state of Little Jilliby Jilliby Creek and what might be lost if significant impacts/modifications occur to the stream network and flow as a result of the planned mine. Some of the relevant stream and aquatic habitats identified by OEH within Jilliby SCA are illustrated below (Figure 1). OEH agrees with WRM's (2103) assessment that the *"upper reaches are in excellent condition"*, however, OEH disputes WRM's subjective assessment that it *"will recover quickly from any impact"*. There are plenty of examples in the Newcastle, Central Coast and Southern coalfields where similar streams once impacted have not recovered despite decadal time frames. It is clear that subsidence of the magnitude (see Subsidence Section) predicted within Little Jilliby Jilliby Creek could lead to the loss of these aquatic habitats and cause the creek to cease to flow except after significant rainfall events.



Figure 1. Little Jilliby Jilliby Creek at powerlines upstream of project area (Left); Off-stream pond near Daniels Pont Rd access track (Centre); Little Jilliby Jilliby Creek near Daniels Point Rd (Right).

OEH considers the EIS to be demonstrably deficient in its lack of on-ground survey work within Little Jilliby Jilliby Creek, including a complete lack of description of any significant features (pools, rockbars, alluvium) or aquatic or semi-aquatic species in the upper 3rd order reaches of Little Jilliby Jilliby Creek where it flows above the proposed longwalls. Insufficient detail is provided on the flow regime/permanency of water in Little Jilliby Jilliby Creek and the effect longwall mining could have on the permanence of aquatic habitat (e.g. potential for increased frequency of cease to flow days). Based on the subsidence predictions, OEH believes the Creek will be fractured for the majority of its length above the proposed longwall panels. No commitment has been made by the proponent to rehabilitate any part of the creek if it is fractured and drained.

OEH believes that Little Jilliby Jilliby Creek is a particularly significant stream within Jilliby SCA with high conservation value and which should have a negligible impact criteria applied (as defined in the Bulli Seam PAC Assessment).

OEH does not believe this can be achieved without redesigning the longwall layout and preventing longwalls being extracted directly under Little Jilliby Jilliby Creek or within its angle of draw.

Subsidence

While there remain a number of issues regarding the relatively unique and untested geological conditions at the proposed Wallarah 2 coal mine, it would be difficult to expect a better assessment of potential subsidence due to the proposed mine plan than that provided by SCT & MSEC (2012) and MSEC (2013). The real problem with the proposal lies not with the subsidence predictions *per se*, but with the longwall layout and the failure of the proponent to adjust the mine layout to take account of Government Agency comments/concerns about the significant surface features that are at risk from the current mine plan. While adjustments to longwall panel and pillar widths have apparently been made to limit subsidence in the Hue Hue mine subsidence area, no such protection has been given to Jilliby SCA (reserved for its conservation values) which is proposed to be undermined by the widest longwalls of the whole proposal. OEH does not accept that an area set aside as a State Conservation Area due to its iconic natural assets warrants a lower level of protection than that of the Hue Hue mine subsidence area.

It is generally acknowledged in the EIS that there remains uncertainty in subsidence predictions due to the untested geological environment of the area (and unvalidated model predictions), but even accepting such predictions there remains the possibility that the magnitude of subsidence can be well outside the range of those predicted. For example, Gale (2011) describe the case at Tahmoor Colliery where subsidence over a longwall panel was twice that previously measured or predicted using the MSEC incremental profile method. Recent impacts at Springvale Colliery, West Wallsend Colliery and Dendrobium Colliery should also provide grounds for concern about the magnitude of potential impacts of the Wallarah 2 Coal mine. Unfortunately these highly relevant experiences are not discussed in the EIS or consultants reports in 'support of' the Wallarah 2 proposal.

While OEH considers the subsidence predictions to be an appropriate base from which to assess potential subsidence related impacts of the proposal, OEH considers the actual assessments of impact likelihood and consequence (i.e. risk) in the EIS to be highly subjective, understated and lacking in scientific rigour given recent experiences at other mines where similar longwall mining techniques have been employed and significant environmental impacts have occurred.

Subsidence Predictions for surface streams above the mine

The Bulli Seam PAC report (Planning Assessment Commission 2010) described the methodology used by the PAC to assess potential negative environmental consequences of the Bulli Seam Proposal. The Bulli seam PAC report identified a number of thresholds above which fracturing of rock strata was possible leading to potential negative environmental consequences. The PAC noted:

- *"As the [Bulli Seam] EA also does not provide points of reference for the significance of strain predictions on ground behaviour, the Panel reverted to those provided in Appendix A of the Metropolitan Coal Project, being:*

Fracturing of sandstone has generally been observed in the Southern Coalfield where the systematic tensile and compressive strains have exceeded 0.5 mm/m and 2 mm/m, respectively

- *The Panel finds that stream values depend on the recognition of the stream system as a continuum with the value of any segment heavily dependent on upstream and downstream conditions and in higher and lower order components of the system. Pools behind rockbars may be visually dominant features but other stream morphologies including boulder fields and pools behind other channel constrictions are also vital components of the linear system.*

- The loss of surface flow to sub surface fracture networks can result in dry periods for otherwise perennial streams and increased periods of zero flow in intermittent streams. The Panel finds that the likely magnitude of this impact would exceed standards generally accepted for allowable impacts on the flow regime in assessment of water resources development projects.
- In the remote areas of sandstone gorges to the east and south of the Study Area, the Panel finds that the value of the stream network is closely associated with its natural characteristics and its pristine setting. The Panel finds that in these zones even small impacts can have major consequences for naturalness values and may be irreversible.
- In consideration of the shallow systems, the Southern Coalfield Inquiry determined that the potential impacts of mining included cracking of stream beds and rock bars as a result of tensile failure and/or bedding shear associated with normal subsidence, or with valley closure mechanisms. Tilt was also noted in relation to upland swamps. Consequences of these mechanisms on stream beds are known to include partial to complete loss of surface flows as water is redirected into underlying fractures, draining of pools upstream of cracked rock bars, erosion of swamp materials as flows are reconcentrated (from tilts), changes to the water table in swamps and associated changes to habitat, and water-rock geochemical interactions along newly exposed fracture pathways. The latter is typically associated with iron (Fe) staining along creek beds and on rock bars, bacterial matting, reduced oxygen levels and unnatural discolouration of stream waters".

There was a great deal of discussion in the Bulli Seam PAC report over the use of non-conventional subsidence (upsidence and valley closure) thresholds to assess additional risks of impact (over and above those from conventional subsidence). Industry advocated a 200 mm valley closure threshold, but the Bulli Seam PAC Panel was concerned about setting a threshold for assessment of risk at >200 mm predicted closure. As knowledge improved the Panel considered:

- "there will undoubtedly be a revision of this figure as a threshold for triggering concern or investigation (there is already evidence of damage occurring to rock bars in streams at lower predicted closures). The Panel is of the view that the more sensible approach as knowledge improves is to develop a prediction methodology that is premised on a correlation between measured closure and measured impacts".

OEH previously commented that it would prefer to focus assessments of potential impacts of non-conventional subsidence on the basis of maximum observed/predicted closure strains. Closure movement (in mm) but not closure strains (mm/m) are detailed in the subsidence assessment. As an illustration of OEH's previous concerns about the valley closure >200 mm threshold, Figure 2 illustrates the upsidence and valley closure graph that appeared in the Bulli Seam PAC review report and the most recent iteration of this graph provided in MSEC (2012). It is clear that Type 3 pool impacts have now occurred at total closure levels well below 200 mm in the Upper Georges River as a result of West Cliff LW33 operations (where the panels did not go directly underneath the river). It is also worth noting that neither of the graphs included the experiences at Waratah Rivulet WRS3/Pool A (Arthur Waddington pers comm. 2012) where Galvin & Associates (2005) identified major pool/rockbar impacts with measured upsidence of only 60 mm.

