17. Summary and Conclusions

This Chapter summarises the key findings from the various studies that comprise this Environmental Assessment.

17.1 Project Suitability

The domestic and global need for ongoing and economical supplies of coal has been clearly established. While scientific research and development continues to advance renewable green energy sources, these alternative systems will not be capable of meeting Australia or the world's demand for electricity in the foreseeable future. Until such time as these technologies are further advanced, the world will continue to rely on coal as a major input to electricity generation.

Australia, and New South Wales and Queensland in particular, contain large deposits of coal. Under current coal demand conditions, it is inevitable that new coal resources will be required and developed.

The W2CP has incorporated extensive exploration work, detailed mine planning, economic modelling including a cost benefit analysis to verify that the project is in fact viable. However, while the ability to economically extract the coal and secure a market has been verified, the ability to carry out the project with an acceptable level of environmental and social impact is also of extreme importance. The era of extracting a resource purely for economic benefit has passed, and consideration of the environmental consequences is recognised as being of utmost importance. Detailed environmental studies have been undertaken to assess the level of anticipated impact, and it is firmly believed that the W2CP can be implemented within an acceptable level of impact, making the project environmentally and socially responsible.

17.2 Summary of Environmental Impacts

Chapter 5 of this EA documents the identification and prioritisation of potential environmental and social impacts associated with, or generated by the proposed W2CP. The WACJV and its consultants undertook a series of risk assessments to determine the importance of potential impacts, and specialist consultants employed to carry out detailed analysis and assessment of these issues. The specialist studies are appended in full to this EA, and a summary of the predicted impacts provided below.

17.2.1 Subsidence

The extraction of coal by underground longwall methods, even at the depths proposed of between 345 m and 690 m below the surface, will result in some surface subsidence. Vertical ground subsidence movement can have implications on surface flooding and stream morphology while surface ground strain and tilts associated with this ground movement can have implications on structures and erosion potential in streams. Each of these implications or risks has been assessed and appropriate management initiatives have been proposed.

The mine plan has been formulated to reduce these effects by incorporating reduced extraction heights near sensitive and constrained areas. The amount of

coal to be extracted beneath the Hue Hue area has been significantly reduced to ensure that surface movement will comply with the levels required within the declared Mine Subsidence District. Houses designed and built in accordance with the Hue Hue Mine Subsidence District criteria should therefore be provided with appropriate levels of structural protection against the impacts of subsidence.

Similarly, when underground mining occurs deep beneath the Dooralong Valley floodplain, which is necessary to access coal reserves within the surrounding State Forest, less coal will be extracted so as to reduce the subsidence effects and to ensure that shallow aquifers are appropriately protected and continue to remain isolated from any deeper, poor quality aquifers within the bedrock.

The Mine Subsidence Board (which is funded by a levy on the coal mining industry) will be responsible for the repair of any damage to surface structures, including houses, should it arise from the effects of subsidence. As part of the ongoing approvals for the mining operation, detailed property inspections will be required for the individual Property Subsidence Management Plans that will be developed in consultation with each affected landowner. These plans will detail the existing condition of all surface structures within a property prior to subsidence occurring. On completion of coal extraction in the vicinity, properties are re-inspected and if any damage is caused by the extraction of coal then it will be fully corrected at no cost to the landowner.

17.2.2 Local Water Supply Scheme and Groundwater

There has been much concern raised over the potential impacts on the Gosford Wyong Water Supply Scheme. In recognition of the importance of protecting the water supply catchment, W2CP has made a public commitment to only propose a mine plan that will safeguard the surface and underground alluvial water regimes which are the ones of concern to the community.

Given the specific geology of this region and the comprehensive approach for mine planning, comparisons with other existing and past mining operations are not valid. For the W2CP, this commitment is in fact a very easy one to make, prove and verify.

The groundwater study has shown that any effects on the alluvial groundwater system will be minor and transient. The full groundwater modelling has extended over an area of more than 400 square kilometres compared with an actual mining area of 37.3 square kilometres in order to determine the full extent of potential groundwater impacts.

The W2CP extraction area covers only 5% of the entire combined Gosford Wyong Water Supply Scheme catchment area, the majority of which lies within the Wyong State Forest. This represents the only area of potential impact to the water supply system that may result from the W2CP. The potential impact in this case would be a result of minor alterations to flow of the drainage lines as an effect of subsidence. However, the overall impact to the water supply system is calculated to be negligible.

The studies undertaken for the project also note that significantly greater risks to the water supply scheme already arise from existing rural residential and agricultural pressures on Jilliby Jilliby Creek and the Wyong River. Data provided by Wyong Shire Council supports current water quality monitoring data being collected by W2CP, which shows high levels of bacteria and nutrients within the waterways as well as elevated specific metal levels. This is combined with a number of dam structures within the Jilliby Jilliby Creek itself, pumping to support intensive

agricultural pursuits, stock and domestic bores as well as variable riparian management practices.

Water quality is also affected by existing erosion and sedimentation problems within some, but not all, sections of Jilliby Jilliby and Little Jilliby Jilliby Creeks, primarily where there is a lack of vegetation cover on the banks of the creeklines and at existing farm crossings.

Despite the fact that the W2CP will not adversely affect the functions of the water supply catchment but given that the water supply scheme has been recognised as an important issue, the project has developed an outline of a voluntary enhancement scheme designed to assist in improving overall water quality. This program will include environmental initiatives such as weed eradication, riparian zone plantings and education programs on agricultural water use and maintenance of sewage treatment and disposal systems.

Other water initiatives that form part of the W2CP include treating any surplus saline water which may be encountered by the underground workings to a standard so that it can be returned to either enhance the environmental flows of the surrounding waterways or directed to the water supply system or other industrial users. This mine-make water occurs at considerable depth, is naturally of poor quality and would otherwise be unavailable to either existing water users or the catchment.

The surface facilities of the mine will include water recycling involving the retention and use of rainwater, water treatment facilities for collected minewater, as well as potential arrangements for the utilisation of treated sewage effluent from the existing Charmhaven Sewage Treatment Plant.

The overall impacts of the project on the water supply scheme will be positive.

17.2.3 Implications on Flooding

There are 79 dwellings in the Yarramalong/Dooralong study area located within the 1 in 100-year ARI floodplain. Of these 79 dwellings, 26 would be adversely affected in the absence of mitigation measures, eight will be negligibly affected, 38 will be beneficially affected, and seven will remain unchanged as a result of subsidence impacts on flood behaviour. Only three dwellings near Hue Hue Creek will be adversely impacted by changes to flooding as a result of mine subsidence and one will be beneficially impacted.

Of those houses affected, and unless specific mitigation actions are taken in consultation with the landowner, seven are categorised as likely to incur major impacts due to a greater risk of inundation by major floods after mining in the area is completed (1% AEP or 1 in 100 year flood), and 10 will be expected to register moderate impacts including increased depth of inundation for house floor levels already inundated by these major floods. Nine houses are predicted to have minor impacts from reduced level of freeboard, but not inundation, in these major floods following completion of mining.

The Mine Subsidence Board will be responsible for developing mitigation measures to rectify, reduce or otherwise compensate for increased risk of flood inundation for properties affected by mine subsidence.

Options available to mitigate flood impacts on dwellings include construction of flood levees, raising houses in-situ and relocating or reconstructing houses on higher ground within the property at no cost to the owners. Where impacted dwellings are

unable to be protected, raised or moved, properties may need to be purchased or the landowners compensated. Each dwelling will need to be assessed individually and properties where land but not dwellings are affected will also need to be considered.

Options to mitigate impacts on access routes include raising bridges, raising low sections of roads, and improving the hydraulic capacity of channels in some sections. Studies have shown that all low points can be addressed by moderate road raising.

17.2.4 Social and Economic Issues

The project will provide significant economic benefits to the Central Coast Region. The project employment policy has set a target to source 70% of its 300 strong workforce from the local region (Central Coast and Lake Macquarie area). The Central Coast Research Foundation has estimated that 2,989 jobs (totalling 5,125 'job-years') are expected to be created on the Central Coast as a result of the mine's three year construction phase. Over 1,800 jobs will be created in the first year of construction alone. In the mine's first year of operation it is expected to generate an additional 428 jobs in the Central Coast economy which will rise to 726 jobs at full production. A further 336 jobs in the Hunter Region will be sustained by the project during operations.

The total potential expenditure in the Central Coast economy from the three years of the mine's construction is expected to be approximately $600 million. This will create a total stimulus to the Central Coast economy of over $1 billion during the construction phase. On top of this will be significant ongoing direct expenditure and flow-on effects to the local economy in the order of $200 million per annum. Total revenue to Governments over the life of the project will be over $1 billion.

