Road Traffic Noise

Traffic volumes were counted from 17 February 2011 to 12 May 2011 as part of a detailed assessment of the traffic impacts to Ulan Road from mining operations within the area by MWRC. The traffic assessment has therefore been based on actual data and traffic counts. The peak hourly traffic flow count on Ulan Road, 100 metres north of the Cope Road intersection has been used for this assessment.

The predicted existing traffic noise levels at the closest receiver to Ulan Road (Receiver 37) are L_{Aeq} 67 dB for the day period and L_{Aeq} 65 dB for the evening period.

Predicted existing traffic noise levels for the nearest residence to the road are already well above the day period hourly criterion of L_{Aeq} 55 dB. Accordingly, consistent with the RNP any change should be limited to 2 dB above existing noise levels.

Sleep Disturbance

A conservative assessment of sleep disturbance impacts was conducted for the MCC. The noise assessment predicted potential significant sleep disturbance effects at Receiver 31 which is also predicted to exceed PSNC by more than 5 dB(A) as shown in **Table 17**.

Five additional properties have been predicted to receive minor to moderate exceedances of the sleep disturbance criterion, all of which are also predicted to receive exceedances of PSNC due to operational noise.

Cumulative Operational Noise

An assessment of cumulative noise impacts with Ulan Coal Mine and Wilpinjong Coal Mine was undertaken and is detailed in **Appendix D**. No properties were predicted to be impacted by cumulative noise additional to that predicted to be affected by Preferred Project operational noise.

4.4.4 Management and Mitigation

MCM will prepare and implement a Noise Management Plan (NMP) for the MCC, which will include the key noise mitigation assumptions from the noise model as described in **Section 4.4.2** and **Appendix D**. The plan will describe practical leading practice noise mitigation and management measures to be implemented at site to ensure noise levels at all private residences from MCC activities are maintained below the predictions in **Section 4.4.3**. The NMP will be provided to DP&I for consideration.

Where practicable, the NMP will include (but not be limited to) the following measures:

- Trucks, excavators and water carts used within mining activities will be fitted with leading practice attenuation packages (including exhaust silencers to reduce noise emissions);
- Sound power level monitoring will be undertaken in accordance with a determined procedure to ensure mobile plant sound power levels are generally consistent with that used in the PPR noise model;
- Mobile overburden fleet will be directed to higher, exposed areas during favourable weather conditions (generally during the day) and to lower, more shielded areas during noise enhancing weather conditions;
- Tracked dozers will be operated at slow speed, particularly in reverse in exposed areas of the site during noise enhancing weather conditions to minimise audible track noise;
- Non-intrusive vehicle warning devices (e.g. reversing alarms, horns and start alarms) with broadband frequency characteristics will be installed on mobile mining fleet to produce the lowest possible noise levels, consistent with safe operation;
- Mobile and coal handling equipment will be maintained in good condition to minimise unnecessary noise;

- The existing Stage 1 ROM coal front end loader will be upgraded with an attenuation package (as per MCM's existing noise reduction program);
- Coal extraction and coal haulage in OC2 will be restricted to the day period only;
- Coal extraction and coal haulage in OC3 will be restricted to the day period only;
- Investigation of predictive modelling to determine alternate operating configurations that work best in various weather conditions;
- Strategic pit design to provide alternate dump locations where required;
- The existing real time noise monitoring system will be reviewed and enhanced as appropriate to assist with the proactive management of operations to minimise adverse noise impacts on neighbouring receivers. The strategic review will consider:
    - Best available monitoring equipment (noise and meteorology);
    - Integration of noise and meteorological data;
    - Improvements to alarm system logic (what combination and trends of parameters warrants an alarm);
    - Reporting of alarms to production;
    - Procedure for recording alarm responses to ensure the production team responds in a timely manner and for reporting; and
    - Mechanisms and procedures for timely feedback to production if higher noise levels are identified, and provision for follow up to identify success or otherwise of changes made.
- Sequenced actions to be undertaken in response to triggered noise alarms to ensure MCC noise levels at surrounding private residences are maintained below PSNC, including:
    - Confirmation that alarm triggering relates to MCC mining noise;
    - Relocation of operations to more shielded areas;
    - Cessation of plant suspected to be responsible for the alarm, where relocation is in effective; and
    - Temporary cessation of mining activities.

The NMP will be provided to DP&I for approval.

MCM will continue discussions with UCML and other mining operations to address the joint management of potential cumulative noise impacts.

Upon receipt of a written request from a private landholder listed in **Table 17** and **Table 18**, MCM will commence the implementation of reasonable and feasible noise mitigation measures at the receiver in consultation with the landholder in accordance with the conditions of Project Approval.

Noise minimisation practices will be implemented to ensure that the MCC does not exceed PSNC at all other privately owned receivers not listed in **Table 17** and **Table 18**.

MCM has pursued consultation with landowners listed in **Table 17** and **Table 18** in order to communicate the predictions of the noise modelling and provide detail on the implications for each landowner associated with the operation of MCC. This consultation is ongoing and has been carried out to ensure landowners are informed of the potential impacts from the MCC.

4.4.5 Summary

When compared to the Project assessed in the Stage 2 EA, the Preferred Project (incorporating the MCC) utilises site specific data gained from the operation of Stage 1 and provides for improved mitigation and management measures as stipulated in **Section 4.4.4** of this PPR.

4.5 BLASTING

Global Acoustics conducted a blast impact assessment for the MCC which is presented in full in **Appendix D**. This section and **Appendix D** replace in full the blast impact assessment carried out for the Stage 2 EA.

4.5.1 Methodology

Introduction

The Stage 2 EA determined that one privately owned Receiver (Receiver 44) would receive blast overpressure impacts above the relevant criteria due to blasting in OC4. This Receiver has since been purchased by MCM.

Blasting Criteria

Current noise and vibration criteria are recommended in the ANZECC Guidelines and are reproduced in **Table 19**. Recommended blasting criteria apply during day light hours Monday to Saturday, excluding public holidays and are consistent with the Stage 1 Project Approval.

4.5.2 Impact Assessment

Blasting in OC4 will be located at a greater distance from all private Receptors than the existing operations in OC1. Therefore, existing Stage 1 operations blast vibration and overpressure level data has been utilised to provide an indication of the likelihood of achieving ongoing compliance.

MCC has provided monitoring results for 136 overburden and coal blasts over the period 7 October 2009 to 17 November 2011. Additionally, Global Acoustics have been contracted to independently monitor the nearby 330 kV electricity line towers when blasting is taking place within 500 m of them; to date this has been required on 18 occasions. A summary of blast monitoring results is presented in **Table 20**.

The results show that blast vibration criteria have been exceeded only once in over two years of mining. It is reasonable to conclude that this aspect of blasting is being adequately managed by MCC.

Table 19
Blasting Amenity Criteria

Criteria *	Overpressure (dBL)	Ground Vibration (mm/s)
Less than 5% of total blasts to exceed	115	5
No blasts to exceed	120	10

** Criteria do not apply where a Private Agreement is in place*

Table 20
Blast Monitoring Summary

Location	Criterion	Maximum Result	Number Of Exceedances
Vibration (mm/sec)			
Ulan School	5/10	2.5	0
Rock Shelters	40	2.5	0
Moolarben Dam	Not specified	4.2	0
Lagoons Road	5/10	0.9	0
Transmission Towers	50	43.4	0
Overpressure (dB)			
Ulan School	115/120	120.6	2/1
Rock Shelters	NA	NA	NA
Moolarben Dam	NA	NA	NA
Lagoons Road	115/120	115.0	0
Transmission Towers	NA	NA	NA

Overpressure has exceeded 115 dB at Ulan School on three occasions, one of which was greater than 120 dB (with the latest occasion on 8 July 2010). Levels greater than 115 dB are permissible for 5% of blasts in a 12-month period. This continues to be complied with under current operations, achieving 0% in 2009, 4% in 2010 and 1.4% in 2011.

4.5.3 Management and Mitigation

A Blast Management Plan (BMP) will be prepared which will include protocols to ensure that blasting does not occur during meteorological conditions that will result in significant off-site dust, hazardous emissions or overpressure impacts on residences, the Munghorn Gap Nature Reserve or Goulburn River National Park. The BMP will include the following management procedures:

- Development of a blast monitoring system (in conjunction with UCML and Wilpinjong Coal Mine) which is representative of the closest sensitive receivers to ensure compliance with the relevant blast criteria;
- Coordination of blasting schedule with UCML and Wilpinjong Coal Mine to avoid potential for simultaneous blast events;
- Notification of blast events to sensitive receivers upon request prior to the blast event;
- Blast events will be designed to meet the relevant overpressure and ground vibration criteria; and
- Blasting to be undertaken during suitable weather conditions.

4.6 GROUNDWATER

RPS Aquaterra (Aquaterra) conducted a review of the Stage 2 EA groundwater impact assessment. The revised groundwater impact assessment is presented in full in **Appendix E** and has been prepared in consideration of the Preferred Project, recent approvals for UCML and Wilpinjong Coal Mine, the Regional Groundwater and Surface Water Study (Aquaterra 2009), relevant RTS and issues raised in the independent peer review subsequent to the submission of the Stage 2 EA.

This section and **Appendix E** replace in full the Groundwater Impact Assessment carried out for the Stage 2 EA.

4.6.1 Background

A brief outline of the existing groundwater system within and surrounding the Project Boundary is provided in the following sections.

Previous Groundwater Investigations

A number of hydrological studies were undertaken in the vicinity of the Project Boundary to understand the surrounding hydrological regime and to assess the potential impacts of mining from the Stage 1 and Stage 2 Projects. The Stage 1 hydrological investigations were undertaken by Peter Dundon and Associates (2006a, 2006b, 2006c, 2007a and 2007b).

Stage 2 hydrological investigations were undertaken by Aquaterra and are presented in **Appendix E**. These investigations included the drilling, installation and hydraulic testing of groundwater monitoring bores and test production bores, collection of baseline data from the region, consideration of water supplies from the surrounding alluvial groundwater aquifers and the characterisation of the hydrogeology.

Regional groundwater and surface water monitoring network rationalisation was undertaken by Aquaterra in (2009). The report concluded that all three mines have sufficient groundwater monitoring networks to provide good regional spatial coverage. In addition, the assessment identified the potential to rationalise the monitoring program for the MCC and Ulan Coal Mine by sharing the data at several locations where duplication exists as this would provide benefits to both mining operations.

A peer review of the Aquaterra groundwater model was also undertaken by Dr Noel Merrick of Heritage Computing with the finding incorporated into the assessment.

Other groundwater investigations associated with the neighbouring UCML and Wilpinjong mining operations have also been utilised to gain an enhanced understanding of the groundwater regime in the vicinity of the Project Boundary.

Existing Groundwater System

Site investigations have determined the groundwater system within the vicinity of the Project Boundary consists of the following hydrogeological regimes:

- Localised aquifers within unconsolidated Quaternary-age (recent) alluvium associated with the present drainage system;
- Localised aquifers within unconsolidated Tertiary-age palaeodrainage channel fill deposits;
- Localised fracture aquifers within Triassic-age sediments (Narrabeen Group);
- Localised fracture aquifers within Permian-age coal measures, principally the Ulan Seam;
- Limited aquifer potential in older Shoalhaven Group sediments and basement rocks; and
- Aquifers in weathered basement granites and volcanics.

Groundwater Levels and Flow Patterns

Quaternary-age Aquifers

The regolith comprises weathered bedrock and Quaternary-age alluvium and colluvium. These units are collectively referred to as the surficial aquifer system. They typically comprise local shallow watertable aquifers, which respond directly to recharge from rainfall infiltration.

Groundwater levels mirror surface topography, with shallow watertable levels in elevated areas and zones of discharge, and lower watertable levels in the valleys. Groundwater flow also follows topography, with flow down gradient to lower valley floor areas.

Discharge occurs locally through topographically controlled springs and seeps or as baseflow to local drainage channels. Some groundwater is lost from these shallow aquifers through vegetation uptake and evapotranspiration.

As the groundwater table is typically shallow, losses also occur via evapotranspiration with negligible percolation to the underlying unweathered hard rock units of the Triassic and Permian.

Tertiary-age Aquifers

The Tertiary-age palaeochannel deposits are part of a remnant drainage system that extends from between UG1 and UG4 eastward along the Wilpinjong Creek valley. Minor tributaries of this palaeochannel are found in the Murragamba Creek and Eastern Creek valleys. This aquifer system is not coincident with the present drainage and is assessed to have only limited hydraulic connectivity with the creeks and associated alluvium. Where groundwater is observed in these channels, it is shallow, occurring at between 2 m and 13 m below the surface.

Investigative bores drilled into the channel between UG1 and UG4 and in parts of OC4 were either dry or only partially saturated. It is believed that these aquifers provide only limited baseflow contribution to the present creek system and as such the Tertiary-age Aquifer has not been assessed further. Recharge is via direct rainfall infiltration.

Triassic-age Aquifers

Triassic-age sandstone units (Narrabeen Group) are present across a significant portion of the Stage 2 Project Boundary. This aquifer is mostly unsaturated above UG1 and UG2 and in the OC4 area, and negligible inflow is expected from these rocks during mining of the Preferred Project. Groundwater is present in the lower Triassic-age sediments in the very northern end of UG4, but the saturated depth ranges between about 0 m to 12 m. The upper Triassic-age sediments are unsaturated across the whole of the MCC area.

Permian-age Aquifers

The Permian-age coal measures comprise the most significant aquifers in the MCC area. Of these, the Ulan Seam is the most significant.

Within the Stage 2 Project Boundary, the groundwater level in the Ulan Seam is more than 90 m below that of the upper parts of the Permian-age overburden and surficial aquifers, indicating limited hydraulic connection through the stratigraphic section.

The Permian rock aquifers are recharged in areas where the aquifer units outcrop, with regional groundwater flow downdip toward the north-east. This flow pattern has been locally disrupted by dewatering at the Ulan Coal Mine, which has locally reduced groundwater levels within these aquifers. This effect extends into the MCC where up to 40 m of drawdown has occurred in the Ulan Seam and lower Permian rock aquifers immediately adjacent to UCMLs longwall operations and along the western margin of UG4.

Groundwater Dependent Ecosystems

The potential for Groundwater Dependant Ecosystems (GDEs) occurring within the Project Boundary was investigated by mapping biological values against groundwater resources by Ecovision Consulting for the Stage 2 EA. The significance of GDEs was assessed using the eight-step rapid assessment process contained within the NSW Groundwater Dependant Ecosystem Policy (DLWC, 2002). Potential impacts to GDEs are considered further in the ecological assessment summarised in Section 5.7 of the Stage 2 EA (which has not been updated for this PPR as indicated in **Section 4.10**).