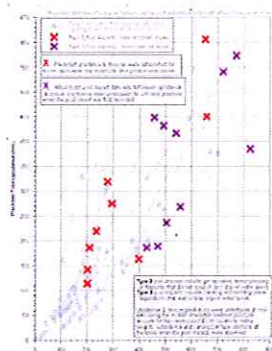


Figure 14: Correlation between Predicted Total Closure and Total Upsidence at Time of Pool Impacts in the Southern Coalfield

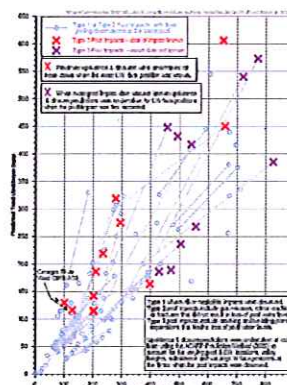


Figure 17: Case Studies from the Southern Coalfield showing the Predicted Total Upsidence and Predicted Total Closure at the Time of Pool Impacts

Figure 2. Correlation between Predicted Total Closure and Total Upsidence from the Bulli Seam PAC Report (left) and Dendrobium 3B MSEC 2102 Report (right).

While there are clearly geological differences between the Wallarah 2 and the Bulli Seam Project Areas, it is highly speculative to suggest that any impact will automatically be lower at Wallarah 2. If the subsidence predictions in MSEC (2013) are considered for the major streams above the Wallarah 2 proposal, many of these predictions considerably exceed the subsidence thresholds used by the Bulli Seam PAC to predict potential negative environmental consequences. Maximum tensile stresses for Jilliby Jilliby Creek, Little Jilliby Jilliby Creek, Armstrong Creek and Myrtle Creek range from 2.25 mm/m to 4.2 mm/m (in some cases over eight times the 0.5 mm/m PAC threshold for rock fracturing). Maximum compressive stresses for Jilliby Jilliby Creek, Little Jilliby Jilliby Creek, Armstrong Creek and Myrtle Creek range from 3 mm/m to 5.55 mm/m (in some cases almost six times the 2 mm/m PAC threshold for rock fracturing). Maximum valley closure levels for Little Jilliby Jilliby Creek, Armstrong Creek and Myrtle Creek range from 775 mm to 1000 mm (up to five times the industry suggested impact threshold of 200 mm and highly likely to cause fracturing in incised river valleys). Maximum upsidence levels for Little Jilliby Jilliby Creek, Armstrong Creek and Myrtle Creek range from 650 mm to 800 mm (also highly likely to cause fracturing in incised river valleys).

Overall, approximately 19.6 kilometres of 3rd order or above streams are predicted to experience upsidence > 60 mm (approximately 13.7 kilometres of streams with predicted upsidence > 100 mm; see **Appendix 1**). Approximately 12 kilometres of 3rd order or above streams are predicted to experience valley closure > 100 mm (approximately 10 kilometres of streams with predicted closure > 200 mm; see **Appendix 1**). This is not a trivial extent of potential impact and highlights the risk of serious adverse consequences of both conventional and non-conventional subsidence on the 3rd order and above streams lying above the project area.

The conjecture that alluvium within these streams will prevent or mitigate impacts to surface flows is speculative, untested and largely unmonitored in the current proposal. Where there is relatively little or no alluvium (e.g. in parts of Little Jilliby Jilliby Creek) there is little scope for the provision of any mitigating effects. Previous impacts on other alluvial streams such as Bowmans Creek and the nearby Diega Creek are testament to the potential for impacts on these alluvium filled streams to occur. It is also worth pointing out that Waratah Rivulet (Pool A behind WRS3) also had significant amounts of sandy alluvium which did not mitigate impacts or prevent the near complete draining of Pool A.

In the driest continent on the planet, the long-term sustainability of the surface and groundwater resources of the area is an important issue. Sustainability of these water resources assumes an even greater importance since the water resources being put at risk from mining at Wallarah 2 form part of the Gosford-Wyong Drinking Water Supply. OEH believes that with careful planning and longwall design coal can be productively extracted from the area without putting at risk the water resources that a large part of the community relies upon. However, OEH does not believe such an outcome is possible if the objective is purely to maximise coal extraction without due regard for the long-term integrity and sustainability of flows in the major 3rd order and above streams of the area. OEH reiterates its view that the documentation provided for the Wallarah 2 proposal often understates and underestimates the magnitude of potential impacts and consequences and therefore risks of the current mine plan to these important water resources.

Faults and lineaments

In response to previous comments on the potential for faults to affect subsidence within the Project Area, the EIS now has a specific volume dealing with Geology (WACJV 2013 Appendix C Geology). This report confirmed the existence and location of the Macquarie and Yarralong synclines, but found no support for the 'Coastal Lineament' proposed by Mauger et al (1985) or the 'Northern Geosciences Faults' proposed by Jones (2005). Figure 7.4 of the Geology Report illustrates the lineament and faults (and proposed lineaments and faults) as well as exploration boreholes. It is clear from Figure 7.4 that there have been no high resolution seismic investigations undertaken in the western region of the project area (i.e. near or within Jilliby SCA).

In previous discussions with the proponent about the potential impacts of faults, OEH was provided with a similar figure to Figure 7.4 which also highlighted faults identified within exploration boreholes (see Figure 3). OEH considers Figure 7.4 of the Geology report to be misleading in not additionally identifying the faults within exploration boreholes, some of which are very close to the major streams within the Project Area. The potential for these faults to increase the risk of impact to significant streams receives virtually no attention in the EIS. If a discussion of faults is to be presented in the EIS, all relevant information, including the location of faults identified within exploration boreholes, should be documented, clearly presented and assessed for their potential to impact major streams within the Project Area. This has not occurred.

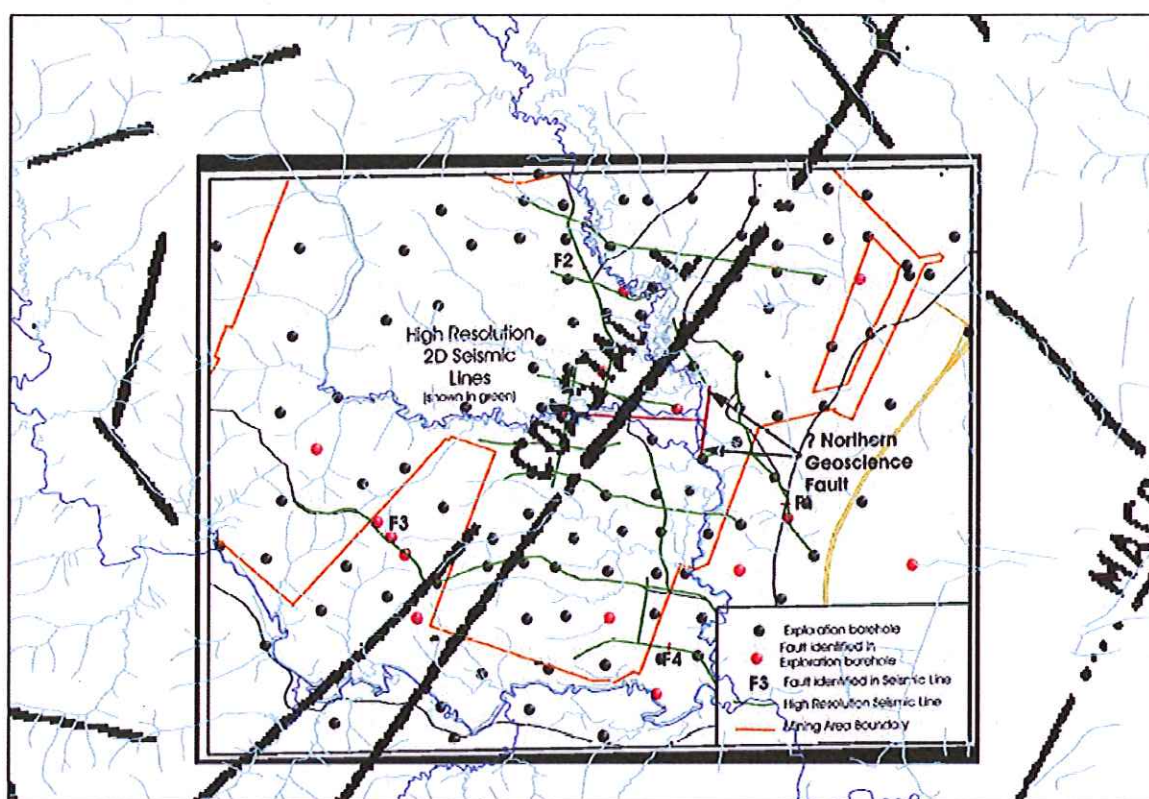


Figure 3. Faults, synclines and lineaments identified within exploration area including those detected in boreholes (red circles). Source: WAJCV and Mauger et al 1985.