However it is recognised that the recipients of these benefits are not necessarily those who will be directly or indirectly affected by the mine. This includes those effects that are only perceptions since it is recognised that these are real to those who perceive them.

In response, the project has developed a Community Enhancement Program (CEP) that will be funded by the project owners and which involves specific works and actions to benefit the local community directly. The main component in the CEP is the development of a Community Trust which will be engaged in local community projects within, and immediately surrounding, the project site and mining area. While a Community Trust Advisory Group has been established, the final details of the Trust program and the broader CEP remain to be negotiated.

17.2.5 Noise

Noise modelling has been undertaken for each of the surface facilities areas for the various prevailing weather conditions. The modelling has shown that the Buttonderry site will meet all noise assessment goals specified under the NSW Industrial Noise Policy. This site does, however, require a number of noise controls on the ventilation fans in order to meet these goals. The controls include physically directing the exhaust mine air away from the residential receptors (directed generally to the north and northeast towards the Buttonderry Waste Disposal Facility and Hue Hue Road), enclosure of the fan motors and baffling of the evase of the fan.

The Tooheys Road site has also incorporated a number of noise controls including partial enclosure of the crushing and screening equipment and acoustic treatment of the mobile plant. The modelling has indicated that some marginal noise exceedences may occur in certain meteorological conditions at two properties to the south of the Motorway Link Road and on the western side of the F3 Freeway along Bushells Ridge Road.

The marginal exceedences are generally within 2 dB(A) of the respective noise goals and only occur when prevailing winds are in the direction of the residences. For the properties to the south of the site, a Noise Management Plan will need to be implemented which provides for further noise monitoring, possible restriction on site activities when prevailing northeast winds occur as well as specific noise mitigation measures or compensation. If ongoing exceedences occur, outright purchase of these properties would be offered by the WACJV if negotiation of suitable compensation or other mitigation strategies fail to achieve an acceptable outcome to the owners during operations.

The existing noise environment for properties to the northwest of the Tooheys Road site is dominated by the F3 Freeway. Although technically the project meets the Industrial Noise Policy guidelines, these are based on existing background levels. In the absence of the elevated background noise from the F3 Freeway, the noise emanating from the project would likely exceed normal assessment criteria at some of the nearest residences.

While the F3 Freeway is clearly a permanent and enduring feature of the locality, W2CP considers it unreasonable to rely only on the influence of the Freeway noise in order to demonstrate full compliance with the Industrial Noise Policy. Therefore the project will offer the same mitigation and management strategy for these properties as it will for the properties to the south of the site. It is likely that a mitigation strategy could be designed which will have the added benefit of reducing the impact of the Freeway noise as well.

17.2.6 Air Quality Impacts

Atmospheric modelling of both construction and operational dust and odour emissions has been undertaken for the project. Concentrations of dust and deposition rates of dust from the construction phase of the project are predicted to be well within the Department of Environment, Climate Change and Water's (DECCW) air quality criteria.

During the operational phase of the project, air quality impacts for particulate matter are in compliance with long-term goals as well as short-term 24-hour PM_{10} goals. The emissions of fine particles (PM2.5) and silica were also modelled and found to readily comply with relevant criteria in all offsite receptor areas.

There will be no measurable environmental effect due to the emissions of greenhouse gases from the Project even when the customer's use of the coal is taken into account. The project will undertake methane gas predrainage and capture for initial flaring to significantly mitigate greenhouse emissions which will be augmented by utilisation of the gas for offsite supply or onsite generation of electricity during full production.

17.2.7 Health Issues

Health risks associated with industrial activities including mining have been the subject of several Australian and International studies of many years. The majority

of studies have related to occupational health but over the last decade there has been an increasing emphasis on environmental exposure outside the workplace. The W2CP has been assessed in terms of the likely risks to various health outcomes. The risk factors used in the analysis have been developed using research results from the last decade on the health effects of particulate matter on human populations in urban areas. Risks of exposure to silica have also been considered along with noise and drinking water.

The analysis provides estimates of the increase in daily mortality due to emissions from the mine at the most affected receptor on the worst day. In addition estimates are provided on the increase in daily hospital admissions that could be expected from the most exposed individual due to emissions from the project on the worst day. The estimates are based on atmospheric modelling of a range of parameters which has demonstrated that the project will comply with emission criteria established by the Department of Environment, Climate Change and Water.

The increase in risk of daily mortality on the worst day in the life of the mine is estimated to be 1 in 16.3 million. This is a small risk. Increase in risk for hospital admission is also low as is the health risk from exposure to silica.

Although there is no theoretical mortality data for noise exposure, the assessment provided in this EA has shown that the project will comply with established criteria relating to human disturbance and responses to external noise. The assessment included both onsite noise sources as well as road and rail traffic.

The assessment of the risks on drinking water revealed that the current water quality of Jilliby Jilliby Creek within the mining area is very poor. Although the mining activity will not influence water quality either directly or indirectly, the project has included a commitment to work with the relevant water supply authority to improve the existing data base on water quality and catchment yield during the life of the project. This data base will include surface and subsurface water flows, rainfall data and water quality.

17.2.8 Ecological Impacts

The surface facilities have been designed and located with a view to minimise vegetation disturbance including both clearance area and habitat fragmentation.

The primary impact of the proposed W2CP surface facilities will be the removal of 4.54 ha of the existing 56.59 ha of native vegetation at the Buttonderry study area, 17.27 ha (of 261.97 ha) of native vegetation at the Tooheys Rd study area and 0.92 ha of native vegetation within the Wyong State Forest. Cumulatively, W2CP direct impacts will be removal 22.37 ha of native vegetation. An estimated additional 10 ha of native vegetation will also be removed within mainly Darkinjung Local Aboriginal Land Council land adjoining the TransGrid transmission line easement for the purpose of constructing the proposed rail loop.

The project will have a direct impact on rare species including *Angophora inopina*, as the local population represents an “important population” at the limit of its distribution, local sub-populations of *Tetratheca juncea,* and potential for impacts on the Squirrel Glider and the Wallum Froglet. As well as designing the surface facilities to be able to minimise vegetation and habitat disturbance, a range of biodiversity management measures are proposed to ameliorate these potential impacts, including revegetation strategies and specific fauna protection initiatives to be undertaken during the construction stage.

All other impact assessments undertaken for identified threatened species concluded that the proposal would not have a significant impact on the threatened species or populations.

WACJV owns approximately 115 ha of higher conservation value forested land that will not require disturbance as part of the development proposal. These lands lie generally between the Buttonderry and Tooheys Road sites. There is an additional approximately 318 ha of forested land within the company owned development areas that would also not be disturbed.

An ecological offset strategy for the estimated loss of approximately 22 ha of existing native vegetation will be developed. Although it is proposed to offset an area of approximately 50 ha of existing native vegetation on lands currently owned by the WACJV, it is also proposed to develop a more comprehensive biodiversity land management strategy that takes into account other aspects of the project in order to provide real and enduring benefits to the wider environment. The main elements of the strategy are discussed below.

Securing 50 ha compensatory offset area of higher value existing native vegetation on WACJV landholdings between the Buttonderry and Tooheys Road surface facilities areas is proposed to provide enduring environmental benefit. This area is proposed to be protected by a permanent land covenant registered on the land title. This provides greater protection than alternative means such as land zoning, voluntary conservation agreements or even dedication as part of the National Parks estate.

The main purpose of this land dedication is to link in with other vegetated land to the south and south west of the Tooheys Road site as well as to the north of the Buttonderry site. This vegetated corridor will be enhanced by active management of dedicated land and will provide a long term fauna corridor in the region.

Remaining vegetated areas within the project facilities sites will be actively managed for ongoing conservation purposes. The area will also serve as a buffer around the facilities to minimise visual impacts.

There are large areas within the infrastructure sites which represent good quality grazing land. The remaining grazing land around the Buttonderry site is currently zoned for agricultural purposes and will remain as such. However, riparian vegetation of Wallarah Creek which flows through the Tooheys Road site will be actively managed for conservation purposes. Specifically, this zone will be enhanced by the removal of existing weed infestation and replanting with compatible native vegetation. On-site seed collection programs have commenced to facilitate future planting strategies.

WACJV will also develop, in consultation with landowners, a riparian zone enhancement program along Jilliby Jilliby Creek. This program will be designed to improve water quality and riverbank stability by a combination of weed removal and new plantings. The program will fall under the Wallarah 2 Coal Community Trust which will be funded by the project owners.