Most of the springs and groundwater seeps in the Murragamba and Eastern creek valleys have been degraded or modified by intensive agricultural activities or dug out to provide in-line stock watering dams. These GDEs range in size from about 0.01 to 0.2 ha and support a variety of plant species including sedges, Narrow-leaved Goodenia, Sundews and Bladderwort (Appendix 7 of the Stage 2 EA).

Where these small constructed GDEs occur within the footprint of OC4 they will be permanently removed as a result of mining. These small degraded GDEs do not support species of conservation interest (Section 5.7 of the Stage 2 EA).

Eastern Creek valley hosts two larger spring-fed GDEs, one at the head of the valley, the other along the lower reaches of Eastern Creek. The GDE located at the head of the valley comprises vegetation species similar to that found at other GDEs in the Murragamba and Eastern creek valleys.

This GDE will not be impacted by mining. The other spring-fed GDE along the lower reaches of Eastern Creek will be impacted by mining in OC4. These items are shown on **Figure 15**.

The assessment of riparian vegetation did not indicate any specific riparian plant communities that could be considered GDEs. The groundwater assessment has indicated that there is negligible baseflow to Murragamba and Eastern creeks. However, there are pools and soaks along the creeks that indicate some of the tree cover along Murragamba, Eastern and Wilpinjong creeks is potentially supported by a locally present shallow water table.

Existing Groundwater Quality

Groundwater quality across the Stage 2 Project Boundary is variable, both in terms of key field parameters (salinity and pH) and hydrochemical constituents (anions and cations).

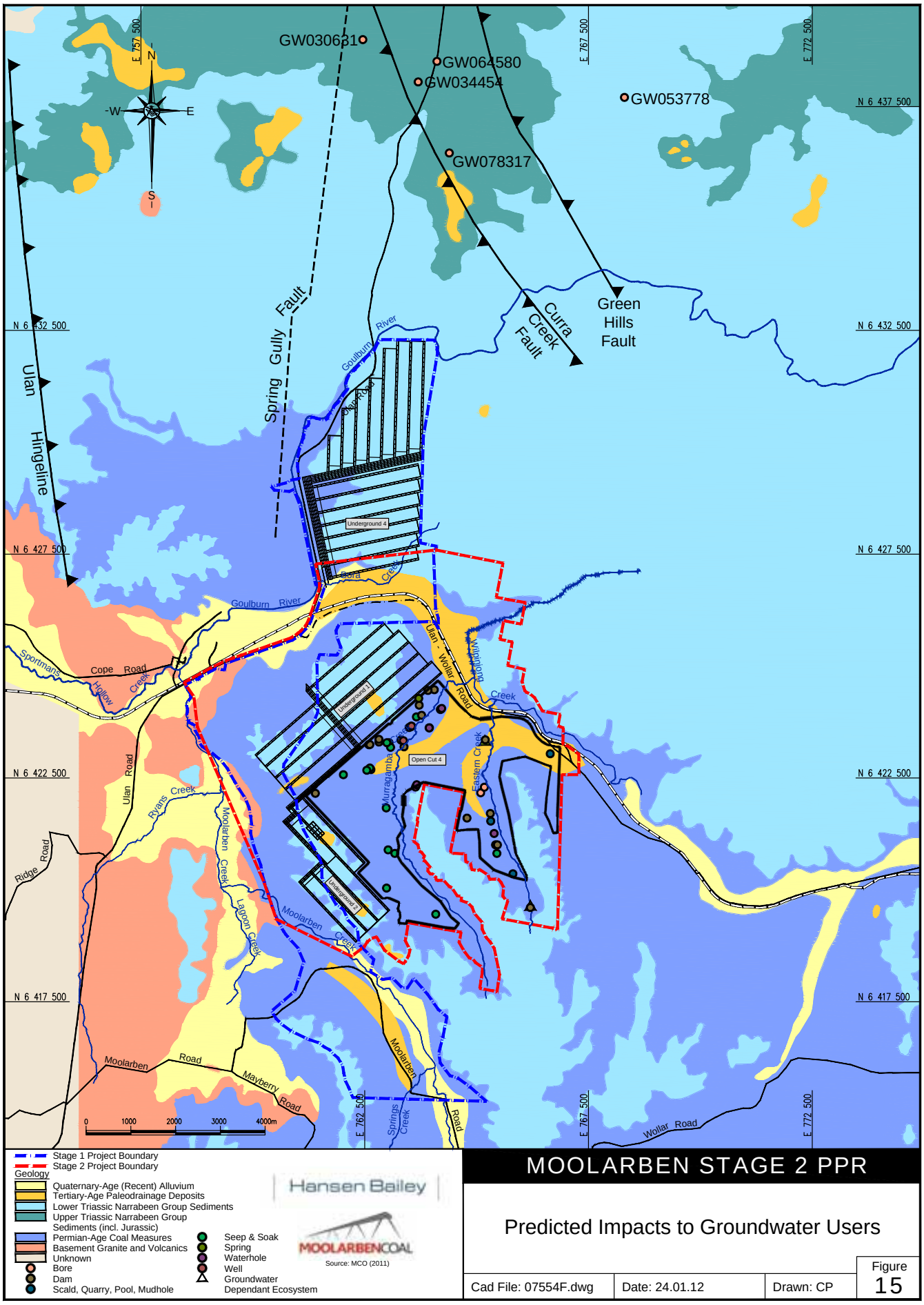
Salinity – Total Dissolved Solids

Salinity concentrations range from less than 200 mg/L total dissolved solids (TDS) (fresh) to more than 11,000 mg/L TDS across the Stage 2 Project Boundary.

Maximum TDS concentration for stock watering of cattle is 5,000 mg/L (ANZECC 2000). Higher TDS concentrations tend to be more pronounced in the surficial aquifer system than in the underlying Permian-age aquifers, although variation in salinity in these latter aquifers does occur.

The most saline groundwater occurs near the downstream end of Murragamba Creek. It is believed that shallow watertable depths, evapotranspiration and surface water–groundwater interactions contribute to concentrating salt in these near-surface systems. Palaeochannel deposits in the Murragamba Creek valley comprise moderately saline to saline groundwater (2,300 to 6,700 mg/L TDS).

Groundwater within the Ulan Seam is low to moderately saline (220 to 2,100 mg/L TDS), although locally elevated values have been recorded.



MOOLARBEN STAGE 2 PPR

Predicted Impacts to Groundwater Users

Cad File: 07554F.dwg	Date: 24.01.12	Drawn: CP	Figure 15

pH

All Stage 2 Project Boundary groundwater is mildly acidic, with pH values ranging between five and six.

Dissolved Metals

Laboratory analysis indicates moderately elevated dissolved metals concentrations in groundwater samples, with zinc concentrations above trigger values for the protection of slight to moderate disturbed ecosystems (ANZECC 2000).

Nutrients – Ammonia and Nitrate

Ammonia and nitrate concentrations are generally below freshwater ecosystem protection guideline criteria (ANZECC 2000), although minor elevated values were recorded in some bores.

Existing Groundwater Users

In the vicinity of the Project Boundary there are a number of land uses that rely on bore water use (**Appendix E**).

There are 130 registered bores and wells within a 10 km radius of the Project Boundary, of which 109 are privately owned. This includes monitoring, water supply and dewatering bores for the neighbouring Ulan Coal Mine and Wilpinjong Coal Mine.

4.6.2 Methodology

The key objectives of the study were to:

- Determine the existing groundwater environment and to identify any existing users and GDEs;
- Assess the cumulative impacts that may arise from the Preferred Project, together with Stage 1 and neighbouring mines;
- Complete detailed numerical modelling of potential groundwater impacts;
- Interpret data and report on groundwater seepage, drawdown and other impacts on connected groundwater;
- Describe any measures that would need to be implemented to avoid, minimise, mitigate and offset the impacts of the Preferred Project (subject to more effective measures being identified in the future); and
- Determine groundwater management and monitoring protocols to be adopted to meet licensing conditions.

A three-dimensional numerical model was developed using the finite difference method using recent hydrology, hydrogeology and geological structure data. The model was originally developed for the Stage 1 assessment and has since been reviewed and updated to include the Preferred Project, more recent publicly available information for the Ulan and Wilpinjong coal mines, comments received during the exhibition of the Stage 2 EA and from the independent peer review.

The three-dimensional groundwater flow model (MODFLOW SURFACT) was used to simulate the cumulative impact of the MCC (i.e. Stage 1 and Stage 2 operating concurrently) on the local and regional groundwater regime over time. The model was also used to determine the cumulative impact of all three mines (MCC, Ulan Coal Mine and Wilpinjong Coal Mine) on the groundwater regime.

The modelling used conservative parameters and values and is considered to represent the worst case scenario for potential groundwater impacts resulting from the combined effect of all mining and dewatering activities associated with the MCC.

The hydrogeological units of relevance to the MCC have been incorporated into the groundwater model as separate model layers, including:

- Regolith and Quaternary / Tertiary alluvium including Tertiary palaeochannel deposits;
- Upper Triassic Narrabeen Group sediments (also includes the Jurassic in the northern extremity of the model area);
- Lower Triassic Narrabeen Group sediments;

- Upper Permian coal measures;
- Middle Permian coal measures;
- Lower Permian coal measures;
- Ulan Coal Seam; and
- Basement units (comprising variously Marrangaroo Formation, Shoalhaven Group, Ulan Granite or Rylstone Volcanics).

The model has been calibrated against publicly available mine dewatering records for the Ulan Coal Mine, Wilpinjong Coal Mine, long term groundwater level monitoring data and the regional groundwater and surface water monitoring network rationalisation. An analysis of the sensitivity of the calibrated model to changes in various model input parameters has been carried out.

4.6.3 Impact Assessment

Mining activities associated with the operation of the MCC (including the Preferred Project) will impact on the groundwater environment on a local scale and, to a more limited extent, regional scale.

Potential impacts on the groundwater system may include the following, each of which is discussed in further detail in the following sections:

- Groundwater level impacts (during and post-mining);
- Potential impacts on groundwater and surface water quality;
- Potential impacts on baseflow to Goulburn River (including 'The Drip'), Wilpinjong Creek, Murragamba Creek, Moolarben Creek and their associated tributaries;
- Potential impacts on GDEs; and
- Potential impacts on other groundwater users.

Predicted Project Impacts on the Regional Groundwater System

Quaternary Alluvium

Predictive modelling shows the Preferred Project will have minimal impact on water levels within Goulburn River alluvium. However, drawdown of more than 2 m will occur in Wilpinjong Creek alluvium, up to a distance of about 700 m immediately downstream of the OC4 pit boundary.

Quaternary alluvium is very poorly developed in the Murragamba Creek catchment, and does not constitute an aquifer of significance in that area.

Tertiary Alluvium

The Tertiary palaeochannel deposits within the Murragamba Creek catchment are sporadically saturated, and contain saline groundwater. Within the footprint of OC4, these deposits will be removed by mining.

A temporary impact on groundwater levels in the downstream extension of these Tertiary palaeochannel deposits within the Wilpinjong Creek valley is predicted, but groundwater levels are expected to fully recover post-mining.

Triassic Narrabeen Group

Predicted impacts from the MCC on groundwater levels within Triassic Narrabeen Group strata are included on Figure 6.5c of **Appendix E**, and are primarily the result of dewatering activities for the approved Stage 1 UG4 mine. This has the effect of partial dewatering of the Triassic (i.e. drawdowns of up to 5 m maximum) above UG4, but less than 2 m drawdown immediately outside the UG4 footprint.

The model further predicts drawdowns exceeding 10 m above the northern portion of the Ulan Coal Mine underground mine due to increased vertical hydraulic conductivity resulting from subsidence fracturing above 400 m wide Ulan longwall panels. (Note, the model assumes that hydraulic conductivity would be affected up into the lower Triassic above 400 m wide panels, whereas hydraulic conductivity increases only extend up to the upper Permian model layer above 208 m wide longwalls, consistent with observed impacts from pre-2006 mining at Ulan Coal Mine).

The revised MCC groundwater model (conservatively) predicts partial saturation of the upper Triassic aquifer above the northern end of UG4, although drilling has revealed that the upper Triassic aquifer is unsaturated across the entire UG4 area, as well as across the Preferred Project UG1 and UG2 areas. There is no Triassic aquifer in the vicinity of OC4.

Predicted groundwater levels for the upper Triassic aquifer at the end of MCC operations show no noticeable cone of depression around UG4.

The plot of predicted cumulative drawdown in the upper Triassic aquifer due to the MCC and neighbouring mines (**Appendix E**) shows less than 1 m drawdown across the MCC, but a small area of less than 2 m drawdown above the Ulan Coal Mine 400 m wide longwall panels, which is believed to be due to the increased hydraulic connection between the Ulan Seam and the upper and lower Triassic within the Ulan Coal Mine footprint.

Permian Coal Measures

The most significant impacts to groundwater levels are predicted to occur within the Permian coal measures, specifically within the Ulan Seam, which as the targeted resource requires dewatering prior to mining.

In the area south of Ulan-Wollar Road and along the rail-line corridor, including the areas of proposed OC4, UG1 and UG2 mines, the Ulan Seam is only partially saturated. Water levels in the Ulan Seam are up to 90 m or more lower than in the overlying sediments.

Further downdip to the north (in the vicinity of the approved UG4 mine), where the Ulan Seam is overlain by progressively greater thicknesses of Permian overburden and Triassic and Jurassic sediments, the Ulan Seam becomes fully saturated, and here (apart from where affected by mining-induced impacts from adjacent mines) groundwater levels in the Ulan Seam are broadly similar to those in the overlying Permian and Triassic.

Drawdowns of 5 m or more due to the MCC are predicted to extend to approximately 13 km in the lower Permian, and 8-9 km in the middle and upper Permian to the north and east of UG4 at the completion of mining.

There is some predicted drawdown impact from MCC in the vicinity of Ulan Coal Mine. This is likely due to the increase in vertical hydraulic conductivity above the Ulan seam caused by subsidence fracturing at Ulan Coal Mine.

This increased conductivity appears to allow some impact from MCC to be transmitted across to Ulan via the Ulan Seam, then upwards into the Permian overburden units via the more conductive subsidence zone. Thus the model predicts greater drawdown impacts in the Permian overburden units within the footprint of the Ulan underground mine than in areas outside its footprint. However, as the Permian is mostly unsaturated in the Preferred Project mine areas, this effect is predominantly the result of the cumulative effect of the approved Stage 1 UG4 mine and the Ulan Coal Mine.