Fracture analysis

MSEC (2013) State:

- "Surface cracking and surface water flow diversions are the most visible and well known impacts associated with mining beneath valleys and streams in the Southern Coalfield. However these surface water flow diversion impacts are unlikely to occur within the Study Area because the major watercourses within the Study Area have deep alluvial deposits covering the bedrock and there are few rockbars or exposed bedrock areas within the smaller tributaries to these major streams." [p73]
- "In the cases of the major streams within the study area, exploration drilling indicates the presence of alluvial deposits of up to 40m deep and; therefore it is unlikely that any fracturing of bedrock would be visible at the surface." [p76]
- "Fracturing shearing and buckling may occur at the rock head in these valleys. However since this will occur beneath the saturated alluvial deposits, the fracture zone will fill as it develops with little or no effect to the surface water level. Similarly since this increased permeability zone will develop gradually and its volume will be small compared to the volume of the overlying saturated alluvium, the impact on the alluvial and the overall surface stream flow is expected to be small". [p76]

Since there has been no systematic mapping of most stream features (e.g. rockbars, exposed bedrock areas, pools, boulder fields, depth of alluvium) in **the majority** of the major streams potentially affected by the proposal, OEH does not agree with the subjective generalization that impacts are *"unlikely to occur"*. OEH notes areas of bedrock outcrop, boulders, pools and shallow alluvium in Little Jilliby Jilliby Creek within Jilliby SCA (see photos). Similar features exist in Myrtle Creek, Armstrong Creek and a number of the other 3rd order or above streams above the proposed longwalls (e.g. see photos in MPR (2103) Aquatic Ecology Report). OEH also notes that shallow alluvium within swamps and streams on the Woronora and Newnes Plateau have failed to protect these features from significant long-term impacts from longwall mining. Previous impacts on other alluvial filled streams such as Bowmans Creek and the nearby Diega Creek are testament to the potential for serious impacts to occur in these alluvial streams. Lastly, there appears to be virtually no monitoring within the proposal (e.g. groundwater levels in the alluvium before and after undermining with a comparison to reference locations (i.e. a BACI design)) dedicated to assessing whether such optimistic conjecture about 'lack of impacts' holds.

OEH further notes SCT & MSEC (2013) statements that:

- *"Some enhanced permeability is anticipated in the near surface strata as a result of subsidence related cracking at rockhead. While local areas of horizontal flow and flow redirection may occur within the near surface, these are not directly connected to the mining zone"*.
- *"The greatest likelihood of potential impacts would be confined to the high relief areas in the western part of the extraction area"*.

The latter statement in particular is considered highly relevant to appropriately assessing risks to Little Jilliby Jilliby Creek and Jilliby SCA.

MPR (2013 p96) concludes that:

- *"With regard to potential subsidence impacts the plasticity of the forested sub-catchment drainages as outlined above means that many of the potential subsidence impacts associated with rock constrained valleys will not occur, are not relevant or will not be exacerbated to any measurable degree. Accordingly, the residual potential combined impacts of subsidence plus tilt and strain that is of concern is the impact on the stability of the vegetation and shallow surface rock along the sides of the gullies and the consequences of increased erosion should the vegetation be destabilised."*

Apart from ignoring the potential for rock fracturing from conventional stress and non-conventional valley movements, it also fails to consider the previous record of impacts in the Newcastle, Southern and Western Coalfields and the very relevant experience at nearby Diega Creek. OEH does not consider this summary of potential impacts to be either objective or realistic.

Stream Flow and Modelling

In the Water Sharing Plan for Jilliby Jilliby Creek (DIPNR 2005), Jilliby Jilliby Creek is regarded as a *"stressed river"*. DIPNR (2005) stated:

- *"This means that, relative to the natural flows in the water source, the potential demand for extraction by water users is high. If everyone pumped water at the same time there would not be enough water for all existing water users and the environmental needs of the water source."*

Most of the modelling for the Project is based on local data for only three NSW Office of Water gauging stations in the area, one of which (Wallarah Creek), ceased operation in 1976. In numerous places within the EIS streams are described as *"ephemeral"* without any appropriate reference or assessment of flow. A perennial stream or perennial river can be defined as *"a stream or river (channel) that has continuous flow in parts of its bed all year round during years of normal rainfall"*. *"Perennial"* streams are contrasted with *"intermittent"* streams which normally cease flowing for weeks or months each year, and with *"ephemeral"* channels that flow only for hours or days following

rainfall. During unusually dry years, a normally *perennial* stream may cease flowing, becoming *intermittent* for days, weeks, or months depending on severity of the drought. The boundaries between *perennial*, *intermittent*, and *ephemeral* channels are indefinite, and subject to a variety of identification methods (but they all require some assessment of actual flow).

MPR (2013) state:

- *"As Wallarah Creek is ephemeral, treated water discharges may occur at times when there is no natural flow in Wallarah Creek."*

WRM (2013) state:

- *"The upland streams in the Wyong State Forest/Jilliby SCA are very steep and ephemeral and major pools are absent...Whenever pools are do occur in the steep upland drainage lines they are ephemeral...During the period of record, Wallarah Creek was ephemeral...During the period of record, Jilliby Jilliby Creek was ephemeral"*

While OEH can agree with the use of the 'ephemeral' term for the majority of 1st and 2nd order streams in the more mountainous areas, OEH disputes the use of the term "ephemeral" to describe third order and above streams (including Little Jilliby Jilliby Creek) over the project area. Indeed if the flow duration curves for Wallarah Creek (Stn 211006) and Jilliby Jilliby Creek (Stn 211010) presented in WRM (2013; Figure 2.19) are considered, it is clear that Wallarah Creek had no flow for approximately 19 per cent of the time period with recorded flows and Jilliby Jilliby Creek had no flow for approximately five per cent of the time period with recorded flows. This is clearly not indicative of an "ephemeral channel that flows only for hours or days following rainfall". As a further illustration of this point, if the low flows for Jilliby Jilliby Creek are analyzed in greater detail (particularly during the 2000 - 2008 Millenium drought; see Figure 4), zero ML/day flows were recorded in Jilliby Jilliby Creek on only seven occasions and flows less than 0.01 ML/day on 31 occasions over the last 12 years. The low flows in Figure 4 in earlier years may actually be indicative of an interaction between low flows and extractive use within the Jilliby Jilliby catchment. It is difficult to reconcile these low flow numbers with MPR's (2013) discussion of baseflows in Jilliby Jilliby Creek, particularly the statement that:

- *"...during prolonged drought periods, the creek would rapidly shrink to a series of isolated pools with little extended duration provided by baseflow."*

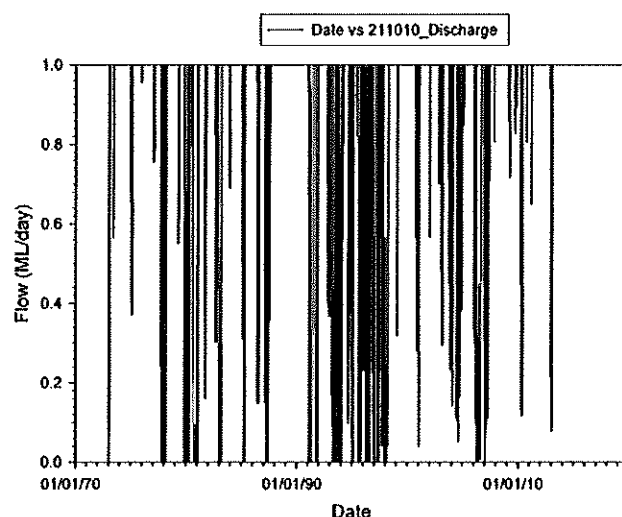


Figure 4. Low flow records for Jilliby Jilliby Creek (Stn 211010).

The use of ill-defined and misleading terminology (i.e. ephemeral) to describe third order streams and the lack of any flow data other than that provided by the NSW Office of Water gauges, points to an inadequate assessment of flows overall for the Wallarah 2 proposal. It is clear that no targeted flow data has been collected for Little Jilliby Jilliby Creek, Armstrong Creek or Myrtle Creek or recent flow

data for Wallarah Creek (last record from the old NSW Office of Water gauge was July 1976). It will therefore be impossible to verify/validate subjective assertions of 'no impact' on streamflow throughout the majority of the project area. In particular, there is no capacity to assess any change to the frequency of cease to flow periods for any major stream other than Jilliby Creek or the Wyong River.