17.2.9 Archaeology and Heritage

An archaeology and heritage assessment was prepared for the surface facilities sites, other proponent owned land and the underground extraction area. Although no sites were recorded in the Tooheys Road study area, two primary zones of archaeological sensitivity were delineated along Wallarah Creek and a tributary of

Spring Creek. There are several points at which the project intersects with areas assessed as archaeologically sensitive. These will be the subject of more detailed assessment , test excavation and monitoring during construction works.

Six archaeological sites were identified within the mining area and these were assessed in terms of predicted subsidence, tilt and curvatures. There are likely to be other archaeological sites within the mining area and these will need to be assessed during further archaeological investigations required under the Subsidence Management Plan process. For currently known sites, the subsidence assessment concluded that the likelihood of significant impacts is low.

The assessment also included all known European heritage sites which included dwellings, silos, buildings, bridges and other structures. Each individual item was assessed in terms of potential impacts from subsidence. The results showed that the impacts would be manageable in accordance with established procedures. Any damage to these structures will be repaired by the Mine Subsidence Board at no cost to the owners which includes those items under public ownership.

17.2.10 Land Use and Local Planning

It is evident that the proposal is compatible with the strategic planning for the region which has recognised the importance of the location for resource extraction and employment generating purposes since the 1977 Structure Plan to the 2008 Central Coast Regional Strategy.

The surface facilities are ideally located. The Tooheys Road site which will contain the main coal handling and rail loading facilities is remote from residential receptors and with intervening existing and planned industrial land uses, road and railway infrastructure and a sewage treatment plant. The site is zoned for industrial purposes and will be complementary with the proposed Wyong Employment Zone.

Being located adjacent to the F3 Freeway and Motorway Link Road, the Tooheys Road site will be partially visible to passing motorists, however these fleeting views will progressively reduce and ultimately will become obscured by proposed landscape works.

The Buttonderry site will be predominantly an office and carpark, which will be complementary to planned commercial land uses associated with the Wyong Employment Zone located directly opposite. The site is located to the south of the existing Buttonderry Waste Disposal Facility and is sheltered from residences to the west by intervening topography.

The Buttonderry buildings will be architecturally finished and landscaped and considered entirely complementary with other proposed commercial development. It is therefore not considered necessary to provide extensive tree screens along Hue Hue Road but site landscaping nevertheless will be undertaken which will provide improved screening.

17.2.11 Greenhouse Gases

There will clearly be no measurable environmental effect due to the emissions of greenhouse gases from the project even when the customer's use of the coal is taken into account. Any environmental assessment would conclude that the effects of the emissions from the project are unmeasurable.

17.2.12 Traffic

Overall the site access point intersections (Hue Hue Road at Buttonderry and Tooheys Road/ Motorway Link Road at the Tooheys Road site) would operate satisfactorily, without the need for additional turning lanes from a capacity perspective. This was tested for the construction period and normal day-to-day operation. However a new intersection will need to be created on Hue Hue Road for access to the Buttonderry site and it is recommended for safety and maintenance reasons that this be installed as a rural Type B (right turn) intersection which allows for passing of right turning traffic.

17.3 Statement of Commitments

Wallarah 2 Coal Project has provided a Statement of Commitments which is detailed in full in Chapter 16. This statement provides for specific planning and design features, operational controls, water supply safeguards, environmental management measures, socio-economic initiatives and community project funding programs. Clearly the ability for W2CP to implement these commitments is subject to the project obtaining a satisfactory project approval, including related licences and leases, and these being acted upon.

17.4 Compilation of Mitigation Measures

Mitigation measures have been developed for the W2CP throughout the planning process. The primary and most significant mitigation strategy has been the redesigning of the mine plan so that an acceptable level of subsidence will result, therefore not placing undue impacts on groundwater, flooding, surface water supply and surface infrastructure (houses, roads etc).

However, where it has been identified that a potential impact will still result, specific mitigation strategies have been developed to combat the impact.

Table 17.1 Compilation of Mitigation Measures for the W2CP

Environmental Issue	Potential Impact	Proposed Control Measures
1 - NATURAL FEATURES		
1.01 Catchment Areas or Declared Special Areas	Environmental effects to Catchment Areas or Declared Special Areas. • Mine is located within the Wyong River catchment area (supply to Mardi Dam)	• Mining under <5% of the region's water supply catchments • Mine design developed in recognition of the commitment that the proposed mine would avoid adverse impacts on the water supply catchments • Commitment to modify mine plan in response to issues as they arise if required • All surface coal handling operations are sited outside the Wyong River drinking water catchment system
1.02 Rivers or Creeks: (associated with subsidence area)	Subsidence effects to the mining area, associated with subsiding areas in the vicinity of: • Wyong River • Jilliby Jilliby Creek • Little Jilliby Jilliby Creek • Hue Hue Creek • Minor tributaries Effects can include Increased levels of ponding, flooding or scouring; changes to stream alignment; fracturing of the bedrock in the floors of valleys; surface water flow diversions to the shallow sub-strata; changes to water quality and release of strata gas.	• Subsidence-induced topographic changes in floodplain are moderated by mine design to limit impacts including: - Focus on the western resource only with eastern resource not included in this proposal - Mine layout modified with shorter LW panels to avoid Wyong River and lower Jilliby Jilliby Creek • Mine longwall configurations and main roadways have been designed with a view to mitigate effects on streams and stream confluences. • Locations of identified risk potential for more than minor morphological changes will be subject to prior stream stabilisation works and/or remedial works resulting in minor residual impacts • Monitoring programs • Commitment to modify mine plan in response to issues as they arise if required • Subsidence monitoring to be carried out once coal extraction has begun to verify the impacts and that subsidence limits are being met. • If monitoring in the future indicates subsidence limits are being exceeded, revision of the mine plan may be necessary.
1.02 Rivers or creeks: (associated with surface facility areas)	Environmental effects to • Wallarah Creek • Buttonderry Creek • Small unnamed creeks	• Surface facilities location, layout and design will minimise potential for impacts on watercourses near surface facilities • Project Water Management Plan to address erosion and sediment controls and water monitoring and management. • No water to be extracted from the Jilliby Jilliby Creek water source • Rehabilitation of impacted areas where appropriate to manage sedimentation Desalination of surplus saline waters and either enhancing surface flows or directing water to industrial users; - Coal washery and rejects emplacement deleted from project - Changes to surface layouts and infrastructure • Surface water management systems to be implemented include: - Water treatment facilities at surface sites for dirty water areas - Dirty stormwater containment and treatment prior to reuse or release. Storages to contain 1 in 100, 72 hr event

Environmental Issue	Potential Impact	Proposed Control Measures
		- Diversion of clean water around surface sites where feasible - Soil and Erosion Control Plans - Bunded facilities for diesel and oils - Brine management will be in accordance with DECCW or other regulatory requirement - Spill kits to be available - Vehicle washdown facilities - Water balance to assist management - Surface facilities, including water containment dams, located above the 100 year ARI flood level - Water treatment plant at surface facilities to ensure water quality is suitable for discharge. - Sealing of roads including Tooheys Road - Tertiary sewage treatment systems and reuse of effluent or connection to sewer system • Minimal clearing, mulching of cleared vegetation, use of mulch in landscaping.
1.03 Aquifers or Known Groundwater Resources	Environmental effects to aquifers and known groundwater conditions namely • regional hard rock strata, within which the coal seam provides limited groundwater storage and the overburden materials act as aquitards or acquicludes (flow rates within system very low: 0.036 – 3.6 mm/yr; brackish to saline). • shallow weathered rock (increased but limited groundwater transmission and storage capacity). • unconsolidated alluvial aquifers within valleys. Rainfall driven, with a shallow water table 2-10 m below ground surface (flow rates within alluvium typically 36 – 3600 mm/yr; fresh to saline).	• Comprehensive investigations of groundwater from drillhole information and monitoring boreholes indentified no significant freshwater hard rock aquifers in the mining area. • Groundwater Monitoring • Subsidence model verification after mining commences • Groundwater modelling revisions to be undertaken if new scenarios and trigger conditions are indicated. • SMP to include further consideration of aquifers and monitoring programs
1.04 Springs	Environmental effects to springs Isolated springs. Geological dip is to southwest and springs expected to be most prevalent on south facing slopes mainly in hilly forested areas.	Localised and small-scale surface rehabilitation can be generally applied to any significant ground cracking in the area of springs. Monitoring and detailed investigation of spring presence and its properties (e.g. flow variability, quality) can be undertaken as part of pre mining monitoring and Property Subsidence Management Plans.