The Drip

The groundwater assessment found that there will not be an impact on high level seepages such as the Drip as it is unlikely they are derived from groundwater under pressure rising from depth.

For that to occur, the recharge zones for that deeper groundwater would need to be at a much higher elevation than the Drip, but the area is close to a regional topographic high, being near the top of the Great Dividing Range.

There is no locality at sufficiently high elevation within feasible distance of the Preferred Project to be able to influence deep groundwater to emerge at elevations such as the Drip.

Baseflows

Murragamba, Eastern and Wilpinjong creeks are ephemeral systems in which baseflow is insufficient to maintain permanent creek flow. Baseflow prior to the commencement of Stage 1 was predicted to be about 23.3 ML per annum in Wilpinjong Creek upstream of the Murragamba Creek confluence and around 43.4 ML per annum in the downstream reach.

Decreases in baseflow in both reaches of Wilpinjong Creek are predicted as a result of MCC operations. Across the Wilpinjong Creek catchment total predicted baseflow volumes at the start of operations is approximately 364 ML per annum. This is predicted to decrease to approximately 219 ML per annum at the end of MCC activities but is predicted to recover to approximately 370 ML per annum at the end of the post-mining recovering period. The model also predicts there will be no loss of flows in Wilpinjong Creek due to leakage to the groundwater system as a result of the MCC.

Goulburn River, Moolarben Creek and Lagoon Creek baseflow impacts were addressed in the Stage 1 EA. No additional baseflow impacts on these streams are predicted to occur as a result of Stage 2.

Groundwater Inflows

Table 21 shows the predicted groundwater inflows for the MCC (cumulative) and for the Preferred Project for Years 2, 7, 12, 16, 19 and 24. Most of the inflows in the later years of the MCC occur in the Stage 1 approved UG4 mine.

The groundwater model predicts the inflows will vary throughout the mine life which is directly related to the mine plan.

Over the life of the MCC, groundwater inflows into all mine voids will vary from a minimum of (approximately) 204 ML in Year 2 to a maximum of 1,245 ML in Year 23 (after pumping from the Northern Borefield has been allowed for – Table 5.9 in Appendix E). Maximum groundwater inflows for the Preferred Project (OC4 and UG1) occur in year 10 and total approximately 893 ML.

Groundwater Users

A number of existing groundwater users have been identified within a 10 km radius of MCC, including groundwater bores, wells, springs, seepages and possible groundwater-fed dams or soaks.

The depressurisation of the coal seam aquifers as predicted for the MCC will result in a reduction of the water levels in existing bores located within the zone of influence. The predicted cumulative drawdown impacts for each bore are listed in **Appendix E**.

Five registered bores completed in the Triassic are predicted to undergo small impacts from the MCC. The maximum prediction drawdown due to Moolarben is 0.6 m, while all other impacts are predicted to be less than 0.4 m.

Bore GW078317 (Williams) is predicted to undergo drawdown impact of 0.6 m by the completion of the MCC, and to have a residual drawdown of 0.4 m at the completion of the 100 year recovery period.

Maximum drawdowns of 0.1 - 0.2 m are predicted at four other registered bores (GW064580 – 0.2 m; GW053778 – 0.1 m; GW030631 – 0.2 m; GW034454 – 0.2 m), all of which are predicted to fully recover post-mining. Bores at UCML's Bobadeen irrigation area are predicted to experience drawdowns of up to 0.4 m, with post mining residual drawdowns of up to 0.2 m. These predicted drawdown impacts are not considered large enough to affect the performance of any of the bores.

Table 21
Predicted Groundwater Inflows

Mine Year	Predicted Inflow Rate (ML/yr) All MCC Pits	Predicted Inflow Rate (ML/yr) Stage 2 (Preferred Project) Pits
2	204	95
7	569	569
12	741	741
16	598	299
19	753	309
24	1,037	97

There are no additional groundwater bores on private land predicted to be impacted by the MCC when compared to the approved Stage 1 EA and Stage 2 EA. Also, at least two private bores (GW047495 and GW800279) predicted to be impacted in the Stage 2 EA are now not predicted to be impacted from the development of the MCC.

Impact to potential GDEs are shown on **Figure 15** and include the spring fed GDE located at the northern end of Eastern Creek.

Groundwater Level Recovery

In applying the model and being consistent with recent practice on other similar projects in NSW in which Aquaterra consulted with NOW, a model run time period of 100 years after the completion of mining, was adapted as adequate for purposes of the Preferred Project. Modelling of groundwater level recovery shows water levels in the Ulan Seam and overlying Permian formations will recover to at least, and in many cases above, present day levels.

At the end of the 100 year recovery period, predicted water levels in all the main hydrogeological units have recovered to at least, and often higher than, the levels prevailing at the start of mining the Preferred Project.

Water Quality

It is expected that there will be some variation in mine inflow quality from year to year and the open cuts in particular may see broad annual fluctuations about the averages due to the spatial variability in water quality.

In the case of OC4, there is likely to be an increase in salinity and a similar accompanying change in some of the other quality parameters, as more saline surficial groundwater is intersected near the northern end of the mine footprint, during Mine Years 8 to 11. Subsequently, salinity levels of mine inflows may gradually reduce as the mine progresses into the Eastern Creek catchment, where groundwater quality is expected to be less saline. Removal of surficial saline groundwater from both Murragamba and Eastern Creek valleys should improve the quality of water draining from these catchments into Wilpinjong Creek.

Peer Review

A peer review of the Aquaterra Groundwater Impact Assessment was undertaken by Dr Noel Merrick. A copy of the peer review report is provided in **Appendix E**.

The peer review concluded that the current model application had been performed competently and all matters raised in the initial review had been addressed satisfactorily.

4.6.4 Mitigation and Management

MCM will expand the current groundwater monitoring program to include Stage 2. The existing groundwater monitoring program includes:

- The volume and quality of water pumped from dewatering and water supply bores;
- The regular measurement of groundwater levels in all pumping bores; and
- Baseline monitoring program (of groundwater quality and water level measurement).

Data collected will enable MCM to establish, and continually assess, the impact mining activities have on other groundwater users. Collection of this data will also enable continual periodic review of any observed impacts against those predicted during numerical modelling, and will allow further refinement of the model if necessary as the mine develops.

MCM will record the following as part of the groundwater monitoring program:

- Groundwater extraction volumes – weekly totals from each pumping bore, and weekly totals from each underground pumping station and open cut sump;
- Groundwater pumping from underground pumping stations;
- Quarterly sampling from all pumping bores and underground pumping stations for comprehensive hydrochemical analysis as detailed in **Table 23**;
- Monthly manual monitoring, or continuous automated monitoring, of water levels from the network of monitoring bores; and
- Annual sampling of representative monitoring bores for laboratory analysis (as outlined in **Table 22**).

Collated monitoring data will be reviewed annually in order to assess the impacts of the Preferred Project on the groundwater environment and to compare observed impacts with those predicted from groundwater modelling which will be reported in the Annual Review.

MCM will endeavour to implement an integrated monitoring program for the MCC, UCML and Wilpinjong Coal Mine for data-sharing at several locations where duplication exists.

Two years after commencement of coal production from Stage 2, a modelling post-audit will be carried out. Following this review, as necessary, the groundwater model will be re-calibrated and confirmatory forward impact predictions made and reported against in the Annual Review.

Table 22
Laboratory Analysis Suite for Groundwater

Class	Parameter
Physical parameters	EC, TDS, TSS and pH
Major cations	calcium, magnesium, sodium and potassium
Major anions	carbonate, bicarbonate, sulphate and chloride
Dissolved metals	aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, zinc
Nutrients	ammonia, nitrate, phosphorus, reactive phosphorus
Others	Fluoride, cyanide

Additional audits will be carried out five-yearly through the remainder of the life of the Preferred Project (and MCC).

Should any review or post-audit indicate a significant variance from the model predictions with respect to water quality or groundwater levels, then the implications of such variance will be assessed, and appropriate response actions implemented in consultation with NOW, DP&I and OEH as appropriate.

Mine related groundwater impact trigger levels will be developed in consultation with Government agencies. In the event that an existing private water supply is adversely and directly affected by the Preferred Project, MCM will provide a replacement water supply of suitable quality for the purpose, or provide alternate compensation where appropriate.

4.6.5 Summary

The groundwater model has been recalibrated to incorporate the changes to the mine plan associated with the Preferred Project, the UCML EA and also to incorporate comments received during the exhibition of the Stage 2 EA and from the independent peer review.

There are no additional groundwater bores on private land predicted to be impacted by the MCC when compared to approved Stage 1 impacts and that predicted in the Stage 2 EA. No additional impacts are predicted to GDEs and there are negligible changes to groundwater inflow to that predicted in the Stage 2 EA.

4.7 SURFACE WATER

A Surface Water Management Strategy was prepared by WorleyParsons as part of preparation of the Stage 2 EA. The Preferred Project surface water impacts, mitigation and management practices are consistent with those outlined in Section 5.5 of the Stage 2 EA.

The mitigation and management measures from Section 5.5 of the Stage 2 EA are included below.

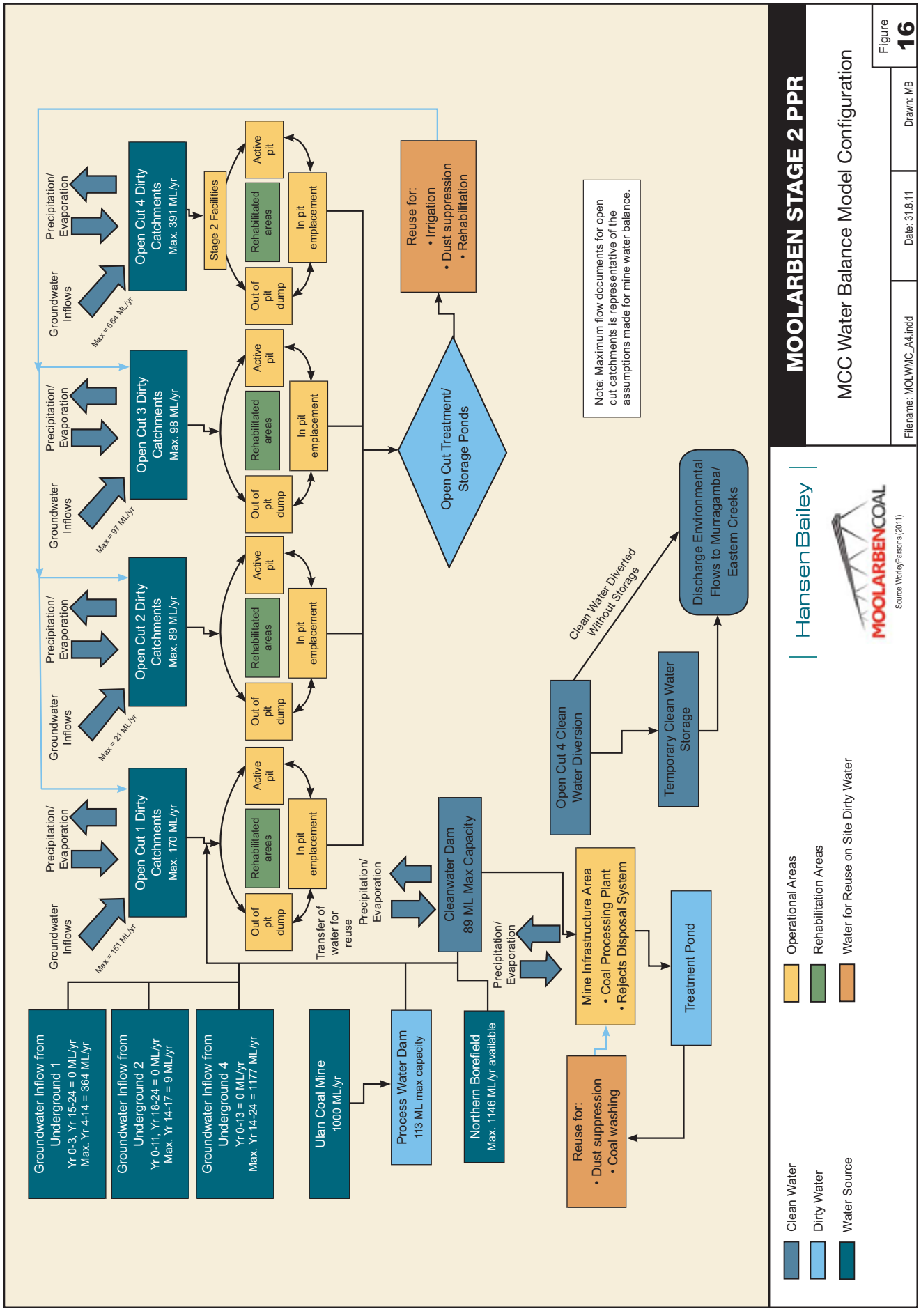
Additionally, as a result of issues raised in the independent peer review following the submission of the Stage 2 EA, additional information regarding existing hydraulic conditions (including surface flow and flood regimes and water quality) and flood modelling is provided in **Appendix F**.

Three issues were addressed and included: water quality and quantity; creek diversions and realignment; and the flood regime. A preliminary design for the diversion of Murragamba and Eastern Creeks is provided in **Section 4.9** and further detailed in **Appendix G**.