OEH notes that under the Water Sharing Rules for Tuggerah Lakes Water Source, licence holders must cease to pump when there is no visible inflow to, or outflow from, the pumping pool. Within the EIS, there is currently no assessment of the contribution of the Wallarah 2 mine to either:

- an increase in the length of disconnected streams and creeks in the area due to fracturing (and what this may mean for aquatic flora and fauna); or
- an increase in the number of cease to flow events in these streams (and their effect on downstream Licence holders and the Gosford – Wyong drinking water supply).

OEH believes it is the proponent's responsibility to gather the data necessary to enable major decisions on risks to the surface water resources of the Wallarah 2 Project Area. This is particularly important in this case since these streams are part of the Gosford-Wyong Drinking Water Supply and provide significant habitat for important aquatic communities.

Other Wetlands

Cumberland Ecology (2103) identifies wetland endangered ecological communities in the study area, specifically:

- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin.

It is difficult to obtain a clear picture in the EIS of these wetland communities relative to the longwall layouts. Paperbark and tea-tree communities appear to be potentially within the zone of influence of the longwall panels, but no monitoring of groundwater levels in these areas has been undertaken to see/confirm whether the groundwater aquifers are perched or directly connected to regional aquifers or whether mining is likely to have an impact on these wetlands. In the past major impacts to swamps have occurred on the Woronora and Newnes Plateaux as a result of longwall mining.

Aquatic Ecology

Survey methods for fish¹ and aquatic or semi-aquatic vertebrates are still not considered adequate to establish the presence or absence of rare species in the Project Area with any degree of certainty. As a result, the sampling and assessment for these species in MPR (2013) is not considered adequate. Further, reference to Figure 5 identifies a complete lack of aquatic fauna/flora sampling in the 3rd order reaches of Little Jilliby Creek, particularly within the native forest areas of the Jilliby State Conservation Area. There has also been no aquatic fauna/flora sampling described within Armstrong Creek and Myrtle Creek, both 3rd order streams over the project area. This was pointed out by OEH in previous reviews but has still not been addressed in the EIS. Given the above issues, OEH has significant issues with MPR's (2013) summary of aquatic ecology (p78) that states:

- "There are no listed aquatic species, endangered ecological communities or critical habitat found or known from the total Wyong River study catchment and none are expected."

1. Page 31 of MPR (2103) states: Estimation of fish occurrence by a combination of overnight or short-term [minimum 1.5 hours] bait-trapping, dip netting and observation with all captured fish identified in-situ and immediately released wherever possible. OEH notes the lack of any backpack electrofishing methodology and the lack of aquatic sampling within Jilliby SCA (including the "oxbow lagoon"; see MPR 2013 Figure 30). See also unsampled aquatic habitat in Armstrong Creek (MPR 2013 Figure 25), Mid Dittons Rd Creek (Figure 27), Little Jilliby Creek upstream Splash Gully (Figure 28).

MPR's comments are also contradicted by the Wyong Water Sharing Plan report card (DWE 2009) which identified:

- four threatened bird species
- one threatened aquatic invertebrate species
- eight threatened amphibian species
- one threatened herbs and forbs species
- platypus have been identified in this water source
- high species diversity.

Groundwater Aquifers

Three types of aquifers are identified in the EIS:

- unconsolidated alluvial aquifers hosted within the Yarramalong and Dooralong valleys (including alluvial aquifers in the coastal areas)
- the shallow weathered rock zone
- more regional sedimentary rocks and coal measures including the WGN seam.

This generally agrees with the findings of Cook (2009), although Cook noted that the dynamics and distribution of the discharge zones for these aquifers were poorly understood; and that the dip of the sedimentary sequence may not be the main driver of the direction of groundwater flow.

Shallower hard rock aquifer systems tend to be localized, are rainfall driven and are likely to be perched in many areas (Mackie Environmental Research 2009). Evidence of pressure driven leakage in the hard rock aquifers was demonstrated at two geological bore sites where artesian pressures were encountered at relatively low elevations. Comments were also made regarding numerous springs throughout the area.

In contrast to the hard rocks, the alluvial aquifers associated with the Wyong River and Jilliby Jilliby Creek are suggested to be more dynamic flow systems with rainfall recharge penetrating the silty aquifer materials (Mackie Environmental Research 2009). Pre-mining upwards leakage from the hard rock strata to the valley fill alluvium was inferred from regional water level monitoring and from aquifer simulation models.

Impacts to Groundwater Aquifers

Impacts to groundwater from longwall mining is mainly through subsidence, strata movements and drainage. Subsidence and strata movements affect groundwater by: deforming existing fractures, enlarging existing fracture apertures, creating new fractures, separating bedding planes, and changing the hydraulic properties of the strata. As a result, the piezometric levels can decline; baseflow discharge to streams can reduce; groundwater flow patterns can alter; aquifers can change from confined to unconfined, causing water quality changes; and upper aquifers can leak to lower aquifers (Booth, 2002, 2006, 2007; Booth et al., 1998, Madden and Merrick 2009, Madden and Ross 2009). Few references to this scientific literature and past experiences are found in the Groundwater Assessment (MER 2013).

MER (2013) state that:

- *"Historical mining operations at other locations (e.g. Mandalong) have preferentially depressurised and dewatered the seam with loss of pressure extending over significant distances in advance of mining (+1km) and ultimately inducing vertical leakage and pressure losses within overlying and underlying strata".*

However, no data from the Mandalong experience are presented in the EIS to identify the potential magnitude of the vertical leakage and pressure losses within overlying or underlying strata.

Recent reviews (e.g. Heritage Computing 2012 & 2013, Madden 2008 & 2010, Ziegler and Middleton 2011, Krogh 2012) of groundwater impacts at Dendrobium mine have indicated major changes to shallow and deeper groundwater aquifers above the mine. Drawdowns of up to 40 metres in the Scarborough Sandstone, 50 metres in the Bulgo Sandstone and 25 metres in the Hawkesbury Sandstone were measured above Dendrobium longwalls and require much greater assessment with regards to their environmental consequence.

In addition, Tammetta (2012) has recently published estimates and equations for the height of complete groundwater drainage above mined longwall panels. The height of complete groundwater drainage numbers obtained using Tammetta's equation for the mining geometry at Wallarah 2 are similar to Gale's (2008) worst case outcome of fracturing extending up to a height of 1.5 times panel width, but with increasing disconnection of fracturing (see Bulli Seam PAC discussion of this point). It is noted that while some of the calculated numbers roughly agree with MER's (2013) estimate of "...of the order of 200m beneath alluvial lands", the height of the zone above the wider longwalls beneath the elevated hard rock areas in the west of the project area (not detailed in MER (2013)) are of the order of only 20-30 metres below ground level. If fracturing within creeklines of up to 15 metres occurs due to valley closure effects (e.g. see Forster 1995), there appears to be a very small margin of cover preventing surface to seam fracturing in some areas of the proposed mine plan.

SCT & MSEC (2013) noted:

- *"Some enhanced permeability is anticipated in the near surface strata as a result of subsidence related cracking at rockhead"; and*
- *"It is expected that the bedrock beneath these saturated riverbeds may fracture, buckle or uplift due to the valley closure and upsidence movements creating a zone of increased permeability in the upper few metres of rockhead."*

MER (2013) also state that:

- *"Cracking in non alluvial elevated hard rock areas may lead to localised redirection of groundwater flow paths in some areas. Fissures that transect drainages in these areas may infill from sediment load during periods of surface runoff, or may remain as localised conduits redirecting flows down slope (including underflows). It is not possible to predict with accuracy, the location and hydraulic connectivity of such cracking."*

Again this highlights the increased risk of mining with the widest longwalls panels under the incised drainages of Jilliby SCA.

Almost all conceptual models of groundwater aquifers suggest that they provide significant baseflow to the many streams within the Project Area; however, groundwater discharge areas and the effect of lowering of groundwater aquifer levels have not been adequately investigated in the EIS. The EIS (MER 2013) notes that panel extraction will result in the dewatering of the deep coal seam and in surrounding strata. It also states that such depressurization could potentially induce leakage from groundwater resources from overlying strata including the alluvial lands hosted within the Dooralong and Yarramalong valleys. Mining company reports for other areas (e.g. GHD Geotechnics 2010 over Dendrobium) also suggests that the recharge pathways for these groundwater aquifers can be altered by longwall mining. This has significant ramifications for the recovery of impacted groundwater aquifers after mining has ceased (if recovery indeed occurs). Given the extremely long timeframes suggested for recovery of groundwater aquifers (500 years suggested in MER 2013) and, by comparison, the relatively short life of the mine (~30 years), any mistakes in calculations of recovery or unexpected adverse groundwater aquifer outcomes from the Project are unlikely to be addressed by the mining company responsible. This point is reiterated in the later section dealing with underground disposal of brine.