Environmental Issue	Potential Impact	Proposed Control Measures
1.05 Sea or Lake	Environmental effects to Seas or Lakes • Budgewoi Lake • Tuggerah Lake (outside subsidence area)	• No mining in the vicinity of the lake proposed • Water management strategies for surface facilities sites which drain to Budgewoi Lake (Tooheys Rd site) and Tuggerah Lake
1.09 Steep Slopes	Environmental effects to steep slopes within the subsidence area	• Baseline assessment completed and location of steep slopes identified. • Subsidence predictions being developed • Monitoring programs will be implemented • Rehabilitation of cracking as required • Address in public safety management plan
1.11 Land Prone to Flooding or Inundation	Environmental effects to land Prone to Flooding or Inundation • Yarramalong Valley floodplain • Dooralong Valley floodplain	• Development of a robust flood model for Wyong and Jilliby Jilliby Creek system and investigation of other creeks (Buttonderry Ck, Wallarah Ck) • Mine layouts modified to eliminate or minimise flood impacts • Narrower longwall blocks below the 1 in 100 flood zone; • Sequencing panel extraction to minimise ponding; • Modifying mine layout to maintain flow gradients while avoiding channel breakout during major flood events • Mitigation works required to minimise impacts. May include: - flood levees; - channel modifications - upgrade of crossings - raising bridges, - raising low sections of roads, and - improving the hydraulic capacity of channels in some sections • Mine budget includes potential for property purchase

Environmental Issue	Potential Impact	Proposed Control Measures
1.11 Land Prone to Flooding or Inundation	Environmental effects to Land Prone to Flooding or Inundation • Yarramalong Valley floodplain • Dooralong Valley floodplain	• Mitigation works required to minimise impacts. May include: - flood levees; - house raising; - house relocation; - voluntary purchase or compensation measures - channel modifications - upgrade of crossings - raising bridges, - raising low sections of roads, and - improving the hydraulic capacity of channels in some sections • compensation or outright purchase of the properties if satisfactory mitigation measures cannot be negotiated • Prepare and implement individual property subsidence management plans • Mine Subsidence Board rectification works • Mine budget includes potential for property purchase • Predictions are based on worst case subsidence which may not occur
1.12 Swamps, Wetlands or Water Related Ecosystems (associated with subsidence area)	Environmental effects to Swamps, Wetlands or Water Related Ecosystems • Water related ecosystems within mining area	• The mine design has been based on avoiding the risk of introducing any continuous cracking from the surface down to the coal seam, thus avoiding the risk of downwards or upwards discernible mixing of the two different water types. At the near-surface are the mostly fresh surface alluvial aquifer groundwaters. These aquifers in most locations are fresher after rain but do not degrade as evidently as the surface waters in the streams and billabongs when they go to low flow and then stagnate. The deep more saline hard rock groundwater at the coal seam level is not capable of migrating to surface and the depressurization of the deep aquifer system will mean that the groundwater flow path will report to the mine void itself (which will be collected and pumped to the mine water management system). • Erosion and sediment control will be addressed in the Project Water Management Plan • Construction phase site management
1.12 Swamps, Wetlands or Water Related Ecosystems (associated with surface facilities)	Environmental effects to Swamps, Wetlands or Water Related Ecosystems • Unnamed wetland to north of Tooheys Road site	• Wetland to north of Tooheys Road site to be safeguarded – access to area to be restricted and water flow quality to area to be maintained. • Erosion and sediment control will be addressed in the Project Water Management Plan • Construction phase site management • Ongoing monitoring
1.13 Threatened or Protected Species (associated with subsidence area)	Environmental effects to Threatened or Protected Species • No critically endangered ecological populations affected • No endangered ecological populations affected • one endangered, six vulnerable and three regionally significant flora species	• Baseline assessment completed and known species within area • establishment of several monitoring points within Riverine Alluvial Gallery Rainforest-Moist Forest to measure and document the health and status of the EEC's as it has potential, albeit low, to be adversely impacted by the proposal • targeted opportunistic surveys for Giant Barred Frog, Green Thighed Frog, Green and Golden Bell Frog, Wallum Froglet and Little Johns Tree Frog should be undertaken as part of the SMP if access to privately owned land is allowed in the future. • Specific vegetation community monitoring prior to mining in nominated vegetation communities within Wyong

Environmental Issue	Potential Impact	Proposed Control Measures
	three regionally significant flora species that have potential to be affected either directly or indirectly • 10 species of threatened and 3 species of regionally significant mammals, 1 species of regionally significant reptile, 2 threatened and regionally significant frogs and 2 threatened and 3 regionally significant species of birds recorded in the study areas, with a further 8 mammals, 3 birds, 2 frogs and 1 insect potentially present. • Four Endangered Ecological Communities above the mining area subject to changed flooding regimes	State Forest and Jilliby State Conservation Area as part of the first SMP covering these areas.
1.13 Threatened or Protected Species (associated with surface facilities)	Environmental effects to Threatened or Protected Species • No critically endangered ecological populations affected • No endangered ecological populations affected • one endangered, six vulnerable and three regionally significant flora species that have potential to be affected either directly or indirectly • 10 species of threatened and 3 species of regionally significant mammals, 1 species of regionally significant reptile, 2 threatened and regionally significant frogs and 2 threatened and 3 regionally significant species of birds recorded in the study areas, with a further 8 mammals, 3 birds, 2 frogs and 1 insect potentially present.	• Baseline assessment completed and known species within area • Mitigation measures as described in OzArk report (Section 13.1.15, 13.1.16) to be employed. • Referral made to the Minister of the Department of Environment, Heritage, Water and the Arts undertaken (Controlled activity assessed) • Offsets strategy involving 50 ha of existing WACJV land • Water management plan and pollution control plan • Site seed collection and propagation strategy for *Angophora inopina* and *Tetratheca juncea* • Landscape Strategy including revegetation and planting of surface site areas • Vegetation enhancement programs for Wallarah Creek and revegetation area for *Angophora inopina* and *Tetratheca juncea* refer Figure 16.1
1.15 State Conservation Areas	Environmental effects to State Conservation Areas • Jilliby State Conservation Area	• Minimising surface disturbance • Localised remediation if required to surface profiles adversely impacted by subsidence • Management plan specific to the area will be prepared

Environmental Issue	Potential Impact	Proposed Control Measures
1.16 State Forests	Environmental effects to State Forests • Wyong State Forest	• Minimising surface disturbance • Localised remediation if required to surface profiles adversely impacted by subsidence • Management plan specific to the area will be prepared
1.17 Natural Vegetation / Ecology – (associated with subsidence area)	Environmental effects to Natural Vegetation / Ecology	• The SMP is to include the establishment of several monitoring points within natural vegetation communities to measure and document the health and status of the EEC's. This body of credible data may be drawn upon at a later date to establish if potential impacts to the EEC are due to subsidence or other external processes and to provide appropriate mitigative measures with improvement of future mining technologies for those areas that are not undermined. • Further investigation to occur for threatened amphibians in the forested areas
1.17 Natural Vegetation / Ecology – surface related areas	Environmental effects to Natural Vegetation / Ecology from Surface infrastructure. Population of squirrel gliders has been identified along Wallarah Creek in the past (1995) but has not been re-recorded since.	• Design of rail loop to minimise habitat fragmentation and wetland disturbance • Minimising extent of clearing required for surface facilities, Wallarah Ck rail crossing, etc • Offsets strategy involving 50 ha of existing WACJV Land holdings • Vegetation enhancement programs for Wallarah Creek and revegetation area for *Angophora inopina* and *Tetratheca juncea* refer Figure 16.1 • Monitoring program • Administrative Controls i.e. inductions and Engineering Controls i.e. clearly marking out areas to be cleared and retained). • Site seed collection and propagation strategy • Landscape Strategy including revegetation and planting of surface site areas • Targeted assessment to determine if squirrel glider population remains and if present, area to be enhanced (for example feral species trapping, vegetation enhancement and nest boxes) and population managed. • Targeted assessment for Wallum Froglet to determine if it occurs in rail loop and if it does, carry out amelioration measure