4.7.1 Management & Mitigation

The conceptual Water Management Strategy for the MCC is shown in **Figure 16** and based on the following broad strategic objectives:

- Clean surface water runoff is diverted around site and used to maintain environmental flows;
- Groundwater inflows to open cut mining areas are used for mining purposes;
- Groundwater from dewatering bores or production bores is used for mining purposes;
- Runoff from disturbed or operational areas is captured and stored in strategically located sedimentation ponds which will be designed to have a capacity of 1 in 50 year rainfall event and used for dust suppression and for the irrigation of rehabilitated disturbed areas;
- Mine water is captured and utilised onsite and is not discharged under Stage 2;
- Water sharing with neighbouring coal mines is undertaken, where possible;
- Development and implementation of a Surface Water Monitoring Program and a Surface Water and Groundwater Response Plan for the MCC incorporating measures and requirements specific to the Preferred Project;


Groundwater Inflows
Precipitation/ Evaporation
Open Cut 1 Dirty Catchments Max. 170 ML/yr
Max = 151 ML/yr
Open Cut 2 Dirty Catchments Max. 89 ML/yr
Max = 21 ML/yr
Open Cut 3 Dirty Catchments Max. 98 ML/yr
Max = 97 ML/yr
Open Cut 4 Dirty Catchments Max. 391 ML/yr
Max = 664 ML/yr
Out of pit dump
Rehabilitated areas
Active pit
In pit emplacement
Stage 2 Facilities
Transfer of water for reuse
Precipitation/ Evaporation
Cleanwater Dam 89 ML Max Capacity
Open Cut Treatment/ Storage Ponds
Reuse for:
• Irrigation
• Dust suppression
• Rehabilitation
Note: Maximum flow documents for open cut catchments is representative of the assumptions made for mine water balance.
Open Cut 4 Clean Water Diversion
Clean Water Diverted Without Storage
Temporary Clean Water Storage
Discharge Environmental Flows to Murragamba/ Eastern Creeks
Groundwater Inflow from Underground 1
Yr 0-3, Yr 15-24 = 0 ML/yr
Max. Yr 4-14 = 364 ML/yr
Groundwater Inflow from Underground 2
Yr 0-11, Yr 18-24 = 0 ML/yr
Max. Yr 14-17 = 9 ML/yr
Groundwater Inflow from Underground 4
Yr 0-13 = 0 ML/yr
Max. Yr 14-24 = 1177 ML/yr
Ulan Coal Mine 1000 ML/yr
Process Water Dam 113 ML max capacity
Northern Borefield Max. 1146 ML/yr available
Mine Infrastructure Area
• Coal Processing Plant
• Rejects Disposal System
Treatment Pond
Reuse for:
• Dust suppression
• Coal washing
Clean Water
Dirty Water
Water Source
Operational Areas
Rehabilitation Areas
Water for Reuse on Site Dirty Water
HansenBailey
MOOLARBENCOAL
Source WorleyParsons (2011)
MOOLARBEN STAGE 2 PPR
MCC Water Balance Model Configuration
Figure 16
Filename: MOLWMC_A4.indd
Date: 31.8.11
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- Re-use of mine water is maximised; and
- Development and implementation of a detailed Creek Rehabilitation Plan for Murragamba and Eastern Creeks.

The surface water monitoring program will be developed in consultation with relevant regulators to the approval of DP&I and will aim to quantify the characteristics within Murragamba and Eastern Creeks for existing conditions and will comprise:

- Installation of streamflow devices along Murragamba and Eastern Creeks downstream of mine disturbance areas;
- Weekly recording of streamflow. It is noted that streamflow is not anticipated during non-rainfall events, however this will provide additional data to assist in understanding the creek's ephemeral characteristics;
- Periodic measurement of water quality indicators (e.g. turbidity, pH, salinity);
- Regular (at least daily) streamflow recordings during rainfall events that exceed 30 mm in 24 hours (or the same depth of rainfall in a period shorter than 24 hours);
- Streamflow gauges have been established on Wilpinjong Creek upstream (MCM managed) and downstream (Wilpinjong Coal Mine managed) within the Stage 2 Disturbance Boundary; and
- MCM will seek to share streamflow and water quality data with Wilpinjong that will be used to develop and calibrate a rainfall runoff model for the Murragamba and Eastern Creek catchments. This will enable a rainfall response curve to be developed. Additionally, pre and post-mining impacts on streamflow will be assessed.

4.8 WATER BALANCE

4.8.1 Background

A Surface Water Management Strategy and Revised Water Balance were prepared by WorleyParsons as part of preparation of the Stage 2 EA.

WorleyParsons has completed supplementary surface water investigations including water balance modelling for the Preferred Project which is reproduced in **Appendix F**. The assessment prepared for the Preferred Project has considered all relevant RTS and issues raised in the independent peer review subsequent to the submission of the Stage 2 EA (see further detail in **Appendix F**).

This section and **Appendix F** replace in full the Water Balance carried out for the Stage 2 EA.

The following section provides a summary of the proposed water balance model configuration for the Preferred Project.

4.8.2 Modelling Methodology

Existing Water Usage

Since MCM began operations associated with Stage 1 mining, analysis has been completed to estimate the net water usage requirements of the CHPP. The analysis suggests that on average, 186 ML of water is used by the CHPP per 1 Million tonnes of washed ROM coal. In addition, a review has been conducted of the Stage 1 water requirements for dust suppression at the site.

Based on the Stage 1 dust suppression requirement of 1.1 ML/day, it is assumed that 2.2 ML/day or 783 ML/yr will be required for dust suppression across the MCC at maximum production. It should be noted that this assumes a dust suppression requirement of 356 days/year. **Table 23** indicates the water demand distribution for Stage 1 as at 2010. Water usage during 2010 was calculated at 1,235 ML/yr. When considering the volume of water used and of the mass of coal mined and processed, the ROM water usage factor during 2010 can be calculated at 282.5 ML/Mt (i.e. includes all water usage across the whole of Stage 1 in 2010).

Revised Water Balance Model

All assumptions for the development of the water balance model are included in **Appendix F**. An analysis of the site water usage at the MCC has been used to develop a ROM factor for the combined Preferred Project and Stage 1 operating conditions. As discussed in **Section 3** the MCC will be capable of mining up to 17 Mtpa of ROM coal of which up to 13 Mtpa OC ROM coal will be washed.

Applying the 186 ML/Mt estimate of CHPP water usage from Stage 1 yields a total water requirement for the CHPP of 2,418 ML at maximum production.

Table 24 indicates the water demand distribution at MCC in Year 20 based on the above considerations during which time an estimated 17 Mtpa will be mined, consisting of 13 Mt from open cut and 4 Mt from underground operations.

The resultant water demand distribution for the MCC indicates the total volume of water required for mining equates to a ROM factor of 227 ML/Mt.

Water Sources

Mine Pit Inflows

Groundwater modelling has been completed by Aquaterra (**Appendix E**) to define the predicted mine inflows across the OC and UG mines at the MCC. The predicted pit inflows are summarised in **Table 21**.

Surface Water Infrastructure

A series of sediment dams will be constructed throughout disturbed catchment areas to facilitate the collection and conveyance of surface water that falls within disturbed or "dirty water" catchments.

In accordance with the '*Managing Urban Stormwater: Soils and Construction Volume 1*' (Landcom 2004) and '*Volume 2E Mines & Quarries Guidelines*' a target design storm of a 50 year recurrence 1 hour duration rainfall event has formed the basis for sizing sediment dams.

Table 23
Existing Stage 1 Water Demand

Area of use	Maximum Water Demand (ML/yr)
Coal handling and preparation plant*	813
Dust suppression across open cut and mine infrastructure areas	402
Potable (Bath-house)	20
Total Maximum Demand	**1,235**

Numbers based on 4.372 Mt of ROM coal mined during 2010.

**Note only ROM coal from OC is washed*

Table 24
Revised Water Demand at Peak Production

Area of use	Maximum water demand (ML/yr)
Coal handling and preparation plant	2,418
Dust suppression across open cut and mine infrastructure areas	783
Potable (Bath-house)	50
Use in underground area	601
Total	**3,852**

Numbers based on 17 Mt of ROM coal at maximum production

As described in the Surface Water Management Strategy, and updated for the preliminary design for the proposed diversion of Murragamba and Eastern Creek (**Appendix G**), surface water infrastructure has been designed to facilitate the diversion of clean water away from the active pit throughout the duration of mining in OC4.

Ulan Water Sharing Agreement

Since the development of the Stage 2 EA, MCM and UCML have reached an Agreement for the transfer of a minimum of 1,000 ML/annum from the Ulan Coal Mine to the MCC under a formalised Water Sharing Agreement (WSA). Water derived from the "*East Pit*" of the Ulan Coal Mine is delivered to MCC via a 250 mm diameter poly pipe to the Process Water Dam located within the rail loop of the infrastructure area (see **Figure 4**).

No maximum transfer is defined under the WSA. It should also be noted however the minimum surplus predicted in the Ulan Coal Mine water balance is 3,001 ML (Umwelt 2009). This clearly illustrates that an adequate water surplus at Ulan exists for MCC's use under the WSA.

Potential Inflows from Northern Borefield

The inflows available from the Northern Borefield have been determined based on groundwater modelling and preliminary pump testing (Aquaterra 2008).

These were documented previously in the Surface Water Management Strategy for the Stage 2 EA. **Figure 16** provides a conceptualisation of the water balance model for the Preferred Project.

4.8.3 Impact Assessment

Water Balance Simulation Scenarios

Four separate climate scenarios have been investigated for the water balance model. The climate scenarios investigated reflect the application of varying rainfall records to the water balance model and include 'average', 'below average', 'above average' and 'conservative dry weather'.

To facilitate this, the complete rainfall record was obtained from the Bureau of Meteorology (BoM) station located at the Gulgong Post Office. The water balance model was then used to determine the volume of runoff from each catchment area that will drain from the open cut pits, overburden areas, areas undergoing rehabilitation and the mine infrastructure area.

Water Deficit

The water balance model predicts a deficit of water across the four climate scenarios investigated for the Preferred Project Years 1 to 24 operating in conjunction with Stage 1 based on mine inflows alone.

However, the predicted deficit for all climate scenarios will be met from the WSA and other sources as nominated within **Appendix F**.

Table 25 provides a summary of the predicted deficit for each of the modelled mine plan scenarios under each climate scenario, based on mine inflows alone and the Northern Borefield source (i.e. not accounting for the WSA).

A full list of results for all years across the four climate scenarios is provided in **Appendix F**. Modelling has confirmed that the WSA will be required in most years of operation to meet maximum production levels.

A maximum deficit of 1,990 ML is predicted for the conservative dry weather climate scenario and a maximum surplus of 220 ML is predicted for the above average climate scenario without the use of water from the WSA.

When considering available sources, there is sufficient water in all years under all modelled climate scenarios. Water supply from the WSA and Northern Borefield will be monitored and controlled to avoid excessive build up so that discharge off site will not be required. Should the need to discharge arise it will be carried out consistent with the Stage 1 Project Approval and EPL 12932.

Table 25
Summary of Deficits Prior to the Application of WSA

	Maximum Deficit		Minimum Deficit	
	Mine Year	ML/yr	Mine Year	ML/yr
Average Rainfall Conditions (ML/yr)	21	-1,790	1	+52
Below Average Rainfall Conditions (ML/yr)	21	-1,912	1	+19
Above Average Rainfall Conditions (ML/yr)	21	-1,618	1	+220
Conservative Dry Weather (ML/yr)	10	-1,990	1	+52

A sensitivity analysis was carried out under average rainfall conditions to account for variation in ROM factor. A 10% increase and a 10% decrease in ROM factor have been modelled to determine the subsequent impacts on water supply.

Results of the sensitivity analysis are documented in **Appendix F** and indicate any variation in water demand due to the ROM factor is able to be met from the WSA and Northern Borefield.

4.8.4 Clean Water Diversion Strategy

Diversion of Environmental Flows

A conceptual framework has been developed to ensure that adequate environmental flow continues to be released from the Murragamba and Eastern Creek catchments throughout the life of the mine.

The framework has been developed through consideration of the following points:

- Murragamba and Eastern Creek are ephemeral creeks. Discharge is typically only generated in either of these catchments following a significant rainfall event;
- The reduction in the available catchment area due to mining operations throughout the life of the mine;
- The Maximum Harvestable Rights Dam Capacity (MHRDC) criteria, which allows a landowner to construct a storage with capacity up to 10% of the mean annual runoff generated by their land area;
- The Splitters Hollow Dam storage area, an on-stream storage located on Wilpinjong Creek, is available to supplement environmental flows into Wilpinjong Creek; and
- The implementation of the clean water diversion strategy.

The framework for the diversion of environmental flow focuses on two key components:

- At any particular stage in the mine life, up to 15% of the runoff from the catchment will be removed due to mining operations; and
- Annual rainfall – runoff response relationship will be developed to determine the volume of water to be released from clean water storages following a rainfall event.

Water levels will be maintained in Splitters Hollow Dam to a level which maintains ecological function as described in the Stage 1 Offset Strategy (MCM 2010), where within MCM's control.

Estimated Reduction in Flow

Sufficient infrastructure has been designed to facilitate the capture and diversion of clean water runoff downstream up to and including the 100 year Average Recurrence Interval (ARI) flood event. Therefore, it will be the impact of the mine pit/overburden area which has the most potential to reduce flows.

A total of 2,580 ha of the Murragamba and Eastern Creek catchments fall within Stage 2 Project Boundary.

A further 290 ha falls within the Stage 2 Project Boundary and will be affected by mining associated with OC4, but which is located adjacent to the eastern side of the Eastern Creek catchment and drains directly to Wilpinjong Creek.

Together, these make a total combined catchment area of approximately 2,870 ha, which represents the total area draining to Wilpinjong Creek, from which the Maximum Harvestable Dam Rights Criteria (MHDRC) can be established.

The MHDRC allows a landowner to construct a storage area with a volume equivalent to 10% of the mean annual run-off, provided it is constructed on a 1st or 2nd order river (DWE 2008). This could be interpreted as being equivalent to a reduction of 10% in the area that collects runoff and releases it downstream from the property. In the context of the proposed OC4, this would represent a reduction in the catchment area of 287 ha at any stage of mining.

Therefore, for approximately two thirds of the Preferred Project life, the catchment area which is impacted by mining operations is less than the proportion from which runoff is permitted to be harvested under the MHRDC criteria, while for approximately one third of the mine life the criteria is exceeded by a maximum of 5%.

This additional 5% reduction in catchment area could be accounted for through controlled releases from Splitters Hollow Dam, provided this does not diminish the ecological function of the dam as described in the Stage 1 Offset Strategy (MCM 2010).

Clean Water Diversions

Figure 5 to **Figure 10** show the proposed infrastructure that will enable the collection and diversion of clean water flows throughout the life of the mine away from the active mining and overburden emplacement areas. Clean water will be collected from areas which have either been undisturbed by mining or from sufficiently rehabilitated areas of overburden post-mining.

The environmental flows that will be diverted off-site will come from two sources. Firstly, areas that drain to the natural watercourses, whether they are the existing or rehabilitated creek lines, will continue to generate a significant portion of the environmental flow for much of the mine life. Secondly, the runoff that is collected and stored in the clean water dams will be diverted downstream via the proposed infrastructure.

In order to determine the volume of runoff to be diverted from a clean water storage following a rainfall event, the following framework is proposed:

- A rainfall-runoff response curve will be developed in consultation with the OEH. This response curve is intended to provide a measure of the clean water which is expected to be collected in a particular storage following a rainfall event; and
- As the rate at which clean water can be released is controlled by the capacity of the available infrastructure (e.g. pumps, pipelines, swales, measuring weirs etc), the total volume will typically be released over a longer period of time than if it was allowed to discharge through an unmodified catchment.