Apart from their intrinsic value, the ecosystem services that groundwater aquifers provide in keeping rivers and streams flowing during periods of low rainfall are vitally important in protecting downstream ecosystems. Decreases to the groundwater levels in wetland and groundwater aquifers are likely to reduce and/or change the location of baseflow discharges, thereby affecting groundwater dependent ecosystems, stream ecosystems and Gosford-Wyong water supply needs. The potential for loss of baseflow (as a result of the alteration of groundwater levels and recharge pathways) to affect catchment water budgets in the Project area needs much greater consideration than that provided in the EIS.

Treatment of waste mine water

The Wyong Areas Coal Joint Venture (WACJV) is proposing to treat mine water on site with releases of treated water to Wallarah Creek as required. Mine water would be treated using a combined reverse osmosis (RO) plant with a capacity of 3 ML/day. At certain times during the operational phase of the project, a brine water treatment plant will be utilised to produce a partly dried mixed salt solid waste product for disposal underground. While OEH considers this a significant improvement on the original proposal (see PB 2008), it still does not fully detail the exact nature and environmental fate/effect of either the treated water or brine/salt waste products.

Discharge of Treated Minewater to Wallarah Creek

Walarah Creek is currently in good condition. The last time OEH sampled Wallarah Creek (16/10/2012) as part of the Monitoring Evaluation & Reporting (MER) program, OEH found 31 taxa (over the last 10 years or so OEH have found an average of approximately 27 taxa - range 23-31). This is in stark contrast to Marine Pollution Research (2102) who collected three samples over the last 12 months in Wallarah Creek yielding an average of only 11 taxa (range 8-15). While MER (2102) sampled a different (more disturbed part) of Wallarah Creek, OEH's results identify a diverse macroinvertebrate community within Wallarah Creek.

WACJV are now planning to treat waste mine water with a Reverse Osmosis treatment plant and release excess treated water into Wallarah Creek. Statements about the magnitude of discharge include:

- "Controlled discharges to Wallarah Creek range between approximately 0 ML/a and 230 ML/a" [or 0 to 0.63 ML/day] p83
- "On average treated water discharges to Wallarah Creek occur for the life of the project"
- "Discharges increase up to year 7 and remain fairly consistent thereafter, ranging from 50 to 500 ML/a" [or 0.14 to 1.4 ML/day] p94.

OEH has concerns about the actual volumes to be discharged and notes that at the nearby Mandalong mine, the current mining operation generates an **average** discharge of 1.59 ML/day at LPD001 (GHD 2013). However during periods of rainfall, discharges at Mandalong can be greater than 10 ML/day (Figure 5.4: Monitored discharges at LPD001 2010-2012, Water Management Impact Assessment GHD 2013). Under the proposed extension of mining works at Mandalong mine, the **average** discharge was expected to rise to 7.1 ML/day (over four times the current discharge). OEH has concerns that the actual volume of water produced (and required to be disposed of) at Wallarah 2 may be underestimated in the EIS (particularly during wet weather events). It is also noted that flows that exceed the design capacity of the 'Stockpile Dam' and 'Portal Dam' will overflow to Wallarah Creek. At these times highly saline and potentially contaminated water will likely flow to Wallarah Creek.

Due to the lack of clarity about the exact volumes and treated and overflow water quality², OEH would like to see additional studies undertaken on the ecotoxicology of the proposed treated and

² Limits set by the proponent (Table 4.3 WRM 2013) still appear to be high in Barium and pH compared to natural Wallarah Creek water quality.

overflow mine water prior to approval³. There are currently a number of problematic licensed mine water discharges in NSW (e.g. Brennans Creek Dam, Berrima Colliery, Upper Goulburn River) some of which exhibit toxicity to aquatic species downstream of the discharge and OEH seeks to avoid the potential introduction of additional ones.

There is a need for reasonable certainty that the introduction of any licensed discharge into Wallarah Creek will not lead to major degradation of the streams ecosystem. In addition, all potential reuse options should be investigated prior to settling on a discharge to a relatively good quality stream such as Wallarah Creek. Detailed investigations of reuse options for the treated water in the Wallarah 2 project do not appear to have been undertaken for this EIS.

Underground disposal of brine

Contamination of groundwater aquifers can have wide implications for drinking water, stock water, surface water, GDEs and the aquatic environment; particularly if injected water makes its way, or is pumped, to the surface or surface drainage lines (e.g. see discussions in Rail 2000, Zemke et al 2005). Zemke et al (2005) suggested that some of the requirements for the appropriate underground disposal of brine require:

- an aquifer reservoir of sufficient areal extent
- favourable reservoir properties (e.g. high layer thickness and good porosity)
- an aquifer covered by a tight cap rock with areal integrity (particularly where high-pressure gradients occur).

Limited information is available in the EIS to determine if the aquifers are truly suitable for the discharge of brine.

Underground injection of liquid waste materials has not been extensively practised within Australia although it has been used in other NSW coalfields (e.g. near Appin). It is, however, used extensively overseas and, in the USA, is regulated by the US Environmental Protection Agency. Concerns about the safety of deep injection disposal led the US EPA to issue a policy statement in 1974 that opposed storage or disposal of contaminants by subsurface injection *"without strict control and clear demonstration that such wastes will not interfere with present or potential use of subsurface water supplies, contaminate interconnected surface waters or otherwise damage the environment."* In December 1974, Congress enacted the Safe Drinking Water Act (SDWA), which ratified US EPA's policy and required the agency to promulgate minimum requirements for state programs that would prevent endangerment of underground sources of drinking water by well injection.

The United States Environmental Protection Agency currently groups underground injection into five classes for regulatory control purposes (USEPA 2004). Each class includes wells with similar functions, and construction and operating features so that technical requirements can be applied consistently to the class. Class I injects hazardous and non-hazardous fluids (industrial and municipal wastes) into isolated formations beneath the lowermost underground source of drinking water (USDW). Because they may inject hazardous waste, Class I wells are the most strictly regulated and are further regulated under the Resource, Conservation and Recovery Act (USEPA 2004). Class II includes injection of brines and other fluids associated with oil and gas production.

In general, US EPA's Underground Injection Control (UIC) Program prevents contamination of water supplies by setting minimum requirements for state UIC Programs. A basic concept of US EPA's UIC Program is to prevent contamination by keeping injected fluids within the intended injection zone, or in the case of injection directly or indirectly into a USDW, the fluids must not endanger or have the potential to endanger a current or future public water supply. Most of the minimum requirements that affect the siting of the injection well, the construction, operation, maintenance, monitoring, testing,

³ While the exact make up of treated mine water for Wallarah 2 may be somewhat unique, guidance could be achieved from undertaking ecotoxicology measurements on reverse osmosis treated mine water from other mines implementing RO processes (e.g. Appin, Ulan, Wilpinjong).

and finally, the closure of the well, are designed to address these concepts. Another basic concept is that all injection wells require authorization under general rules or specific permits. Finally, States are expected to have primary enforcement authority (primacy) for the UIC Program.

Potential movement of supersaturated saline waters into groundwater aquifers

WACJV are proposing to place up to 5270 m³/year (see Table 3.1, WRM 2013) of semi-solid salt waste product from the RO and brine concentration plant into underground storage (at least for the first 14 years). Thereafter, the brine solution (not concentrated) will be pumped to a 120 ML sump. There is no mention of lining the underground storage, so it must be assumed that over time the supersaturated salt solution (707,500 mg/L hypersaline solid; 290,500 mg/L super saline brine solution; see Table 6, MER 2013), can or will migrate into the surrounding groundwater aquifer(s).