Environmental Issue	Potential Impact	Proposed Control Measures
1.19 Air quality	Environmental effects to Air quality	• Detailed air quality studies prepared including PM10, PM2.5 and silica • Coal stockpile sprays to be activated when wind > 10 m/s • Upgrade of unsealed Tooheys Road to sealed road • Dust suppression – road watering • Water sprays at key coal handling transfer points and on stockpile areas • The crusher and screens on the Tooheys Road site will be fully enclosed. • Coal conveyors will be three quarter enclosed, against prevailing winds. • Trains loaded via underground tunnel reclaim leading from enclosed conveyor which delivers coal to a rail bin • The product stockpile will be equipped with wind activated water cannons. • All active major roads on the project sites will be clearly defined and suitably paved and the development of minor and unpaved tracks will be limited. • Speed limits to be enforced on all roads on site. • minimum practicable area for construction of surface facilities and infrastructure will be disturbed. • Cover crops established on any topsoil and subsoil stockpiles in place >6 months. • Meteorological conditions will be monitored and weather data will be considered in the conduct of day to day operations such as stockpile management. • Dust control measures to be employed during construction will include use of water carts, defining of trafficked areas, imposition of vehicle speed limits, use of vegetative matting or other erosion control measures on key dust sources, and constraints on work under extreme unfavourable weather conditions. • A spontaneous combustion management strategy will be developed for the project and will include coal stockpile management measures and monitoring of the potential causes and occurrence of spontaneous combustion conditions. • W2CP will install first flush systems on rural residential rain water tanks, at the request of landowners located within 500 metres of the project disturbance boundary at time of construction. • Monitoring Program to include - high volume samplers and dust deposition gauges - protocol for evaluating compliance with the air quality impact assessment and land acquisition criteria in the project approval • real-time dust monitoring to assist with pro-active dust control from project operations. • If dust emissions generated by the project exceed stated criteria at any non company-owned residence, or on more than 25% of any privately owned vacant land, W2CP will, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures set out in the project approval. • compensation or outright purchase of the properties if satisfactory mitigation measures cannot be negotiated (for further information see PAE Holmes, 2009 and EA)

Environmental Issue	Potential Impact	Proposed Control Measures
1.19 Odour	• Environmental effects to odour	• Odour modelling carried out • 30 degree angle of discharge from upcast vent shaft included in design • Operational odour campaign monitoring in shaft
1.20 Acoustic Amenity (Noise)	Environmental effects to Acoustic Amenity (Noise)	• Inclined drift obviates need for conveyor transport across F3 or private land • Rail loop to be constructed to prevent noise from road transportation • Preparation of a noise and vibration management plan that contractors will have to comply with during construction • Noise controls at Tooheys Road site: - location of stockpiles and infrastructure to take advantage of natural topographic shielding where practical; - double skin cladding of coal handling plant; - low noise rated conveyors and motor drives; - conveyor structures designed with side and roof screens to provide effective directional noise amelioration; - underground coal reclaim system to minimise reliance on dozers for loading trains; - mobile plant fitted with secondary noise control kits; - removal of surface rail crossings and hence the requirement for trains to sound warning horns whilst on-site; - laminated (soft loading) steel chutes; - low level 'broadband sound' mobile plant reversing alarms; and - selection of plant to limit noise emissions. Where practical and feasible, motor drives and gearboxes would be specified and selected to achieve a noise level of less than 85dB(A) measured at one (1) metre from the source. • Noise controls at Buttonderry site: - enclosing the mine winding equipment; - enclosing the mine ventilation fans/motors; - inline attenuators installed on the fan discharges; and - earth bunding along the southern alignment of the car park. • Mine to comply with existing standards for assessment and monitoring procedures for noise, which provide sufficient safeguards against noise impacts • Where risk of exceedance exists or impacts occur, a noise management agreement will be developed with landowner if required • Noise Monitoring Program may include a combination of real-time and attended monitoring measures, and a noise monitoring protocol for evaluating compliance with the noise impact assessment and land acquisition criteria in the project approval. • Potential noise mitigation strategies to be discussed with the property owners if: - the owner believes he or she is adversely affected by intrusive noise from the proposal; and - noise level measurements confirm the recommended goals are exceeded. • Where a predicted exceedence is of a minor and intermittent nature, it is unlikely that outright purchase of property would be necessary. However this would be offered if noise monitoring during operation confirms that the recommended goals cannot be complied with and other acoustic treatments at these locations are not successful. (for further information see Atkins, 2010 and EA)

Environmental Issue	Potential Impact	Proposed Control Measures
1.21 Soils	Environmental effects to soils due to subsidence	• Pre-mining inspections • Repair program for mining related disturbances to the soil surface • Monitoring of - banks of Jilliby Jilliby, Little Jilliby Jilliby and Myrtle Creeks - scattered ridgetops throughout mining area - Small section on western perimeter of mining area - Scattered locations adjacent to creeklines - Isolated occurrences of water flow changes • Filling of cracks if required
1.21 Soils	Environmental effects to soils from surface infrastructure	• Soil and Erosion control plan proposed to manage soil impacts • Water Management Plan • Landscaping and revegetation of surface facilities sites following construction • No acid sulphate soils have been mapped in surface facilities development sites
1.22 Energy Usage	Environmental effects from excessive energy usage	• Energy and Greenhouse Strategy to be developed within 2 years after the commencement of longwall coal extraction / Energy Savings Action Plan • Installation of energy efficient appliances, lighting and hot water system (such as gas boosted solar hot water system). • Project design excludes a washery and site tailings disposal and rejects emplacements – significantly reducing energy demands. • Co-ordination of energy development requirements in consultation with energy authorities
1.23 Greenhouse	Environmental effects from greenhouse gas emissions	• Flaring of methane from an early stage of the project will be augmented by further gas management and utilisation initiatives when commercialisation is feasible • Use of 5% bio-diesel or similar and low-sulphur diesel fuel, where feasible • Energy and Greenhouse Strategy to be developed within 2 years after the commencement of longwall coal extraction • Coal mine methane and utilisation strategy to be developed within 3 years of longwall operations following monitoring experience
2 - PUBLIC UTILITIES		
2.01 Railways	Environmental effects to Main Northern Railway	Railway not being subsided and not affected by surface sites. Project aims to use railway for coal transportation. W2CP will continue co-ordinate with rail infrastructure authorities and service providers to develop project facilities and operational requirements. Environmental management factors on the Main Northern Rail Line are governed by licence conditions upon the facility owner.

Environmental Issue	Potential Impact	Proposed Control Measures
2.02 Roads (All Types) associated with subsidence areas	Environmental effects to Roads (All Types • Local roads above mining area – sealed and unsealed	• F3 Freeway not affected by subsidence • Will comply with requirements of SMP (to be prepared in the future) • MSB to cover road impacts • Prepare and implement Plan of Management to address road impacts and ensure the safety and serviceability of public roads, 4WD tracks and existing fire fighting access tracks. To be done as part of SMP process.
2.02 Roads (All Types) associated with surface facilities	Environmental effects to other roads • F3 Freeway • Wallarah Interchange • Motorway Link Rd / Tooheys Road intersection • Sparks Rd / Hue Hue Rd intersection • Local roads	• No product coal to be hauled on public roads • W2CP to co-ordinate with road authorities and landholder to develop a strategy for managing Tooheys Rd during construction (including temporary relocation of Tooheys Road) and in the long term. • intersection of Hue Hue Road and the Buttonderry pit top mine access road to be a Type B rural layout with a left turn auxiliary lane as well as a right hand turn lane from Hue Hue Road into the proposed access road.
2.03 Bridges associated with F3	Environmental effects to bridges	• Small movements predicted and liaison with RTA to address potential impacts as part of SMP. • Predicted movements, to be provided to the RTA, so that a structural assessment of the bridges can be undertaken based on the predicted far-field horizontal movements. • It may be necessary to undertake some preventive measures, if the bridge movement joints and bearings were not able to tolerate the predicted differential movements.
2.03 Bridges associated with subsidence area	Environmental effects to bridges	Bridges in mine area • Prepare and implement Plan of Management to address any subsidence impacts to bridges in subsidence area. To be done as part of SMP process. • MSB to address repairs if necessary.
2.04 Tunnels	Environmental effects to tunnels	• No tunnels impacted by mining or surface facilities
2.05 Culverts	Environmental effects to culverts	• Culverts identified in subsidence study and predications made. • Repairs covered by MSB
2.06 Water Infrastructure in subsidence area	Environmental effects on: • Gosford-Wyong Water Supply Scheme (Mardi Dam, Wyong Weir, Proposed Mangrove Creek Pipeline)	• Mining area does not include any significant public water reticulation systems. • No mining under Mangrove Creek Dam, Mardi Dam, Wyong River, Ourimbah Creek, Porters Creek Wetland or related infrastructure • The predicted movements along the proposed route have been provided to the designers of the pipeline. • Proposed Mangrove Creek Pipeline designed in line with current subsidence predictions.
2.06 Water Infrastructure in subsidence area	Environmental effects to Water supply infrastructure within the mining area	• Treelands Drive Reservoir – low subsidence and no impacts predicted. No mitigation measures required.