If required, additional water will be released from Splitters Hollow Dam to meet any shortfall in the projected environmental flow.

The collection of clean water in storage areas and the associated controlled release of that water, together with the proportion of water which releases across undisturbed / rehabilitated catchments to the creek lines is considered to generate sufficient water such that the reduction in environmental flow resulting from the mining operations is expected to be limited to what is accepted under the MHDRC criteria.

Therefore, based on the above framework, it is expected that the Preferred Project will not significantly impact on environmental flows downstream from the Stage 2 Project boundary.

4.8.5 Management and Mitigation

MCM will implement the following management and mitigation measures for the Preferred Project:

- Investigate and implement reasonable and feasible CHPP recycling and water reduction measures should the water balance review determine the need;
- Undertake an annual review of the site water balance with actual data to ensure adequate water supplies exist to operate the MCC and report the same in the Annual Review;
- Maintain environmental flows to Wilpinjong Creek for the duration of the Preferred Project. The availability of water for environmental flow requirements is described in **Appendix F**;
- Implement surface water monitoring of Murragamba and Eastern Creek to quantify flows in the creeks and typical rainfall response mechanisms for the catchments under existing conditions;
- Limit dirty water catchments to within harvestable rights limits where practicable;
- Supplement environmental flows in Wilpinjong Creek with water from the Splitters Hollow dam where required;
- Shallow saline groundwater which has the potential to increase the salinity of water discharging to Wilpinjong Creek will be removed during mining of OC4;
- Undertake detailed hydrologic modelling following the collection of baseline streamflow data for Murragamba and Eastern Creek;
- Clean water will be diverted around mine disturbance areas and used to maintain environmental flows; and
- Design and implementation of clean water diversions, sediment dams and erosion control structures to contain and manage dirty water on site as described in Section 5.5.6 of the Stage 2 EA.

4.8.6 Summary

The Stage 2 EA water balance indicated that 3,536 ML/annum would be required to operate the MCC with a deficit of up to 865 ML in some years. Since that time, Stage 1 (including the CHPP) has operated for over 12 months providing updated data with which better to calibrate the draft water balance model.

A revised water demand estimate has conservatively estimated a maximum water demand at peak production for the MCC of approximately 3,852 ML/annum.

This demand is able to be met from available water sources including pit inflows, the WSA and the Northern Borefield. It is however, anticipated that as production increases at MCC, water usage efficiencies will be able to be utilised, which will include increasing the proportion of water recycled and re-used by the CHPP which will reduce the demand from the available water sources.

4.9 CREEK REALIGNMENT

4.9.1 Background

A preliminary design for the proposed diversion of Murragamba and Eastern Creeks has been completed for the Preferred Project by WorleyParsons and is reproduced in **Appendix G**.

The assessment prepared for the Preferred Project has considered all relevant RTS and issues raised in the independent peer review subsequent to the submission of the Stage 2 EA (see further detail in **Appendix G**).

This section and **Appendix G** have been prepared at the request of DP&I during submissions following the public exhibition of the Stage 2 EA. No stand alone creek realignment report was prepared for the Stage 2 EA.

As presented in **Figure 3** the proposed OC4 will be situated over the existing alignment of Murragamba and Eastern Creeks. Accordingly, in these areas works will be required to divert the flow of water that would otherwise travel along these creeks.

The following section provides a summary of the preliminary design of the proposed creek realignments required for the Preferred Project.

Catchment Description

The site for the Preferred Project is located within the upper Goulburn River catchment. Mining operations associated with the Preferred Project will predominantly occur within the smaller catchments of Murragamba and Eastern Creeks, which drain to Wilpinjong Creek, a southern tributary of the Goulburn River. The combined catchments of Murragamba and Eastern Creeks cover a total area of approximately 3,400 ha.

As presented on **Figure 5** to **Figure 10** the proposed layout of OC4 generally extends south from the Ulan-Wollar Road and includes the valley floors of the Murragamba and Eastern Creek catchments.

In addition, Stage 2 ROM coal facilities will be located adjacent to OC4 with a raw coal stockpile located adjacent to the Stage 1 ROM coal facilities and OC4 surface facilities located at the northern extent of OC4, south of the Gulgong-Sandy Hollow Railway (see **Figure 3**).

Proposed Creek Realignment Description

Murragamba Creek

The length of the existing section of Murragamba Creek that will be impacted by the proposed OC4 and will require realignment is approximately 4.1 km. The approximate total length of the existing Murragamba Creek upstream of Ulan-Wollar Road is 8.6 km.

The total length of the post-mining alignment of Murragamba Creek will consist of the following:

- A length of 5 km of realigned creek channel which is to be constructed within the area of OC4 mining operations. This corresponds to the existing 4.1 km section which is to be replaced;
- The retained section of Murragamba Creek, which includes the section identified as morphologically stable (approximately 1.1 km) and the section of creek upstream and within the Project Boundary (approximately 2.7 km); and
- The stretch of creek downstream of the OC4 mining area, upstream of Ulan-Wollar Road, which will be retained and rehabilitated (approximately 0.7 km).

The proposed realignment of Murragamba Creek has been based on maximising the opportunity to incorporate channel meanders, while at the same time recognising critical constraints such as the existing morphologically sound section of creek, the extent and sequence of mining for OC4 and the topography across the surrounding areas.

The meanders have been included to mimic existing conditions at the site as well as increase the length of the diverted channel, thereby increasing the potential for stream energy to be dissipated through bed friction and changes in flow velocity to be minimised.

Figure 3 presents the proposed realignment of Murragamba Creek.

Eastern Creek

The total length of the Eastern Creek realignment is approximately 4.9 km and covers the entire length of the creek upstream from Ulan-Wollar Road. This compares with the natural stream length of 4.2 km.

As with the Murragamba Creek realignment, the Eastern Creek diversion is also based on maximising the opportunity to incorporate meanders, while at the same time accounting for the extent of mining operations for OC4 and the topography of the surrounding area. **Figure 3** presents the proposed realignment of Eastern Creek.

4.9.2 Methodology

Creek Diversion Design Criteria

A number of critical hydraulic parameters have guided the decision making for the proposed creeks diversion design.

These parameters include:

- The Froude Number of less than one for the creek diversion channel and the associated in-channel velocity;
- The required channel flood design:
    - Minimising the release of floodwaters across the mine site from the realigned channel in events up to and including the 100 ARI flood;
    - Containment of flood flows within the creek alignment corridor for all events up to and including the 100 ARI flood; and
    - Designing the main channel section to be capable of containing flows during events up to and including the 1 year recurrence flood.
- A flood with a recurrence event of 1:100 years which will form the basis for the design of the rock riffle structures.

The preliminary design has been configured to ensure that the typical characteristics of a natural creek are reinstated.

In particular, numerous meanders have been incorporated between the headwaters of each creek and Ulan Wollar Road to replicate the meander characteristics of the existing channel.

These meanders have radii of curvature of approximately 50 m and have been designed in accordance with the Cooperative Research Centre for Catchment Hydrology's document titled, *'A Rehabilitation Manual for Australian Streams'* (*Volume 2*).

In order to assess the potential impact of the post-mining channel alignments, the existing hydrological model of Murragamba and Eastern Creek was modified to include the proposed changes.

Design

The preliminary design for the proposed creek diversion works was developed considering the potential implications of flooding across the post-mining landform.

Erosion and sediment control and wildlife habitat requirements have also been considered. The design also recognises the importance of geomorphic features, stream ecology and the environmental corridor. The diversion is to comprise a trapezoidal shaped low flow channel with a base width ranging between 2 m and 4.5 m and a typical depth ranging between 0.65 m and 1.45 m.

This low flow channel has been designed to carry the peak release in the 1 year recurrence flood. Low flow channel side-slopes are to be graded at 1(V) in 4(H). To either side of the low flow channel, the design incorporates an in-channel terrace. The in-channel terrace ranges in width depending on the location within each of the creek alignments. From the terraces, the channel rises to the finished surface of the proposed post-mining floodplain. The terrace section has been sized to convey the 100 year recurrence flood.

Pool and Riffle Sequences

A pool and riffle sequence will be incorporated into the design for the diversion of both Murragamba and Eastern Creeks. The pool and riffle sequence will allow the channels to mimic a more 'natural' creek regime while also reducing average channel bed slopes and thereby reducing peak flow velocities.

Artificial riffles, or drop-structures, will be constructed within the low flow channel at requisite intervals sufficient to reduce peak flow velocities over the length of each channel diversion.

The riffle structures will control in-channel velocities and minimise the potential for bed scour and erosion along the low flow channel. They have been designed to allow for the passage of fish and can be constructed to replicate aquatic habitats encountered along the existing creek lines.

A channel slope 1(V) in 20(H) is proposed for the rock riffle. This is the standard slope employed in the design of rock ramp/riffle structures throughout NSW to facilitate fish passage. The proposed pool and riffle sequence uses a rock ramp riffle which results in an effective channel bed drop of up to 0.5 m.

The toe of the riffle is defined by a row of large armour stone (nominal diameter of 800 mm) extending across the width of the channel to resist bank erosion through the process of outflanking.

Wherever possible the use of large woody debris will be incorporated into the design of the pool and riffle structure.

This will enable the development of a more natural design that will use materials that may be produced during the clearing of areas that are to be mined in OC4.

Erosion and Sediment Control

In order to protect the realigned channel from erosion a number of techniques will be incorporated into the design of the channel.

It is anticipated that the constructed creek channel will require rip-rap protection and rock protection of creek banks on the outside bends of the creek and areas where high flow velocities are identified.

In addition, oversizing of the low flow path to allow for some sedimentation and to limit potential scour during the early establishment phase and incorporation of a temporary retardation storage upstream of the inlet of the reconstructed creek to ameliorate potential scour associated with high flows during establishment phase.

It may also be necessary to incorporate temporary armouring and reinforcement of banks in riffle zones to provide stability during the vegetation establishment stage of the creek realignment.

Riparian Corridor Rehabilitation

It is proposed that the channel be vegetated to create a similar habitat to that found in the well vegetated / forested areas of the existing Murragamba and Eastern Creek channels. A combination of native shrubs, herbs, native grasses and tree species specially selected, will be determined as part of the detailed design.

In addition, wooded debris is to be stockpiled throughout the life of the mine and will be installed within the reach of the creek to facilitate the development of appropriate habitat for aquatic species and to replicate natural stream conditions.

Waterholes will be incorporated into the creek design in order to facilitate habitat development and food sources. To facilitate this, ponds will be installed at various locations along the creek.

The exact layout, including number and size of the pond areas will be determined during the detailed design stage and will require input from appropriately qualified ecologists.

Construction

The creek realignment is to be constructed in overburden material which will be placed during mining activities. As a result, it will be necessary to compact the overburden material sufficiently along the main channel section of the diverted creeklines to prevent excessive loss of surface water into the overburden fill and to ensure the bed and banks of the main channel section present a significant barrier to the infiltration of water. The exact level of compaction will be specified during the detailed design phase of the Preferred Project.

In locations where the permanent water sources are to be located it will be necessary to line the base of the channel with clay, which will be stockpiled as part of mining operations.

Suitable soil will be retained for use in the construction of permanent water sources and for rehabilitation of the creek beds.

Material identified as having high stone characteristics will be used for rock ramp riffles, drop structures and erosion and protection control.

Standard testing of the compacted fill will be undertaken in accordance with '*Guidelines on earthworks for commercial and residential developments' (AS 3798)*, and '*Methods of testing soils for engineering purposes' (AS 1289)*. Sampling and analysis will be undertaken at periodic intervals of the overburden fill where the main channel of the creek alignment will be constructed. Collected samples will be analysed to determine whether the soil characteristics are sufficient to facilitate the degree of compaction which will be adopted.

The staging of the creek diversion has been developed to allow the permanent creek diversion to be stabilised and rehabilitated over a period sufficient for the overburden fill beneath the creek line to consolidate and stabilise and for the bed, banks and flood terraces to be sufficiently revegetated.

Additional time has been provided to particular stages as required by the staging of the creek diversion works.

The timeframe will be achieved through the installation of a number of temporary dams upstream of the permanent creek diversion. A pipe system, extending from the dam to the downstream end of the length of creek being constructed or rehabilitated will release the necessary environmental flow.

MCM will undertake regular monitoring of the diverted creek lines. Should rehabilitation of the diverted creek line be achieved in a timeframe shorter than anticipated, with the prior approval of the relevant regulator, sections of the Creek would become operational in less than five years.

For further detail on the staging and construction proposed for Murragamba and Eastern Creek alignments see **Appendix G**.

Provision of water into the permanent creek diversion during the rehabilitation and consolidation period will be incorporated into the design to facilitate plant growth and enable controlled testing of the rehabilitated creek diversion to be conducted.

In addition to the permanent creek diversion works, it will be necessary to divert and contain surface runoff upstream of the open cut pit to prevent water contamination. The diverted water will be used as a clean water source for environmental flow requirements from both Murragamba and Eastern Creek to the downstream catchment.

The surface water runoff from areas upstream of the Preferred Project will be diverted around OC4. Water will be diverted through trench drains either directly into the existing creek channel or into temporary clean water storage dams. Water stored in a clean water storage dam would then be piped to a suitable location and released into Murragamba and Eastern Creeks.

4.9.3 Impact Assessment

A number of different scenarios have been identified which have the potential to affect the performance of the realignments of Murragamba and Eastern Creeks.

These scenarios included the following:

- Settlement of backfilled overburden and waste rock materials causing cracking of the bed and banks of the realigned creeks and subsequent loss of in-channel surface flows;
- Infiltration and loss of in-channel surface flows into backfilled overburden and waste rock materials caused by poorly prepared reconstructed creek beds;
- The occurrence of a major flood event during the period in which the creek diversion is being revegetated, stabilised and rehabilitated; and
- Excessive erosion and sediment transport of the creek bed downstream of the Preferred Project Boundary.

Results from the analysis of the 100 year recurrence event flood have been extracted at approximately 200 m intervals and indicate that the peak 100 year recurrence flood is completely contained within the proposed post-mining creek corridors for Murragamba and Eastern Creeks.

Results from the modelling also showed some relatively high velocities of between 2 and 3 m/s within the channel of both Murragamba and Eastern Creek. With this in mind, it is proposed that additional rock rip-rack scour protection will be utilised at locations where predicted velocities are high.

The construction of the Murragamba and Eastern Creek post-mining creek alignment has the potential to induce stream bed and bank erosion, which could result in sedimentation of the lower reaches of both creeks as well as Wilpinjong Creek.