OEH looked carefully at MER (2013) to try and understand where the current groundwater aquifers might discharge. OEH could not identify from MER (2013) whether the current coal seam aquifer ultimately discharges into the ocean or whether it has the potential to be intersected by the streams/lakes of the Central Coast floodplain. As identified earlier, groundwater discharge areas and the effects of lowering of groundwater aquifer levels have not been adequately investigated in the EIS. This is considered a major deficiency in the EIS because the ultimate fate of the supersaturated salt solution for the project remains unclear. MER (2013) suggest that:

- "...after more than 500 years, water levels in the workings are predicted to have recovered (up dip) about 110 m above an initial minimum elevation of -480 m AHD to about -370 m AHD. This elevation is above the deepest goaves hosting the brine, but still below the elevation of the stored solid waste."

It is difficult to find the difference in elevations referred to by MER (2013) for the solid salt and brine disposal areas, and which specific aquifers may therefore be impacted by super-saline waste products. There is also no discussion of uncertainty in MER's (2013) modelling, especially considering the exceedingly long timeframes (well past the life of the mine) involved. OEH questions whether this method of disposal, as currently proposed, will simply end up becoming a legacy problem for future generations.

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FLOODING COMMENTS

OEH provided comments at the Adequacy Review stage of the application process in October 2012. This was followed up by a meeting with the proponents' representative and their Flood Engineer. OEH's comments primarily related to the lack of detail included in the report with regard to assumptions used in the modelling. OEH also raised concerns with the methodology used for the hydraulic modelling. These issues were not adequately addressed in the subsequent Flood Impact Assessment report submitted as part of the EIS, and have been detailed below.

Reference is made to Section 7.4 and Appendix K – Flood Impact Assessment of the Environmental Impact Statement for the components of the development application which I have reviewed.

Summary of flooding impacts

The Flood Impact Assessment states that there are 283 properties, which contain 88 structures (83 dwellings and five sheds) that are located within or immediately adjacent to the 1% AEP design flood extent that may be impacted by the proposed project. Due to subsidence, some of these properties are projected to experience an increase in flood affectation and others a decrease in flood affectation. There are 15 key access points along the roads within the catchment that are projected to be affected by subsidence, some of these projected to have significant impacts on the duration of inundation of floodwaters along the road. One of these roads will have an increase in inundation duration of 31 hours for the 20% AEP and 27 hours for the 1% AEP design flood events, which will impact 172 dwellings.

The report states that there are 13 other dwellings located downstream of the study area that will be beneficially impacted by the proposed project due to the flood detention affects upstream due to predicted subsidence in the floodplain.

The impact in the PMF is unknown. The PMF is indicated on Figure 10, however, due to the scale and quality of this figure it is almost impossible to discern from the other information on the figure. The impacts in the PMF are not discussed anywhere in the Flood Impact Assessment or body of the EIS.

Potential impacts due to climate change have been included in the assessment by way of increased rainfall intensities and increased tailwater levels due to an increase in the water levels of Tuggerah Lakes. The report states that there would be no additional dwellings impacted by flooding due to the proposed development under either of these scenarios, however flood affectation at existing floodprone properties would be increased.

Comments on Flood Impact Assessment

- The NSW Floodplain Development Manual defines the floodplain as that area which is subject to inundation up to and including the PMF. The EIS and Flood Impact Assessment refer to the floodplains of the Wyong River and its tributaries (Little Jiliby Creek, Jiliby Creek, Hue Hue Creek) however this appears to be referring to the extent of the 1% AEP design flood and not the PMF. Section 5.6 of the Flood Impact Assessment briefly discusses the modelling of the PMF, however the report does not include any discussion or consideration of the impacts in the PMF. The extent of impact in the PMF needs to be included in the assessment so that appropriate management measures for this residual risk are included as part of the assessment process. The inclusion of the PMF extent on Figures 1 – 12 would have been beneficial.
- The methodology used in the hydrological analysis of 'rainfall-on-the-grid' for this sized catchment is not one that OEHS generally supports. Assumptions used in the hydrological and hydraulic modelling have not been clearly indicated. The report continues to advocate the use of "conservative model parameters" however this comment is not substantiated due to the lack of detail included for any of the parameters actually used in the modelling. The results of the model calibration using the three selected years of 1989, 1990 and 1992 do not appear to correlate very well as indicated in Table 5.1. The 2007 flood should have been used as one of the calibration events, considering it is the most recent flood and has significant recorded information available. These results were not verified against any historical floods, which would be expected on a flood study of this size. The comments included in Section 6.5 do not give any indication of where the resultant variations in flood levels occur in the catchment between this study and previous flooding assessments. However, for the sake of an impact assessment, the pre- and post-development scenarios have both used the same methodology and modelling parameters (with these concerns), and so the above discrepancies and issues are considered in this context.
- The flood mitigation and management measures proposed as part of the proposal include raising of houses and other structures such as sheds; raising of infrastructure; relocating of homes; construction of levees and voluntary acquisition if no other appropriate mitigation options are suitable. Section 7.3 of the Flood Impact Assessment states that the length of several of the roads that would need to be raised would be over 400 metres in length to re-instate the inundation durations in the 1% AEP design flood event. The proponent has stated that the detail design of these mitigation options will be developed in consultation with individual landowners as part of the Mine Subsidence Management Plan process. It is expected that this process will occur through the Mine Subsidence Board. The detail design of each of these mitigation options will need to ensure that they do not exacerbate the local flooding and do not impact on flood behaviour of the river or tributary. Section 7.2 should refer to Councils DCP for flood related development controls in the area. The proponent should work with Wyong Shire Council to identify the properties and update these controls in areas impacted by the proposed development.
- Wyong Shire Council is in the final stages of completing the Wyong River Catchment Flood Study, which OEHS has worked closely with Council on this project as it was funded under OEHS's Floodplain Management Program. The final report is expected in July or August of 2013. The results of that study should be compared to the Wallarah 2 flood study for consistency in results, as Wallarah 2 falls fully within the boundary of the Wyong River Catchment Flood Study.

THREATENED BIODIVERSITY

In relation to matters concerning threatened biodiversity OEH has reviewed the Appendix O 'Ecological Impact Assessment' prepared by Cumberland Ecology for Hansen Bailey. OEH has assessed Appendix O in relation to its conformity with the Director General's Requirements (DGRs) (12 January 2012) and the Supplementary DGRs (24 July 2012) in relation to Commonwealth Matters of National Environmental Significance (MNES).

It is noted that the extent of the impacts upon ecological communities and their species are considered in the EIS to include the removal of 53.4 hectares (ha) of native woodland/forest and 7.3 ha of derived grassland, including four threatened ecological communities (TECs) (13.3 ha in total) and 8.8 ha of Groundwater Dependent Ecosystems (GDEs). The proposal will remove the habitat of at least three threatened flora species recorded during surveys and the habitat of at least eight threatened fauna species recorded during surveys by the proponent. This includes at least three flora species listed as threatened and one migratory species listed under the EPBC Act.

In addition, there is an area defined as the Subsidence Impact Limit (SIL) of which there are 728.3 ha of TECs and 635.7 ha of GDEs, a significant amount of which lies outside of the 'Project Boundary'. OEH will consider the 'indirect impact' on the natural communities as that lying within the entire SIL. While the proponent provides some figures relating to the areal extent of habitats for various threatened species within this area, it does not provide a breakdown of the extent of the various vegetation communities within the SIL including TECs and GDEs. The SIL contains the habitat of at least 10 threatened flora species and at least 13 threatened fauna species. This includes at least six flora species and two fauna species listed as threatened and six migratory fauna species under the EPBC Act.

These figures reflect the results of the surveys undertaken by the proponent and the numbers of affected species is likely to be higher, if previous records from other databases are taken into account.

The proponent has proposed that a Biodiversity Management Plan (BMP) (in consultation with OEH and other regulatory authorities) will co-ordinate the impact mitigation and offset measures for this project. The mitigation measures include avoidance measures, dust minimisation, noise minimisation, management of surface water, erosion and sedimentation, visual lighting management and clearing protocols.

Three offset sites are proposed, all are near the surface development footprint and combined provide 208 ha of remnant vegetation offset including five TECs totalling 83 ha. No Commonwealth listed TECs are present in the direct impact, subsidence or offsets sites.

Review of Survey Effort

OEH has reviewed the methodologies used to inform the ecological assessment and considers these to be generally not consistent with OEH survey and assessment guidelines (DEC 2004; DECC 2007). There are a number of matters that OEH raised in the Adequacy Review (31 October 2012) which have been addressed while others have not been addressed in the EIS.

Of particular note is the inadequacy of the survey effort. Undertaking a field survey with sites that are stratified according to minimum required effort (DEC 2004) is important for OEH to be able to adequately determine the presence/absence of threatened species, local habitat conditions and overall patterns of biodiversity.