Environmental Issue	Potential Impact	Proposed Control Measures
2.06 Water Infrastructure in regional area	Environmental effects to Hunter water supply pipeline	• No controls needed as no predicted impacts
2.06 Gas Infrastructure	Environmental effects to Gas Infrastructure	• Sydney-Newcastle oil and gas pipeline located to the east of the F3 Freeway - no impacts predicted so no control measures required.
2.06 Sewerage Infrastructure	Environmental effects to on site waste water systems (No public sewage infrastructure to be impacted)	• Preparation of Property Subsidence Management Plans including on site waste water disposal systems • MSB to repair any damage
2.08 Electricity Transmission Lines or Associated Plants	Environmental effects to 330 kV transmission lines – suspension and tension towers **Note**: assessment based on assumption that putting supply at risk is not an option.	• Subsidence predictions developed • Mining will only proceed if approval obtained from DII (Mineral Resources) and TransGrid • Detail design co-ordination and post-approval process will address protection of transmission line (SMP process). Predicted movements at the transmission towers to be reviewed by TransGrid so that a detailed structural analysis of the towers can be undertaken. • Mitigative measures where required such as - cable sheaths, cruciform structures - Strengthening of the tension towers - Installation of additional temporary towers or poles - Realignment or re-routing of the transmission lines - Direct burying the transmission line cables, providing approvals can be obtained from the land owners and that the engineering and safety constraints can be overcome, and - Providing coal barriers beneath the tension towers. • it is currently proposed to establish a subsidence management committee with officers from the WACJV, TransGrid and the Mine Subsidence Board with a view to avoid sterilising coal in these cases where cruciform solutions would not work (ie where two high angle tension towers occur that are not due to be mined within the first 20 years). As tension towers have been constructed in many countries overseas to minimise the effects of subsidence, it is expected that replacement towers could be installed to support these transmission lines.
2.08 Electricity Transmission Lines or Associated Plants	Environmental effects to 132 kV Transmission lines	• Unlikely to be significantly impacted so no control measures required
2.08 Electricity Transmission Lines or Associated Plants	Environmental effects to Local overhead lines	• Address in SMP process. Readily managed. • some remedial measures likely to be required, including some adjustments of the cable catenaries, pole tilts and the consumer cables. • Management strategy to be developed in consultation with Energy Australia
2.09 Telecommunication Lines or Associated Plants	Environmental effects to Telecommunication Lines or Associated Plants • optic fibre cables • Copper underground services • Cellular Mobile Telephone Services (CMTS) sites • GSM Tower	• Management plans addressing each item of infrastructure to be prepared as part of SMP process. Impacts readily managed. • GSM tower built to MSB requirements

Environmental Issue	Potential Impact	Proposed Control Measures
2.11 Dams, Reservoirs or Associated Works	Environmental effects to Dams, Reservoirs or Associated Works • Mardi Dam (outside subsidence zone) • Mangrove Creek Dam (outside subsidence zone)	• No mining under Mangrove Creek Dam, Mardi Dam, Wyong River, Ourimbah Creek, Porters Creek Wetland or related infrastructure
2.12 Air Strips	Environmental effects to air strips	• No air strips within the mining area or directly affected by surface facilities. • Warnervale air strip in vicinity of surface facilities. Facilities designed in accordance with airport obstacle limitation surface (OLS) requirements. • Aerodrome operators to be notified prior to construction for any specific requirements for the use of cranes on site. • Co-ordination with relevant authorities during detail design stage.
2.13 Any Other Public Utilities	Environmental effects to Any Other Public Utilities • Buttonderry Waste Management Facility (outside mining area)	• W2CP planning for co-operative land use management with Buttonderry tip and other potential land uses in the Council property (eg. W2CP provision of access)
3 - PUBLIC AMENITIES		
3.03 Schools affected by subsidence	Environmental effects to Schools Jilliby Public School in mining area.	Jilliby Public School is located in the subsidence study area but not above the longwalls. The school is at a sufficient distance from the longwalls not to experience noticeable subsidence.
3.05 Community Centres	Scout Camp located in subsidence study area. Dooralong Hall and Wyong Creek Halls outside subsidence area.	Scout Camp located in subsidence study area but not above longwalls. The camp is at a sufficient distance from the longwalls not to experience noticeable subsidence.
3.13 Visual Amenity	Environmental effects to visual impacts of infrastructure	• Choice of building colours to blend into the natural surrounds • Undertake measures to provide landscape mounding and screen plantings to improve the visual character of the surface development sites of the project including: - Vegetation screening between the Tooheys Road site and the F3 Freeway and along Hue Hue Road; - Planting of native vegetation along noise control bunding - Landscaping around buildings and carparks • rail spur will be proposed to be located adjacent to the existing power line easement to minimise impacts of new clearing • Where practicable, workshop doors will be orientated so as to reduce light spill to any light-sensitive adjacent properties and land uses. • At night, work will be restricted to reduce noise impacts which will also reduce potential direct lighting effects from vehicular sources such as dozer or truck headlights and flashing beacons • Rehabilitation plans outlined in Chapter 2
4 - FARM LAND AND FACILITIES		

Environmental Issue	Potential Impact	Proposed Control Measures
4.01 Agricultural Utilisation or Agricultural Suitability of Farm Land	Environmental effects to agricultural Utilisation or Agricultural Suitability of Farm Land	• Flood management plan, including evacuation planning • Addressed in Property Subsidence Management Plan and other post-approval processes (SMP/Extraction Plan, other)
4.02 Farm Buildings or Sheds	Environmental effects to farm Buildings or Sheds	• Management required as part of SMP process. • Individual Property Subsidence Management Plan to be prepared for each property addressing farm buildings and sheds (compensation / remediation / protection addressed in PSMP), in consultation with landowners. • Structural inspections to be conducted • MSB make good repairs as required
4.07 Irrigation Systems	Environmental effects to Irrigation Systems	• Irrigation systems present
4.08 Fences	Environmental effects to Fences	• MSB make good repairs as required
4.09 Farm Dams	Environmental effects to Farm Dams	• Dam inspections prior to and after mining. • In the event of subsidence damage, W2CP will remediate the damage and reinstate the dam in conjunction with the Mines Subsidence Board. If required, an alternative water supply will be provided to the dam owner until the dam can be reinstated and water supply is restored.
4.10 Wells or Bores	Environmental effects to Wells or Bores • 12 bores within subsidence zone	• Commitment to ensure that no landholder's water supply capacity within the mining area will be significantly affected • Monitoring of mine waters and groundwaters to verify model predictions • Provision of water to landholders if required • Repairs if required
5 - INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS		
5.03 Business or Commercial Establishments or Improvements	Environmental effects to Business or Commercial Establishments or Improvements Disused quarry, Turf farms, equestrian establishments, cattle properties, nursery, forestry operations, etc.	• Mine plan design and subsidence management to meet subsidence guidelines and surface constraints. Property mine subsidence management plans to be developed for all landholders, in consultation with landholder, which will address site enterprise issues through monitoring and remedial measures. • Restrict access to disused quarry while it is being mined beneath and develop management plan to address potential for rock fall.
5.04 Gas or Fuel Storages or Associated Plants	Environmental effects to minor Gas or Fuel Storages associated with rural properties	• Property subsidence management plans will address property specific issues