The post-mining realignment of Murragamba and Eastern Creek has been designed to increase the stream length and sinuosity when compared to the existing creek alignments. This will ensure that the post-mining alignment has a reduced average bed slope compared to the existing creek.

The post-mining alignment of Murragamba Creek will increase the overall stream length by approximately 900 m. This will result in an approximate overall decrease in the average bed slope from 0.0115 m/m to 0.0104 m/m.

The post-mining alignment of Eastern Creek will increase the overall stream length by approximately 700 m. The existing average bed slope for Eastern Creek is 0.0144 m/m, this compares to an approximate post-mining bed slope of 0.0123 m/m.

Despite the reduction in average bed slope for both creek alignments the potential for high flow velocities within the channel remains. These high flow velocities may cause bed and bank erosion due to the high shear stresses against the constructed channel surfaces. Channel scour in the creek alignments will be mitigated by the inclusion of strategically located drop structures and constructed ramp riffles.

Downstream Impacts

The Preferred Project has the potential to reduce the base environmental flows that enter the Wilpinjong Creek system from the Murragamba and Eastern Creek catchments.

In order to prevent the degradation of Wilpinjong Creek from the loss of environmental flows, it will be necessary to utilise any clean water captured for use to maintain the base environmental flows in the Wilpinjong Creek system (see **Section 4.8.4**).

The Preferred Project Water Management System has been designed to utilise poorer quality runoff from the mining area for coal processing and dust suppression. This will minimise the potential for adverse off-site water quality impacts as a result of releases.

A staged water management system has been developed that seeks to minimise the catchment area of the mine water management system at any time while still providing adequate control for runoff from disturbed areas and prevention of inflows from drainage lines and creeks into the open cut pit.

Post Mining Landform

Following the development of a post mining final landform annual flows from Murragamba and Eastern Creek flowing into Wilpinjong Creek are expected to be similar to those existing prior to mining in the long term. In the period immediately following mining there may be some slight reduction in surface water run-off from the two catchments.

The design of the final landform will be developed to include suitable drainage and contours to allow the conveyance of surface water flows from the undisturbed upper reaches of the catchments down to the rehabilitated main channels of Murragamba and Eastern Creeks. The slopes of embankments within the post mining landform will contain erosion and sediment control structures such as contour banks and sediment dams to reduce the risk of soil loss.

4.9.4 Mitigation and Management

MCM will develop a Creek and Aquatic Rehabilitation Plan for the effective management and mitigation measures required for the Murragamba and Eastern Creek realignments.

The Creek and Aquatic Rehabilitation Plan will describe the monitoring and remediation techniques, outline erosion and sediment control measures to be implemented and outline suitable flood management design measures. Each of the proposed mitigation measures is described further below.

Monitoring

Monitoring of each of the permanent creek realignments will be regularly carried out to ensure the early detection of areas within the realigned creek where excessive consolidation, erosion or inhibited plant growth may be occurring. This will facilitate the application of appropriate remediation techniques.

In addition, it will be necessary to ensure that those locations within the creek channel that will function as ponded areas are adequately protected against surface fractures.

Since the ponded areas are proposed to be clay lined, it is expected that any fracture zones which may develop will self anneal due to the properties of clay. However, monitoring of the creek lines will determine any non conformance within the creek lines and allow the implementation of appropriate contingency measures in consultation with relevant regulators.

Remediation Techniques

The techniques employed to undertake remediation will depend on the particular conditions which arise during the rehabilitation of the creek line.

In the first instance, remediation will replicate aspects of the original design and rehabilitation proposal described previously in this report. This will include planting additional vegetation or undertaking further compaction of the creek bed to provide stability to the creek realignment and prevent the loss of surface flow.

Periodic monitoring of the creek will identify locations within the bed and banks where settlement has occurred leading to excessive infiltration. This may be localised settlement or settlement along a length of the diverted creek channel.

The possible remediation options for this scenario include the following:

- Where local settlement of the channel has occurred, overburden material may be used to restore the channel to its intended functionality. If necessary, additional compaction and revegetation of the layer may be undertaken;
- Alternatively, it may be more effective to line the settled area with clay so that it forms a permanent water source. The viability of this procedure will depend on the size of the settlement and its context within the overall creek alignment;
- Where the settlement is likely to result in the formation of a scour hole, leading to erosion, selected rip-rap may be placed to protect the scour hole from further erosion; and
- If a section of the channel undergoes settlement, an assessment will be made of the potential impact on the creek functionality. Extra overburden material will be compacted as necessary to prevent infiltration of surface water.

Where infiltration and loss of surface flow is identified, the section of creek bed will be remediated so as to reduce this loss. The material will be re-confirmed that it is suitable for reuse as bed and bank material. If not it should be placed elsewhere and more suitable material provided. The creek channel will be reinstated and compacted as originally detailed. Following this, the area will be revegetated.

Erosion and Sediment Control

At the downstream end of each reconstructed section of the creek channel, a sediment trap will be installed which will be maintained while the creek is being constructed and rehabilitated.

This will allow for the capture and repatriation of the erosion of sediments while the creek channel is still being established.

In locations where excessive erosion occurs within the reconstructed creek channel, rock rip-rap or other suitable material will be used to provide protection to the creek bed and banks. The rip-rap will be placed as required to stabilise the eroded stream. In addition, rock and gravel may be used to anchor finer bed sediments and prevent erosion.

Flooding

MCM will construct temporary dams at the upstream end of the creek diversions. The primary purpose of these dams will be to capture and store clean water to be released in order to meet natural environmental flow requirements. However, some provision for the capture and storage of flood water is proposed to retard the peak of the hydrograph and volume of floodwater entering the rehabilitated creek.

The exact quantity of flood storage will vary depending on the size of the catchment draining to the dam and the quantity of rainfall which has fallen and been stored in period prior to the flood event.

In addition, inspection of the revised creek alignment will be undertaken following a flood event. As a general guideline, inspection will be undertaken following a flood event equivalent to the 1 year ARI flood (i.e. near bank full flow of the main channel section). Observation of a particular flood event will be required to assess if an inspection of the reinstated creek line is necessary.

In the event that a flood occurs which causes damage to the reconstructed creek, remediation of the creek will be undertaken in accordance with the remediation measures described above.

4.9.5 Summary

The Preferred Project results in the avoidance of the relocation of 2.7 km of Murragamba Creek proposed to be disturbed in the Stage 2 EA.

The avoidance of this section of creek allows for the conservation of additional C/EEC and Aboriginal heritage sites. The extent of the Aboriginal Heritage conservation zone located on Murragamba Creek is able to be extended to encompass further sites as a result of the site layout changes.

In consideration of the mitigation and management measures stipulated in **Section 4.9.4** when compared to the Project assessed in the Stage 2 EA, the Preferred Project minimises its environmental impact in relation to the creek realignments.

4.10 ECOLOGY

An ecological impact assessment was carried out by Ecovision Consulting as part of preparation of the Stage 2 EA. The Preferred Project ecological impacts are generally consistent with those outlined in Section 5.7 of the Stage 2 EA.

The Stage 2 EA proposed a number of mitigation and management techniques in order to avoid and mitigate impacts of Stage 2 on ecology.

The mitigation and management measures from Section 5.7 of the Stage 2 EA are also summarised below. These are broadly defined as follows:

- Avoidance of areas of ecologically important values where possible;
- Establish, restore and reinstate functional aquatic (creek), terrestrial and riparian corridors;
- Increase the net native vegetation cover within the locality;
- Enhance the ecological values of retained aquatic ecological resources and of native vegetation cover and associated habitats;
- Conserve fauna habitats through managed salvage and compensatory works (including retention of large woody debris for use in creek diversion and rehabilitation activities);
- Establish and enhance wildlife connectivity between conservation reserves and adjoining unreserved native vegetation cover;

- Incorporate specific rehabilitation techniques for use in an integrated rehabilitation strategy designed to restore key ecological function;
- Offset areas of significant ecological values; and
- Ensure that the development is consistent with the *Guidelines on Developments adjoining DECC Land (DECC 2008)*, especially with respect to ecological connectivity, erosion, sedimentation, runoff, pests, weeds, edge effects, fire management, boundary encroachments and indirect impacts.

MCM will continue to implement its Land Disturbance Protocol for the Project, to be included in the Rehabilitation and Offset Management Plan (ROMP). This Land Disturbance Protocol requires the Environmental Manager (or delegate) to carry out an inspection of proposed disturbance areas prior to any disturbance activities occurring.

This Protocol also provides a process to ensure compliance with the relevant licences and approvals, that sensitive ecological (and Aboriginal archaeological, see **Section 4.13.4**) features are not impacted upon directly, and that appropriate mitigation is put in place prior to any disturbance.

Additionally, proposed in the Stage 2 EA was an ecological offset strategy which aimed to compensate for the impacts associated with Stage 2. As part of this PPR MCM has revised its Stage 2 Biodiversity Offset Strategy which is outlined further in **Section 4.11**.

4.11 BIODIVERSITY OFFSET STRATEGY

4.11.1 Background

Cumberland Ecology has prepared a biodiversity offset strategy for the Preferred Project. The biodiversity offset strategy is presented in full in **Appendix H** and has been prepared in consideration of the Preferred Project and all relevant issues raised during submissions.

This section and **Appendix H** replace in full the Biodiversity Offset Strategy developed for the Stage 2 EA.

The Stage 2 EA Ecological Impact Assessment (Ecovision Consulting, 2008) documented the impacts of the Project to ecology and provided a suggested Offsets Strategy. Since that time, submissions to the Stage 2 EA and additional consultation with DP&I, OEH and SEWPaC confirmed the need to revise the suggested strategy.

MCM, with the assistance of Cumberland Ecology, has developed a more comprehensive Biodiversity Offset Strategy for the Preferred Project which is detailed in **Appendix H**.

The Strategy investigates the impacts of the Preferred Project on current biodiversity values, including threatened species, populations and ecological communities protected under the *Threatened Species Conservation Act 1995* (TSC Act) and the EPBC Act.

The following section provides a summary of the Preferred Project's revised impact on biodiversity values within the Project Disturbance Boundary and describes the proposed strategy to mitigate and offset this impact.

4.11.2 Methodology

MCM has developed a comprehensive Biodiversity Offset Strategy for the Preferred Project which will ensure that impacts to ecology are reduced as far as practical, including:

- **Avoid** – to the extent possible, the Preferred Project should be designed to avoid or minimise ecological impacts;
- **Mitigate** – where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the Preferred Project; and
- **Compensate** – following the implementation of mitigation, the residual impacts of the Preferred Project should be compensated to offset what would otherwise be net loss of habitat.

The Preferred Project has been modified to the extent practicable to avoid and reduce impacts to C/EEC. This has been achieved by relocating the proposed southern OOP emplacements to a single northern OOP emplacement area, and modifying the OC4 footprint.

Mitigation measures will be deployed on the site and will include rehabilitation of the mined areas, including areas of secondary grassland that currently have little habitat value, to create forest and woodland. This will provide larger treed areas than currently occur in the proposed disturbance area in the long term.

Notwithstanding the proposed avoidance and mitigation measures, the project would clear a substantial area of habitat and could entail a significant impact without the provision of offsets.

Offset measures are generally developed in cases where the proposed disturbance is likely to have an impact on native flora and fauna, particular threatened species, populations, communities and / or habitat and which cannot be adequately mitigated or remediated as part of the development.

An offset package has been developed which aims to address impacts to a C/EEC and the loss of native remnant vegetation, including habitat for a suite of threatened species (see **Appendix H**) all of which are well represented in the offset strategy.

This includes various birds, mammals, bats and plants with a particular emphasis on species listed under EPBC Referral (No 2008/4444) including: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland (Box Gum Woodland) and Derived Native Grassland C/EEC; Large-eared Pied Bat; Greater Long-eared Bat; Regent Honeyeater; Swift Parrot; Brush-tailed Rock Wallaby; and Spotted-tailed Quoll.

Mine Plan Design

The Preferred Project reflects a series of mine design changes to avoid as far as practical the loss of native remnant vegetation and consequently, threatened ecological communities and habitat for threatened species.

Figure 17 and **Table 26** demonstrate the changes in impacts to C/EEC associated with Stage 2 of the MCC. These mine design changes for the Preferred Project have directly resulted in a 33.5 ha reduction in impacts to Box Gum Woodland and Derived Native Grassland C/EEC along with other reduced impacts to remnant vegetation.

Approach to Offset Identification

Ideally, Biodiversity Offsets should be able to address Preferred Project impacts in a strategic and meaningful way that will deliver a real biodiversity outcome.