In the flora surveys, the minimum effort that was required was 53 quadrats. OEH notes that 48 were undertaken but 22 of these were done during 2006-07. OEH generally does not consider surveys undertaken more than five years ago, as stated in the adequacy review. In terms of targeted surveys

for threatened flora species, OEH notes that *Angophora inopina* and *Melaleuca biconvexa* were subject to density estimates, no other threatened flora were targeted for specific surveys.

For fauna surveys, OEH notes that the effort undertaken within the Project Boundary has been a long way short of a minimum standard. If only one site were undertaken for each stratification unit, then Elliot A trapping, Cage trapping, Harp trapping, bird surveys and reptile surveys are well short of a minimum target. For amphibian (a key group considering the high proportion of threatened taxa known to be present in the Project Area) targeted surveys have not been undertaken according to state (DECC 2009) or Commonwealth guidelines (DEWHA 2010). Large areas of potentially suitable habitat associated with the Little Jiliby Jiliby, Jiliby Jiliby, Armstrong and Myrtle Creeks have received virtually no survey effort, despite records of the Commonwealth listed species, Giant Barred Frog *Mixophyes iteratus*, Stuttering Frog *Mixophyes balbus* and Heath Frog *Litoria littlejohni* as well as another state listed species, the Green-thighed Frog *Litoria brevipalmata* and the Giant Burrowing Frog *Heliophorus australicus* which is known from similar habitat in the locality.

OEH acknowledges the proponent has undertaken bird sound recordings and camera traps surveys, though notes that the sound recordings did not catch the "dawn chorus". With respect to the camera traps, OEH notes that 3 cameras were placed in the Hue Hue Road Offset and 13 cameras were placed in the Development Areas at different times for four/five days and nights. Camera traps are good for catching cryptic species, such as potoroos, bandicoots and quolls, though while Spotted-tailed Quolls *Dasyurus maculatus* should have been targeted as per the Commonwealth Survey Guidelines for Mammals (DSEWPaC 2011) OEH notes that the baits would not have attracted this species and there is no justification provided for the locations and intensity of effort for the camera traps.

OEH also notes that the survey effort for the following threatened flora species is not sufficient to identify their presence/absence in the SIL; *Acacia bynoeana*, *Angophora inopina*, *Cryptostylis hunteriana*, *Grevillea parviflora* sp. *parviflora*, *Melaleuca biconvexa* and *Tetratheca juncea*.

Given these constraints, OEH can only assume the presence of local populations of these species in the SIL.

Review of Impact Assessment

Impacts of subsidence

Given the likelihood of significant impacts with the SIL upon 3rd order and higher riparian systems and their associated alluvial communities and species and the uncertainty related to the lack of survey effort, OEH cannot agree with the conclusions put forward in p. 7.3 of Appendix O of the EIS and has to use the precautionary principle and identify a significant, residual impact upon the following matters listed under the TSC Act such that their local occurrence may be placed at risk of local extinction (areas of potential impact given in brackets):

- Swamp Sclerophyll Forest on Coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (26.7 ha)
- River Flat Eucalypt Forest on Coastal floodplains of the NSW North Coast and Sydney Basin Bioregions (25.5 ha)
- Lowland Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions (582.3 ha)
- Freshwater Wetlands on NSW North Coast, Sydney Basin and South East Corner Bioregions (1.2 ha)
- *Mixophyes iteratus*
- *Mixophyes balbus*
- *Litoria littlejohni*

- *Litoria brevipalmata*
- *Melaleuca biconvexa*.

OEH considers it likely that the proposed levels of subsidence will exacerbate the following Key Threatening Processes:

- alteration to habitat following subsidence due to longwall mining
- alteration of natural flow regimes or rivers and streams and their floodplains and wetlands.

In relation to MNES, OEH has determined that the impacts of subsidence will have a significant impact on the Giant Barred Frog as it is likely to meet all of the listed criteria under the Significant Impact Guidelines (DEWHA 2009) for endangered or critically endangered species.

Impacts of direct habitat removal

OEH notes that there will be a significant removal of native remnant vegetation and habitat for threatened species and ecological communities within the areas of direct impact (Western Shaft, Buttonderry and Tooheys Road): including the removal of:

- River Flat Eucalypt Forest on Coastal floodplains of the NSW North Coast and Sydney Basin Bioregions (5.9 ha)
- Swamp Sclerophyll Forest on Coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (2.9 ha)
- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (0.8 ha)
- Habitat for at least three threatened flora species recorded during surveys and the habitat of at least eight threatened fauna species recorded during surveys, including the Commonwealth listed species *Tetratheca juncea*, *Angophora inopina* and the Spotted-tailed Quoll.

It is expected that the proposal will exacerbate the following key threatening processes:

- clearing of native vegetation
- loss of hollow-bearing trees
- removal of dead wood and dead trees
- anthropogenic climate change.

However, no residual impact on threatened biodiversity is expected if the offset package conforms to current OEH Offset policy and /or guidelines. This is assessed in the section below (4).

Review of Avoidance/Mitigation Measures

OEH acknowledges the measures undertaken by the proponent to minimise impacts upon threatened biodiversity by design features of the longwall operations, however does not consider these to be sufficient to avoid impacts such that significant impact on sensitive riparian ecosystems and species is avoided.

OEH acknowledges the other measures taken in relation to dust minimisation, noise minimisation, management of surface water including erosion and sedimentation, visual lighting management, vegetation restoration and rehabilitation and due diligence measures for clearing procedures. However as the latter two will be detailed in the BMP, OEH reserves judgement on the adequacy of these measures.

Review of Compensatory Package

OEH acknowledges the Biodiversity Offset Strategy (BOS) as outlined in Appendix O of the EIS has stated it will include a total of 261 ha remnant vegetation in three adjacent offset areas. The total areas offset for each vegetation community that will have direct impact as a result of vegetation removal is generally of a quantum which would be acceptable to OEH with the exception of:

- Mountain Blue Gum – Turpentine moist shrubby forest of the coastal ranges of the Central Coast, Sydney Basin (no offset identified)
- Scribbly Gum – Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin (1.2:1 is insufficient under the OEH Interim Offset Policy 2011);
- Spotted Gum – Grey Ironbark Open Forest on the foothills of the Central Coast, Sydney Basin (no offset identified) and
- Derived Native Grassland (1.5:1 is insufficient under the OEH Interim Offset Policy 2011).

The proponent has used the Principles for the use of Biodiversity Offsets in NSW (DECC 2007) and the Commonwealth Principles from the 'Draft Policy Statement: Use of environmental offsets under the Environmental Protection and Biodiversity Conservation Act' (DEWHA 2007) to determine the adequacy of the offsets proposed.

Of particular concern is that the offset mechanism for the proposed offset package has not been determined and so there is no guarantee that any of these areas can or will be secured in perpetuity. The guidelines state that offsets established prior to development so as to minimise ecological risk through time-lags. OEH has a concern that as this issue has not been finalised, and that some quantification of the offset required needs fine-tuning.

Principle 5 states that "*Offsets must be underpinned by sound ecological principles*", however, as not all of the vegetation communities to be removed has been offset by a vegetation community that has the same structural elements, this area is deficient.

Principle 5 also states that the proponent must "*consider the conservation status of ecological communities*". While the total area of TEC in the offset areas is 83 ha compared to 13.2 ha to be cleared, the offsets do not provide for an offset of the TEC 'River Flat Eucalypt Forest on Coastal floodplains of the NSW North Coast and Sydney Basin Bioregion'.

Principle 9 states that offsets must be quantifiable and based on a "*...quantitative assessment of the loss of biodiversity ... and a gain in biodiversity from the offset.*" The only appropriate way, under a SSD scenario, to achieve this quantification is by the use of the BioBanking Assessment Methodology (DECCW 2008) which the proponent has avoided using. OEH recommends that prior to the finalisation of the offset strategy that a BBAM be undertaken so as to give the appropriate level of quantification for the retirement of biodiversity credits in relation to this project.

References

Department of Environment and Conservation, 2004. Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft). New South Wales Department of Environment and Conservation, Hurstville, NSW.

Department of Environment and Climate Change, 2007. Threatened species assessment guidelines: The assessment of significance. New South Wales Department of Environment and Climate Change, Goulburn Street, Sydney, NSW.