Environmental Issue	Potential Impact	Proposed Control Measures
5.07 Surface Mining (Open Cut) Voids or Rehabilitated Areas	Environmental effects to Surface Mining (Open Cut) Voids or Rehabilitated Areas Disused Quarry: No significant impacts anticipated while quarry not operational.	• Preparation of a Property Subsidence Management Plan or equivalent to address potential risks in the currently disused quarry. This will include restricting access to disused quarry while it is being mined beneath and developing a management plan to address potential for rock fall.
6 - AREAS OF ARCHAEOLOGICAL OR HERITAGE IMPORTANCE		
6.01 Areas of Archaeological Significance in the Subsidence Area	Environmental effects to Aboriginal heritage: • five known archaeological sites within the subsidence footprint and more expected to exist. • No specific heritage surveys were undertaken for this EA, however certain areas were identified as having potential for sites to be present.	• Additional targeted survey over areas of highest potential if project approved for inclusion in SMP.
6.01 Aboriginal Heritage in the Surface Infrastructure Study Area	Environmental effects to Aboriginal heritage: • Two Sensitive Archaeological Landforms (SALs) present along Wallarah Creek in Tooheys Rd site • No sites identified in Buttonderry or Western Shaft areas	• Pit top facilities redesigned to minimise effects of crossing Wallarah Creek • Archaeological investigation currently being undertaken over SAL areas in the vicinity of Wallarah Creek where avoidance is not possible. This work is in the form of test excavations to determine the presence, nature, extent and significance of potential Aboriginal site material. The test excavation programme has already been designed and will be completed prior to project determination. • This test excavation programme will provide the necessary data to allow project determination and will also feed into design of further management measures (i.e. salvage or monitoring). • Potential off-set area for formal conservation of three sites. • Thee Indigenous sites were located at the Hue Hue Road offset area along Wallarah Creek and its tributaries. The preferred management of these sites and indeed the entire creek line which is delineated as an area of archaeological sensitivity is to see the area formally conserved through a mechanism such as a covenant on the title of the land.
6.01 Areas of European Heritage Significance in the Subsidence Area	Environmental effects to European heritage: • 10 potential items in subsidence area; • 2 listed items in subsidence area.	• Significance assessments still remain to be applied to the list of potential heritage locations. Such assessments should be undertaken through applying the NSW Heritage Office criteria, and if necessary, undertaking landholder consultation and as well as investigation through historical societies, Shire Council etc. This will enable a better understanding of the potential impacts of the project to the heritage values /significance of these locations and allow the development of appropriate mitigative measures. • With regard to the two items on the Wyong LEP that will be impacted by the potential subsidence effects of longwall mining in the W2CP subsidence study area (a silo and a house) further assessment and the development of appropriate mitigative measures will be required. As these items are all privately owned, impacts to them will also be addressed in the PSMP. Consultation with the Wyong Shire Council and the heritage Office may also be required.

Environmental Issue	Potential Impact	Proposed Control Measures
6.01 Areas of European Heritage Significance (in surface facility areas)	Environmental effects to Areas of Archaeological Significance • No items identified in areas for surface facilities	• As no items of non-Indigenous heritage value were recorded there are no specific recommendations regarding non-Indigenous heritage items.
7 - ITEMS OF ARCHITECTURAL IMPORTANCE		
7.01 Items of Architectural Significance		No items of architectural importance within the mining area or affected by surface facilities.
8 - PERMANENT SURVEY CONTROL MARKS		
8.01 Permanent Survey Control Marks	Environmental effects to Permanent Survey Control Marks	Base line assessment completed, known sites of the survey control marks within the area. SMP will address management of survey marks. • Completed SMP to include consideration of Permanent Survey Control Marks and the monitoring programs • Liaise with Land and Property Information (LPI) until mining has ceased and Permanent Survey Control Marks can be re-established
9 - RESIDENTIAL ESTABLISHMENTS		
9.01 Houses	Environmental effects to houses	• Predictions achieved through computer modelling techniques developed by Strata Control Technology Pty Ltd used in conjunction with empirical modelling methods developed by Mine Subsidence Engineering Consultants Pty Ltd • Mine design developed in recognition of the Hue Hue and Wyong Mine Subsidence Districts • within the Hue Hue Mine Subsidence District, the maximum predicted total strains and tilts at the completion of mining, are consistent with criteria prescribed for that district • Mine layout modifications in “subsidence protection zones” including Yarramalong and Dooralong Valleys and Hue Hue rural residential area. Measures include shorter/narrower longwalls and reduced coal extraction height • Repairs to be undertaken by MSB and appropriate compensation made where necessary • Development of a scientifically sound and defensible subsidence prediction model. • Calibration of the model based on actual mining results from other operations. • Alterations made to the mine plan to ensure subsidence limits can be met. • Running of the model on the revised mine plan to verify that subsidence limits can be met. • Modelling results show that required subsidence limits can be achieved. Subsidence Management Plan process to be undertaken including one on one liaison with affected landholders via Property Subsidence Management Plans • Inspection prior to and after mining

Environmental Issue	Potential Impact	Proposed Control Measures
		• Subsidence monitoring to be carried out once coal extraction has begun to verify the impacts and that subsidence limits are being met. • Inspection of damage to verify the cause and repair if necessary. To be undertaken through the mine subsidence board. • Mine plan can be modified if impacts are greater than predicted
9.05 Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	Environmental effects to Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	• Property subsidence management plans will be undertaken and will address these • On site waste water systems may be temporarily affected but repairable as part of Property Subsidence Mgmt Plan actions • W2CP will install first flush systems on rural residential rain water tanks, at the request of landowners located within 500 metres of the project disturbance boundary at time of construction.

17.5 Environmental Monitoring

A detailed environmental monitoring plan has been developed to cover the construction and operational phases of the W2CP. Environmental monitoring will provide the verification of the impact predictions made in this document. It will also allow the environmental performance of the operation to be assessed and will give the opportunity to fine tune the development works as they proceed.

Environmental Resource Management Australia Ltd Pty (ERM) has been responsible for the environmental monitoring program since 1996. The program has been modified and expanded as required during this period.

The environmental monitoring systems proposed were developed with reference to the "*Leading Practice Sustainable Development Program for the Mining Industry – Evaluating Performance: Monitoring and Auditing*" published by the Australian Government Department of Resources, Energy and Tourism in 2009.

The proposed monitoring locations are shown on Figure 17.1. The program will be expanded to include additional residential receptors during the construction phase however these will be reviewed during the operation period in consultation with DECCW. The primary purpose of the program is to provide the necessary data to accurately verify the impact predictions made in this EA. However, should complaints be received from residences located further away then additional monitoring will be undertaken at more distant locations. It is possible, though highly unlikely, that residences located further from the proposed works will experience higher levels of noise and dust.

The basic program consists of:

- ambient air quality measurements recorded by static dust gauges and high volume air samplers (HVAS) that measure finer <10µm (PM10) and coarser particles (TSP). These have been located and operated throughout the development area and surrounding localities;

- water quality monitoring through measurement of field parameters and collection of water samples from creeks, rivers and streams, taken from locations upstream and downstream of the development area; and

- a weather station installed to record meteorological parameters including rainfall, temperature, wind direction, wind speed and sigma theta (variability of wind direction).

Water and air quality monitoring sites extend from Wyee in the north to Tuggerah in the south. At the completion of the 2002 monitoring period, a total of 20 dust deposition monitoring sites, 21 water quality monitoring sites and six suspended particulate monitoring sites had been established. Since May 2006, the environmental monitoring program was modified with monitoring sites predominantly located on the western side of the F3 Freeway. Figure 17.1 illustrates the location of the sampling sites in operation since May 2006.