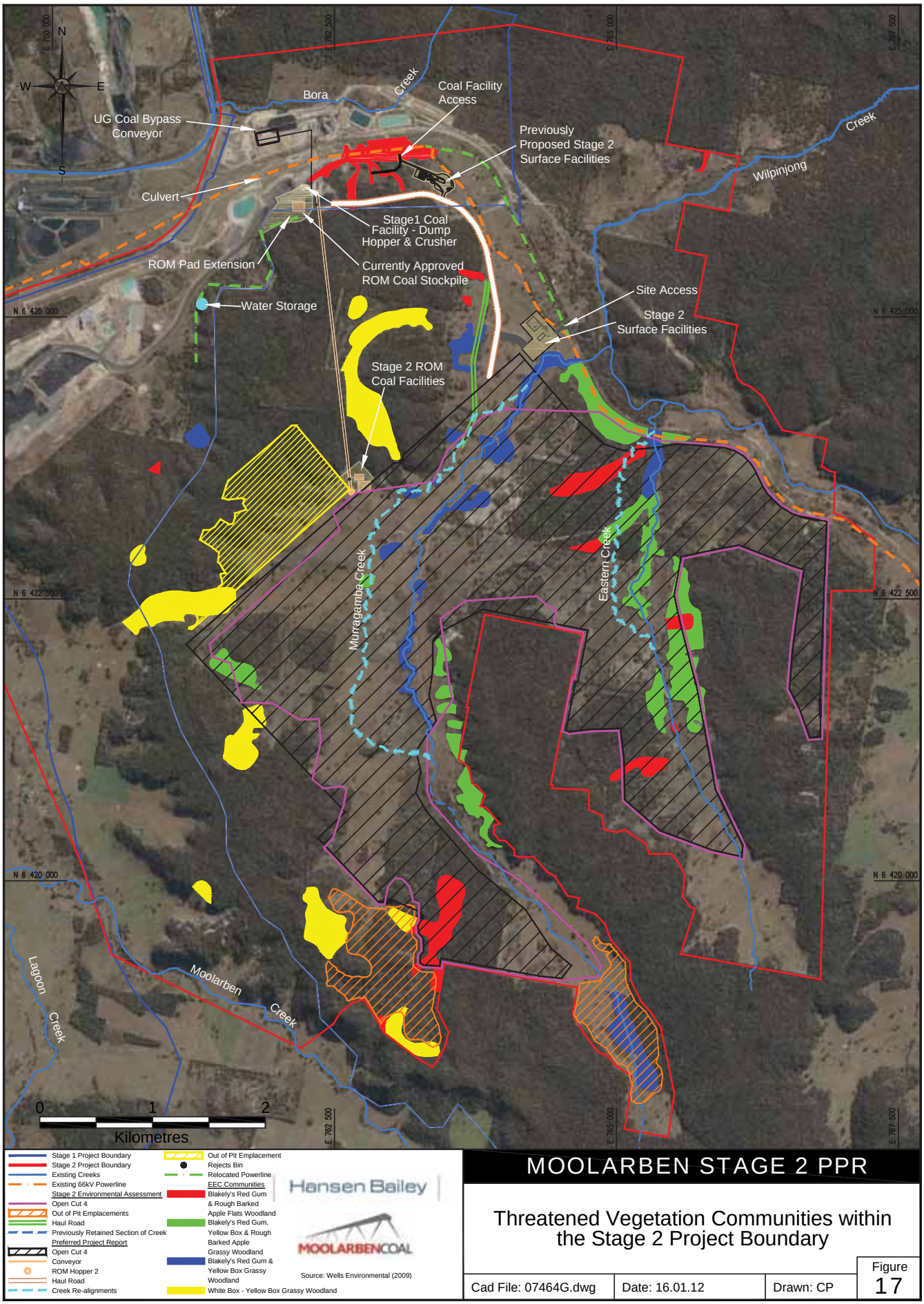
MCM and Cumberland Ecology took a considered approach in developing the Biodiversity Offset Strategy for the Preferred Project which is detailed in **Appendix H** and comprised the three key steps outlined below:

- Identifying the desirable features of an offset package. This assisted in the identification of potentially suitable offset land;
- Implementing a series of actions to prioritise potential land for further investigation; and
- Conducting preliminary surveys to verify the suitability of candidate properties.

Offsetting Principles

The Biodiversity Offset Strategy has been developed to generally comply with the biodiversity offsetting principles developed by both the State and Commonwealth Governments and include:

- *DECCW Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A Developments* (DECCW 2010); and
- *Draft Policy Statement: Use of Environmental Offsets under the Environment Protection and Biodiversity Conservation Act 1999* (DEWR 2007).



MOOLARBEN STAGE 2 PPR

Threatened Vegetation Communities within the Stage 2 Project Boundary

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Table 26
C/EEC Avoidance due to Preferred Project

Vegetation Type	Retained (ha)
Modification to OC4 footprint to avoid of impacts to C/EEC	20.7
Construction of a single Northern OOP emplacement area in lieu of two southern OOP emplacements to reduce impact to C/EEC	12.4
Realignment of the OC4 haul road to avoid impacts to C/EEC	0.4

Table 27
Vegetation Disturbance within the Preferred Project Boundary

Vegetation Type	Vegetation to be Cleared (ha)
Box Gum Woodland and Derived Native Grassland C/EEC	
Blakely's Red Gum - Rough-Barked Apple Woodland	36.8
Blakely's Red Gum - Yellow Box - Rough-Barked Apple Grassy Woodland	49.0
Blakely's Red Gum - Yellow Box Grassy Woodland	29.6
White Box - Yellow Box Grassy Woodland	7.9
Sub Total	**123.3**
Remnant Native Vegetation	
Western Slopes Dry Sclerophyll Forest	458.6
Murragamba Sands Woodland	320.5
Sub Total	**779.1**
Non Remnant Native Vegetation	
Secondary Grassland and Shrub lands	631.5
Disturbed / No Natural Vegetation	11.8
Sub Total	643.3
Total Remnant Native Vegetation Impacted by the Preferred Project (including C/EEC)	**902.4**
Total Preferred Project Disturbance Area	**1,545.7**

The aim of the above mentioned policy is to outline the Commonwealth governments' position in relation to the use of offsets and to ensure that the best environmental outcomes are achieved through the consistent, transparent and equitable application of offsets under the EPBC Act.

One of the key principles of this draft policy is that environmental offsets, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like' (DEWR 2007).

4.11.3 Impact Assessment

The Preferred Project will remove forest and woodland habitat, comprising non-listed forest and woodland communities and the listed C/EEC Box Gum Woodland and Derived Native Grassland within the Disturbance Boundary.

Table 27 provides a summary of the disturbance of native vegetation including C/EEC associated with the Preferred Project Disturbance Boundary.

The Preferred Project will result in a disturbance footprint of approximately 1,546 ha of land. This includes approximately 779 ha of remnant native vegetation (non-threatened) and an additional 123 ha of the State and Commonwealth listed C/EEC Box Gum Woodland and Derived Native Grassland. The remaining areas of potential disturbance comprise secondary grasslands and heavily modified or existing cleared areas.

The offset strategy for the Preferred Project aims to achieve an overall offset goal of 3:1 for all remnant native vegetation to be cleared, with a proportion of that offset to comprise a 5:1 offset for impacts to C/EEC.

Therefore, proposed offset lands contain a sum total of no less than 3,516 ha of native vegetation, of which at least 620 ha will consist of, or have the potential to be rehabilitated to, Box Gum Woodland and Derived Native Grassland.

4.11.4 Management and Mitigation

Biodiversity Offset Strategy

The Biodiversity Offset Strategy that has been formulated for the Preferred Project comprises a total of 3,572 ha and requires the acquisition of land holdings that contain a substantial amount of remnant vegetation.

Figure 18 presents the locations of these land holdings and locations in the immediate vicinity of the Preferred Project Boundary which include:

- Property 9 'Dun Dun' in Hargraves comprises 2,734.6 ha (Lots 60 & 61 DP 704158, Lots 79 & 80 DP 704159 and Lots 14 & 15 DP 756867);
- Property 17 in Windeyer comprises 502.5 ha (Lots 112 DP 756864); Property 18 in Ulan comprises 372.3 ha (Lot 279 DP 40917, Lot 1 DP 592376, Lots 1 & 2 DP 809642);
- Property 18 in Ulan comprises 365.4 ha (Lot 279 DP 40917, Lot 1 DP 592376, Lots 1 & 2 DP 809642); and
- MCM owned land within the Project Boundary and outside the Disturbance Boundary appropriate for conservation comprising 442.3 ha.

Detailed descriptions and mapping for each property is provided in **Appendix H** with each discussed below.

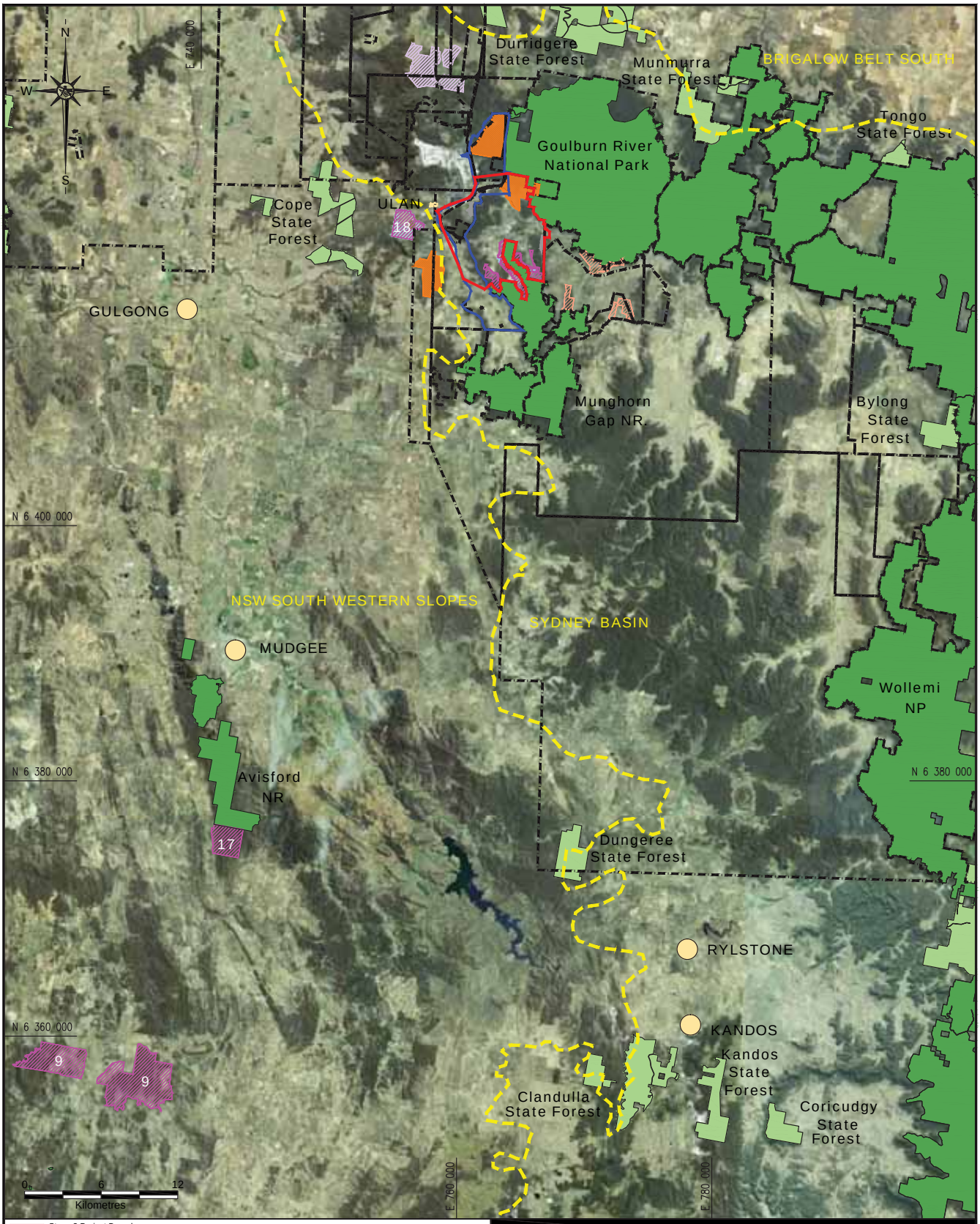
Property 9 'Dun Dun'

"Dun Dun" is a large property under Agreement with MCM and divided into two, the eastern and the western parts which are separated by a distance of approximately 1 km. The eastern part (hereafter called 9E) is 1,776 ha in size and the western part (hereafter called 9W) is 959 ha.

The southern boundary of 9E is formed by Pyramul Creek, which contains permanent fresh water. The River Oak riparian forest located along the Pyramul Creek is on Crown land and has been excluded from grazing.

Permanent water within the property boundary consists of several farm dams. The property is currently being grazed by sheep at a very low stocking rate on areas of low diversity derived native grassland. Most of the grassland on this property would have originally formed part of the Box Gum Woodland C/EEC, some of which still exists in small patches. The Red Stringybark-Scribbly Gum-Peppermint Open Forest located in the middle of the property is largely undisturbed and has not previously been subject to clearing.

Property 9W (**Figure 18**) is located in steeply undulating terrain between 600m and 870m above sea level. Dun Dun Creek passes through the south eastern corner of the property and Willerang Creek forms most of the western boundary. The eastern half of the property comprises mostly cleared grassland and woodland with occasional patches of dense vegetation. The remnant canopy species include White Box, Yellow Box, Red Stringybark and Red Box, which are all characteristic species of Box Gum Woodland. The western half is mostly inaccessible, steeply undulating and covered in Red Stringybark-Scribbly Gum-Peppermint Open Forest.



MOOLARBEN STAGE 2 PPR

Preferred Project Biodiversity Offsets
In Regional Setting

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MCM holds an Agreement to purchase this property. This property provides the opportunity to conserve and enhance Box Gum Woodland and affiliated species including a suite of threatened species of birds, bats and mammals.

The EPBC Act listed migratory Rainbow Bee-eater and Satin Flycatcher have been surveyed on this property, as well as the following species listed as vulnerable under the TSC Act: Brown Treecreeper, Varied Sittella, Speckled Warbler, Scarlet Robin and Eastern Bent-wing Bat.

The property also contains habitat and / or foraging habitat for the Regent Honeyeater, Swift Parrot, White-throated Needletail, Cattle Egret, Rufous Fantail, Eastern Long-eared Bat, Large-eared Pied Bat and the Spotted-tailed Quoll, all listed under the EPBC Act.

Additionally Property 9 has habitat for *Ozothamnus tesselatus,* Capertee Stringybark and the Small Purple-pea, which are all flora also listed under the EPBC Act.

The property provides a stepping stone between other patches of remnant vegetation within a heavily cleared landscape and also forms part of a riparian corridor along Pyramul Creek. The property is large enough to become a conservation reserve in its own right and could form the nucleus from which adjoining properties could be added. Property 9 includes approximately 2,735.1 ha of native vegetation including 519.1 ha of C/EEC and 1,653.2 ha of Red Stringybark-Scribbly Gum-Peppermint Open Forest.

Property 17 (Windeyer)

Property 17 in Windeyer is a MCM owned property of approximately 502.5 ha and is located adjacent to the Avisford Nature Reserve where it acts as the southern extension of the reserve.

Only the eastern edge of this property has been surveyed. Assumptions have been made regarding the vegetation communities in the parts of the property that have not been surveyed.

While this property will be used as an offset due to its location adjacent to Avisford Nature Reserve, it has, however, not been included in the offset ratio calculations.