Department of Environment and Climate Change, 2009. Threatened species survey and assessment guidelines: Field survey methods for fauna: Amphibians. DECC, Sydney.

Department of Environment, Water, Heritage and the Arts. 2009. Matters of Environmental Significance – Significant Impact Guidelines 1.1. Environment Australia, Canberra.

Department of Environment, Water, Heritage and the Arts. 2010. Survey guidelines for Australia's threatened frogs: Guidelines for detecting frogs listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia, Canberra.

Department of Sustainability, Environment, Water, Populations and the Community. 2011. Survey guidelines for Australia's threatened mammals: Guidelines for detecting frogs listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia, Canberra.

Office of Environment and Heritage, 2011. NSW OEH interim policy on assessing and offsetting biodiversity impacts of Part 3A, State significant development (SSD) and State significant infrastructure (SSI) projects. Approved by the Chief Executive Officer 25 June 2011.

ABORIGINAL CULTURAL HERITAGE ASSESSMENT

A review of the EIS, including Sections 7.1, and 7.14, Table 103 and Appendix S entitled: 'Aboriginal Cultural Heritage Assessment - Wallarah 2 Coal Project - Wyong, NSW' (dated December 2012) was undertaken by OEH to assess the potential impacts of the project on Aboriginal cultural heritage, in accordance with OEH's Aboriginal cultural heritage assessment guidelines and the requirements of Part 6 of the *National Parks and Wildlife Act 1974* (NPW Act).

Aboriginal cultural heritage values

OEH acknowledges the significance of the local environment to the local Aboriginal community. OEH notes the existence of numerous registered Aboriginal sites in the immediate locality and acknowledges that the project area contains landforms which have yielded a significant volume of evidence of Aboriginal occupation. These include sandstone engravings, grinding grooves, artefact scatters, isolated finds, culturally modified trees, shelters, middens, burials, camp sites and potential artefact deposits. There is also a possibility that currently undetected cultural material may be present within the project area in those areas where Aboriginal objects have not been previously identified. The proponent's archaeological consultant also supports this view.

OEH also acknowledges the results of previous assessments of the project area which identified three grinding groove sites and the recent targeted field surveys of the project area undertaken during November 2006, January 2010 and September 2011 which resulted in an additional eight Aboriginal sites identified, including two artefact scatters, one isolated find, a culturally modified tree and four grinding groove sites.

OEH reiterates that a search of the Aboriginal Heritage Information Management System (AHIMS) revealed that sites 'WC-OS2', 'WSF-AG1', 'WSF-AG2', 'WSF-AG3' and 'WSF-AG4' identified during field assessments of the project area conducted in January 2011 and September 2011 have not been registered in AHIMS. It is further noted that additional subsurface investigations were undertaken in March 2012 at site 'WC-OS2' and additional information concerning this site was obtained. However, the results of this assessment have not been supplied to AHIMS to compliment the data available for this site.

Accordingly, the proponent is advised to promptly complete Aboriginal Site Recording Forms for each site and submit to the AHIMS Registrar, as per the requirements of Section 89A of the NPW Act. Any management outcomes for these sites must be included in the information provided to AHIMS. The proponent is also advised that penalties now apply to corporations for failing to fulfil these requirements. AHIMS contact details: Phone: 9585 6470, address: Level 6, 43 Bridge Street, Hurstville, NSW, 2220, e-mail: ahims@environment.nsw.gov.au.

Impacts on Aboriginal cultural heritage

OEH refers to Sections 7.1.3 and 7.14.3 of the EIS. It is noted that the modified project area is likely to be directly disturbed by a range of mining related activities including the development of additional surface infrastructure and subsidence. This is likely to result in the likely impact or harm to a number of Aboriginal objects associated with the project area. These include five grinding groove sites and

one artefact scatter. It is therefore expected that the proponent develop culturally appropriate management strategies to alleviate any likely or possible impact on these sites in consultation with the registered Aboriginal parties for the project.

Management of likely impact on Aboriginal cultural heritage values

OEH refers to Section 7.14.4 and Table 5.20 of the EIS and Section 10 of the ACHA. OEH notes that the proponent has developed a range of mitigation strategies to manage the likely impact from the project on Aboriginal cultural heritage values.

OEH acknowledges the proponents commitment to develop and implement an Aboriginal Cultural Heritage Management Plan (ACHMP) for the project area in order to support the management of the potential impacts on Aboriginal cultural heritage. It is also acknowledged that the plan is to be developed in consultation with the registered Aboriginal parties for the project. OEH supports these processes.

OEH refers to Section 7.14.4 of the EIS. It is understood that the proponent proposes to salvage Aboriginal objects associated with site 'WC-OS2' prior to being directly impacted by the proposal. It is recommended that this process is undertaken in consultation with the registered Aboriginal parties identified for the project. OEH also notes that the objects must be recorded and managed in accordance with the requirements of sections 85A1(c) and 89A of the NPW Act. It is also recommended that these actions/procedures are detailed in the proposed ACHMP.

OEH acknowledges that the proponent proposes to develop protocols for the monitoring of earthworks during construction of the surface facilities. OEH supports this process. However, it is recommended that this procedure is developed in consultation with a suitably qualified cultural heritage specialist and the registered Aboriginal parties. It is also recommended that the proponent provide the registered Aboriginal parties with a fair, reasonable and timely opportunity to participate in this process. Any Work, Health and Safety matters should be addressed prior to implementing the program. Records should be collected of any attendance and results accurately documented in accordance with the requirements of sections 85A1(c) and 89A of the NPW Act. The proposed methodology should also include specific archaeological procedures/triggers in the event that significant archaeological/cultural finds are identified during the investigations. For example, hearths, human remains, knapping floor, rare objects, etc.

The proponent is also reminded that all Aboriginal sites impacted by the project must have an Aboriginal Site Impact Recording Form completed and be submitted to the AHIMS Registrar within 3 months of being impacted (www.environment.nsw.gov.au/resources/cultureheritage/120558asirf.pdf).

Conclusion

OEH has no additional concerns with the Aboriginal cultural heritage assessment for the project application and recommends that the following conditions of approval for Aboriginal cultural heritage are reflected in any approval conditions for the project.

Location	Maximum Predicted Conventional Subsidence (m)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted conventional Hogging curvature (km ⁻¹)	Maximum Predicted Conventional Sagging Curvature (km ⁻¹)	Tensile Stress (mm/m)	Compressive Stress (mm/m)	Maximum Upside (mm)	Maximum Valley Closure (mm)	Length of Creekline in km Subject to upsidence > 60mm	Length of Creekline in km Subject to upsidence > 100mm	Length of Creekline in km Subject to valley closure > 100mm	Length of Creekline in km Subject to valley closure > 200mm	Source
Wyong River	175	1	0.01	0.01	0.15	0.15	150	100	1	0.2	0	0	MSEC 2013 Fig. E05
Jilliby Jilliby Creek	1500	10	0.15	0.2	2.25	3	150	75	2.5	1	0	0	MSEC 2013 Fig. E06
Little Jilliby Jilliby Creek	2000	12	0.2	0.25	3	3.75	650	775	5	3	3.2	2.7	MSEC 2013 Fig. E07
Armstrong Creek	2600	13	0.25	0.3	3.75	4.5	650	775	2.2	2	1.8	1.4	MSEC 2013 Fig. E08
Myrtle Creek	2500	15	0.28	0.37	4.2	5.55	800	1000	2.7	2.6	2.4	1.9	MSEC 2013 Fig. E09
Remaining Streams	2600	15	0.28	0.37	4.2	5.55	800	1000					
Other Streams with 3rd order sections													
Calmans Gully	350						420	480	1.5	1.2	1.4	1	MSEC 2013 Fig. E12
Coutts Gully (Drainage Line D)	2400						1000	1300	1.3	1.1	1.1	1.05	MSEC 2013 Fig. E17
Drainage Line K	2200						710	1300	1.25	1	1	0.9	MSEC 2013 Fig. E24
Drainage Line L	2050						750	1000	2.2	1.6	1.25	1.1	MSEC 2013 Fig. E25
Total									19.65	13.7	12.15	10.05	

Appendix 1: Subsidence predictions for 3rd order and above streams in the Wallarah 2 Project Area (* Maximum Tensile stress calculated as 15*maximum hogging curvature; Maximum Compressive stress calculated as 15*maximum sagging curvature).