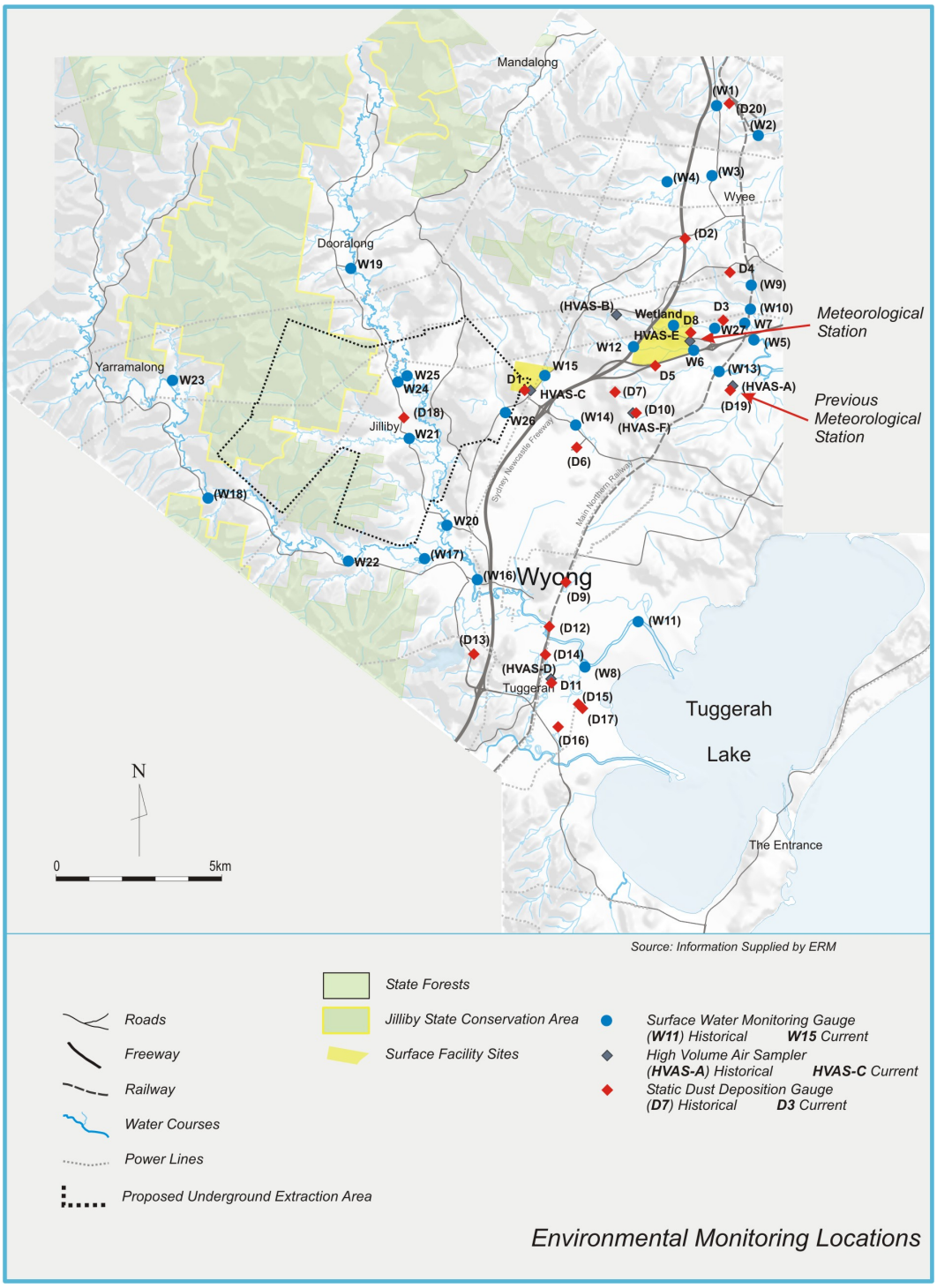

Figure 17.1 Environmental Monitoring Locations

The current program consists of:

- surface water sampling and analysis undertaken monthly at up to 14 monitoring locations (depending on water flow and accessibility) to analyse physical parameters, major ions, nutrients and dissolved metals.

- Additional sampling events were performed following significant rainfall events to augment the data set;

- meteorological monitoring using an automatic weather station (AWS);

- ❒ static dust deposition monitoring undertaken monthly at six monitoring locations (due to vandalism, some data was lost); and

- ❒ TSP and PM10 particulate monitoring undertaken every six days at two monitoring locations.

The data collected over 13 years has provided an excellent basis for accurately determining the real impacts of the operation and to verify the impact predictions made in this EA.

Groundwater monitoring will recommence in March 2010 to allow several years worth of data prior to underground extraction within the Dooralong Valley area. The proposed bore locations are provided in Figure 17.2 and described in Section 8.5.
The monitoring program will determine the following parameters:

- ❒ Physical depressurisation of the shallow coal measures rock strata and potential indirect impacts on alluvial aquifer systems associated with the Dooralong and Yarramalong Valleys; and

- ❒ Changes to shallow groundwater storage induced by subsidence.

Impact verification analyses would include:

- ❒ Quarterly assessment for departures from identified monitoring or predicted data trends. The key data sets in this regard should be the mine water seepage rate calculated from the underground water balance, and the pressure monitoring data for multi level piezometers. If the average daily seepage rate exhibits an increase beyond the rate predicted (allowing for 0.5 ML/day additional transient storage depletion), or if consecutive pressure monitoring data over a period of six months exhibit an increasing divergence in an adverse impact sense from the previous data or from the established or predicted trend, then such departures should initiate further actions. These may include a need to conduct more intensive monitoring (including installation of additional piezometers) or to invoke impacts re-assessment and/or mitigative measures;

- ❒ Formal review of depressurisation of coal measures and comparison of responses with aquifer model predictions biennially. Expert review should be undertaken by a suitably qualified hydrogeologist; and

- ❒ Annual reporting (including a summary of all water level and water quality data) as part of the Annual Environmental Management Report (AEMR).

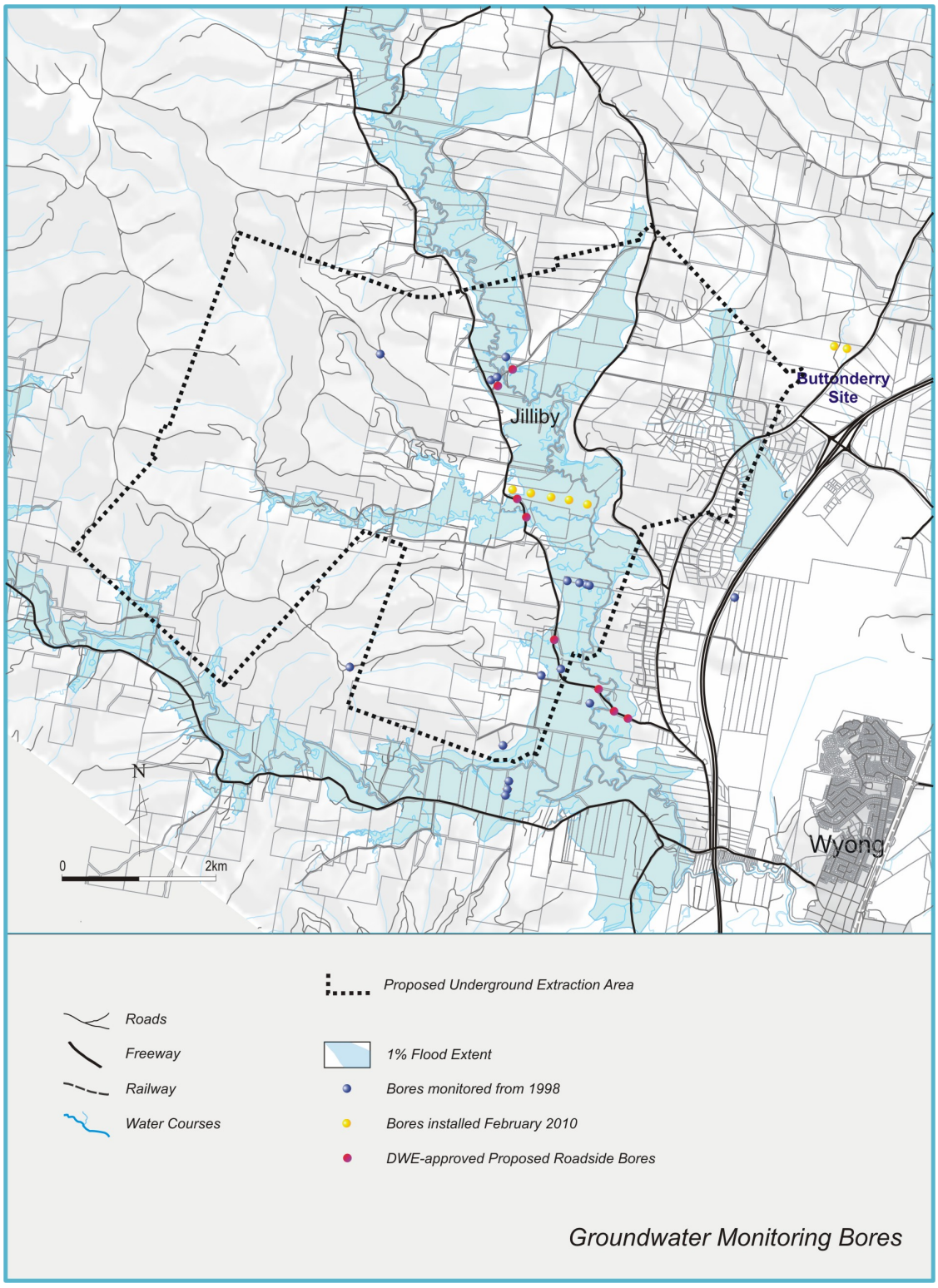

Figure 17.2 Initial Groundwater Monitoring Bores

17.6 Conclusion

On the basis of the assessments detailed in the various sections of this document, the project proposed provides the option for the lowest impact on the region when compared with other mine plans developed for the project.

The impacts of the W2CP will be both positive and negative. Negative impacts will be mitigated wherever possible by appropriate measures to reduce their impacts on the environment. With the implementation of WACJV's environmental management systems and sustainability package, the impacts on surrounding residents, water supply, flooding impacts, native flora, fauna or fauna habitats as a result of the proposed development are considered acceptable.

The proposed underground mine is consistent with the requirements of the Department of Industry and Investment (Mineral Resources) for the efficient utilisation of coal resources within NSW. The development can meet environmental objectives and will provide significant economic benefits to the local and regional economy.

The balance between environmental impacts and benefits resulting from the proposal clearly favours the development proceeding.