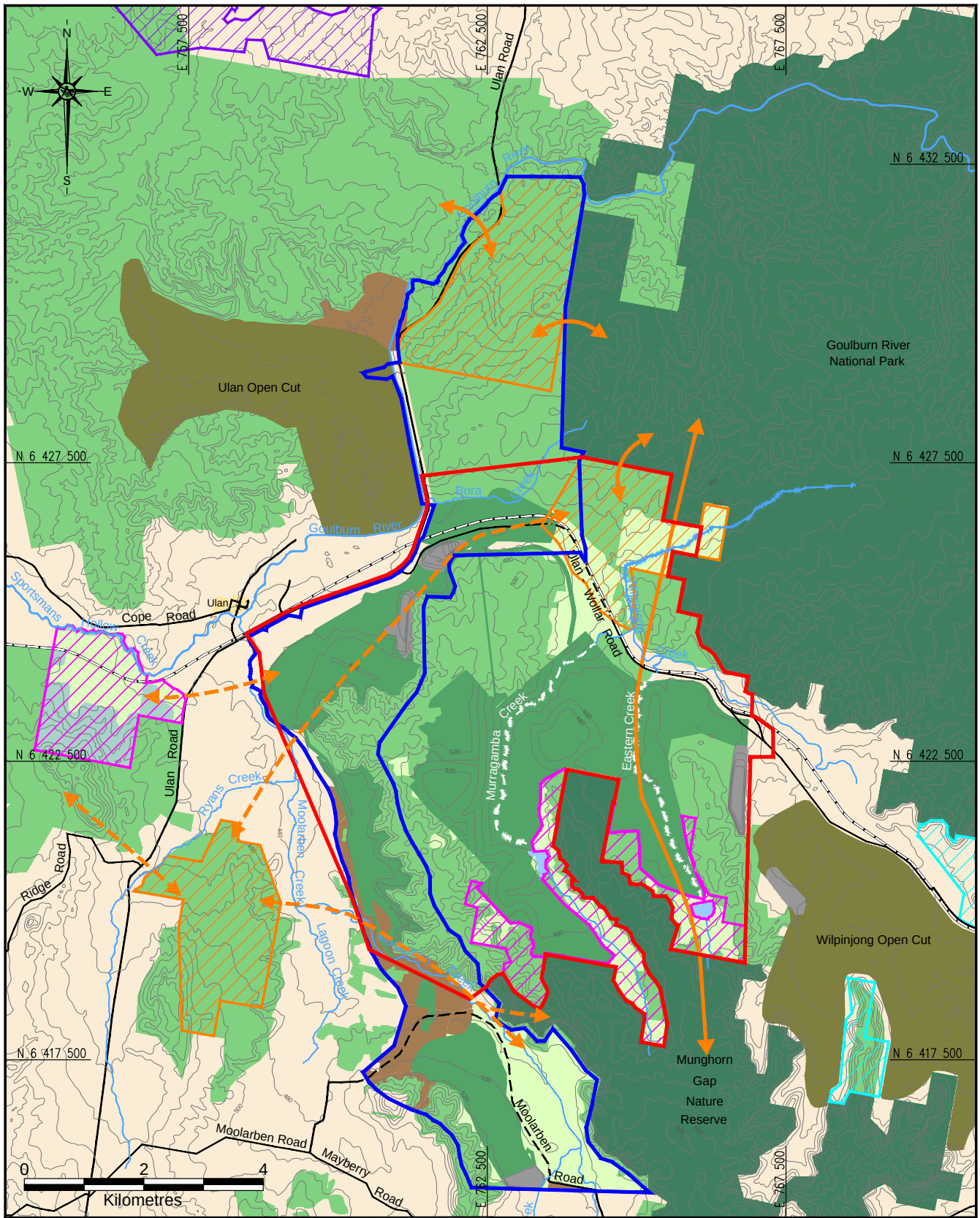
The property contains undulating hills, ridge-lines and gullies with a predominantly east-west aspect. The property contains many small ephemeral creeklines and is completely covered in native vegetation, most of it being Red Stringybark-Scribbly Gum-Peppermint Open Forest. A small area along the western boundary has been cleared and contains grassland with scattered trees.

Property 17 provides habitat for numerous threatened species under the TSC Act including many birds, mammals and Plants. It also contains habitat and / or foraging habitat for the Rainbow Bee-eater, Regent Honeyeater, Swift Parrot white-throated Needletail, Large-eared Bat and the Spotted-tailed Quoll, all listed under the EPBC Act. Additionally Property 17 has habitat for *Ozothamnus tesselatus,* Capertee Stringybark and the Small Purple-pea.

Property 17 includes approximately 502.5 ha of native vegetation including 126.9 ha of C/EEC and 375.6 ha is Red Stringybark-Scribbly Gum-Peppermint Open Forest. Through consultation, it has been indicated by OEH that this property would provide an appropriate addition to the Avisford Nature Reserve and, increasing linkages with surrounding vegetation and increasing habitat for threatened species.

Property 18 (Ulan)

Property 18 adjacent to Ulan village is approximately 372.3 ha in size and is owned by MCM. The northern boundary runs along Sportsmans Hollow Creek, which contains running water year round (see **Figure 19**). The property is surrounded by other private properties and contains flat land in the northern two thirds and a moderately steep incline towards Goat Hill in the south. The property contains River Oak riparian forest along Sportsmans Hollow Creek and the large dam.



MOOLARBEN STAGE 2 PPR

Cumulative Offset and Rehabilitation Strategy

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Most of the low diversity derived native grassland is currently being grazed by cattle and there are a few areas which have been cropped in the past. The Ironbark forest areas in the southern half of the property are partially disturbed and contain some acacia and Kunzea regrowth.

The following species have been surveyed on this property, all of which are listed as vulnerable under the TSC Act: Brown Treecreeper, Varied Sittella, Speckled Warbler, Eastern Bent-wing Bat and Large-eared Pied Bat (also listed as vulnerable under the EPBC Act).

Property 18 provides habitat for numerous threatened species under the TSC Act including numerous birds, mammals and Plants. It also contains habitat and / or foraging habitat for the Rainbow Bee-eater, Regent Honeyeater, Swift Parrot White-throated Needletail, Cattle Egret, Rufous Fantail, Large-eared Bat, Eastern Long-eared Bat and the Spotted-tailed Quoll, all listed under the EPBC Act. Additionally Property 18 has habitat for *Ozothamnus tesselatus,* Capertee Stringybark and the Small Purple-pea, also listed under the EPBC Act.

Property 18 includes approximately 338.16 ha of native vegetation, of which 48.4 ha is C/EEC and 1 ha consists of Ironbark Open Forest. This property is located directly adjacent to the properties predicted to be affected by noise from the MCC and the Offset Areas for Stage 1.

These areas combined with the rehabilitated final landform will provide for a stepping stone between Cope State Forest and Goulburn National Park along with excellent connectivity to existing offsets and national parks / nature reserves around the Preferred Project.

MCM Owned Land within the Project Boundary

This area is located in the southern part of the buffer land between the Preferred Project Boundary and the Project Disturbance Boundary and is owned by MCM (see **Figure 19**). The area consists of 442.3 ha of woodland and grassland directly adjacent to the Munghorn Gap Nature Reserve.

The area contains 52.7 ha of Box Gum Woodland and Derived Native Grassland C/EEC (Ecovision Consulting 2008).

It also contains 189 ha of grassland which is likely to host a viable native soil seed bank due to its proximity to the C/EEC and Munghorn Gap Nature Reserve.

For this reason it is anticipated that the grassland will naturally regenerate into woodland with appropriate management and exclusion of stock. A total of 198 ha of this area is covered in Western Slopes Dry Sclerophyll Forest, which provides habitat for many native flora and fauna species.

Figure 19 shows the connectivity via a corridor between Munghorn Gap Nature Reserve and the Goulburn River National Park which will be achieved following the regeneration of the MCM Owned land within the Preferred Project Boundary and final rehabilitation following the mining of OC4. It also shows potential for further connectivity following Ulan and Wilpinjong Coal Mine's final rehabilitation following open cut mining.

Summary of Biodiversity Offsets

A summary of the biodiversity offsets is provided in **Table 28**. The three offset properties combined contain an approximate total of 3,073.8 ha of native vegetation of which approximately 567.5 ha is C/EEC Box Gum Woodland and Derived Native Grassland.

With the inclusion of land within the Project Boundary the total offsets provide for a total of 3,516.0 ha of native vegetation of which 620.2 ha is comprised of C/EEC Box Gum Woodland and Derived Native Grassland. This results in an offset ratio of 3.9:1 for native vegetation and 5:1 for C/EEC. This does not include mined land that will be rehabilitated back to native woodland.

The overall Biodiversity Offset Strategy achieves the objective of obtaining a 3:1 offset ratio for native vegetation (TSC Act) and the 5:1 offset ratio for C/EEC (EPBC Act).

Table 28
Summary of Biodiversity Offsets

Vegetation Type	Properties					Total
	9E	9W	17	18	Within Project Boundary*	
White Box-Yellow Box-Blakely's Red Gum Woodland (C/EEC)	114.6	111.2	114.9	48.4	52.7	326.9
White Box-Yellow Box-Blakely's Red Gum Derived Native Grassland (C/EEC)	293.2		12.0			293.2
Ironbark Open Forest				118.0		118.0
Riparian Forest		12.7		3.9		16.6
Red Stringybark - Red Box Woodland		95.7				95.7
Scribbly Gum-Red Stringybark Woodland		23.9				23.9
Scribbly Gum-Peppermint-Red Stringybark Open Forest	1,281.3	371.9	375.6			1,653.2
Western Slopes Dry Sclerophyll Forest					198.0	198.0
Murragamba Sands Woodland					2.5	2.5
Acacia / Kunzea Shrubs				13.1		13.1
Secondary Grassland and Shrublands					189.1	189.1
Low Diversity Derived Native Grassland	86.7	343.9		155.2		585.8
Exotic				22.3		22.3
Cleared / Farm Dams				4.5		4.5
Total offset Area (ha)	**1,775.8**	**959.3**	**502.5**	**365.4**	**442.3**	**4,045.3**
Total Native Vegetation (including C/EEC) (ha)	**1,775.8**	**959.3**	**N/A***	**338.6**	**442.3**	**3,516.0**
Total C/EEC (ha)	**407.8**	**111.2**	**N/A***	**48.4**	**52.7**	**620.1**

**Outside the disturbance footprint*
***Property 17 is not included in the offset ratio calculations*

Reasons for Selection

The properties selected for inclusion in the Biodiversity Offset Strategy have been selected for the following reasons:

- They contain values of ecological significance that will assist in maintaining and enhancing biodiversity values within the region in the medium to long term;
- They contain appropriate vegetation communities in good condition, comparable to or in better condition than the vegetation proposed to be cleared for the Preferred Project;
- Offsets consisting of strategically located properties with linkages to other areas of remnant native forest and woodland vegetation;
- 'Dun Dun' (Property 9E and 9W) is large enough to become a stand-alone conservation reserve in its own right (2,735 ha) and has the potential to be used as a nucleus for future projects;

- The offset properties contain at least 9 of the 16 bat species potentially impacted by the development, two of which are threatened species (*Chalinolobus dwyeri* and *Miniopterus orianae oceanensis*). Additionally the offset properties contain two bat species that have not been detected in the impact area;
- The offset properties contain at least 100 of 170 bird species recorded on the impact site (nearly 60%), including five threatened bird species (TSC Act) and two migratory species (EPBC Act). This is likely to be an underestimate of the diversity of the offset properties considering the far greater survey effort for the impact area. Additionally the offset properties contain five bird species that have not been detected in the impact area;
- They contain habitat for threatened species that are predicted to be impacted by the Preferred Project – the quality of such habitat will be improved by management such as livestock removal;
- They contain a large diversity of good quality micro-habitats (such as creeks, dams, gullies and ridges), which provide suitable habitat for threatened fauna species;
- They have the potential to increase environmental value through implementation of appropriate management on all three properties; and
- All three offset properties are freehold land that is free of coal mining tenements and are either in MCM's ownership or under purchase agreement and can be secured in the long term.

Rehabilitation and Offset Management Plan

A ROMP for the Preferred Project will be developed (inclusive of the Biodiversity Offset Plan), to guide the restoration and management of land for biodiversity offsets.

The ROMP will ensure:

- Management of land that contains and/or can be regenerated to provide habitat for C/EECs as well as non-EEC vegetation;
- Management and improvement of land that includes habitat for all relevant threatened flora and fauna species that could be impacted by the Preferred Project;
- Management of land that contributes to any existing regional biodiversity conservation strategies;
- Identification of specific management actions regarding weeds, feral animals, tracks, revegetation, monitoring, etc.;
- Utilisation of the existing Land Disturbance Protocol as part of the ROMP to ensure pre-clearance surveys are conducted as described in **Section 4.10**;
- Ensure that offset management objectives are compliant with existing recovery plans for C/EECs and threatened species; and
- Funding and permanent conservation mechanisms are addressed.

Summary

Compared to the Stage 2 EA, the Preferred Project will avoid impacts to 33.5 ha of Box Gum Woodland and Derived Native Grassland C/EEC along with other reduced impacts to remnant vegetation.

Additionally, the Biodiversity Offset Strategy described above and in **Appendix H** will achieve an offset ratio of five hectares to each one hectare of C/EEC proposed to be disturbed and an offset ratio of 3.9 ha to each one hectare of native vegetation proposed to be disturbed.

The Stage 2 EA presented an offset ratio of two hectares to each one hectare of C/EEC proposed to be disturbed; and one hectare to each one hectare of native vegetation proposed to be disturbed.

Compared to the Project assessed in the Stage 2 EA, the Preferred Project minimises its impact on Biodiversity.

4.12 SUBSIDENCE

4.12.1 Background

A Subsidence Ground Movement Prediction and a Subsidence Impact Assessment was carried out by Mine Subsidence Engineering Consultants (MSEC) as part of preparation of the Stage 2 EA. This report has since been updated to be consistent with the Preferred Project and is attached in **Appendix I.** This report replaces the Subsidence Ground Movement Prediction and a Subsidence Impact Assessment provided in the Stage 2 EA.

The following section replaces Section 5.8 of the Stage 2 EA and provides a summary of the predicted subsidence parameters and assessed impacts associated with the Preferred Project and describes the proposed strategies to mitigate and manage the impacts.

Assessment of subsidence impacts to Surface Water, Ground Water, Ecology, Aboriginal Archaeology and Non-Aboriginal Heritage impacts have also been addressed in the relevant studies and reports that have been prepared by other consultants.

4.12.2 Identification of Surface Features

The Subsidence Study Areas for UG1 and UG2 are defined as the surface area that is likely to be affected by the proposed mining of Longwalls 1 to 13 in the Ulan Seam by MCM. The extent of the Subsidence Study Area has been calculated by combining the areas bounded by the following limits:

- The 26.5 degree angle of draw line;
- The predicted vertical limit of subsidence, taken as the 20 mm subsidence contour; and
- Features sensitive to far-field movements.

As the depth of cover above the proposed longwall varies between 35 and 165 m, the 26.5 degree angle of draw line has been conservatively determined by drawing a line around the outer edge of the proposed longwall voids at a horizontal distance that varies between 18 and 88 m. The Subsidence Study Area is shown on **Figure 20**.

Natural Surface Features

Natural features located within the Subsidence Study Area include drainage lines, cliffs and natural rock formations, steep slopes and threatened species and vegetation communities.

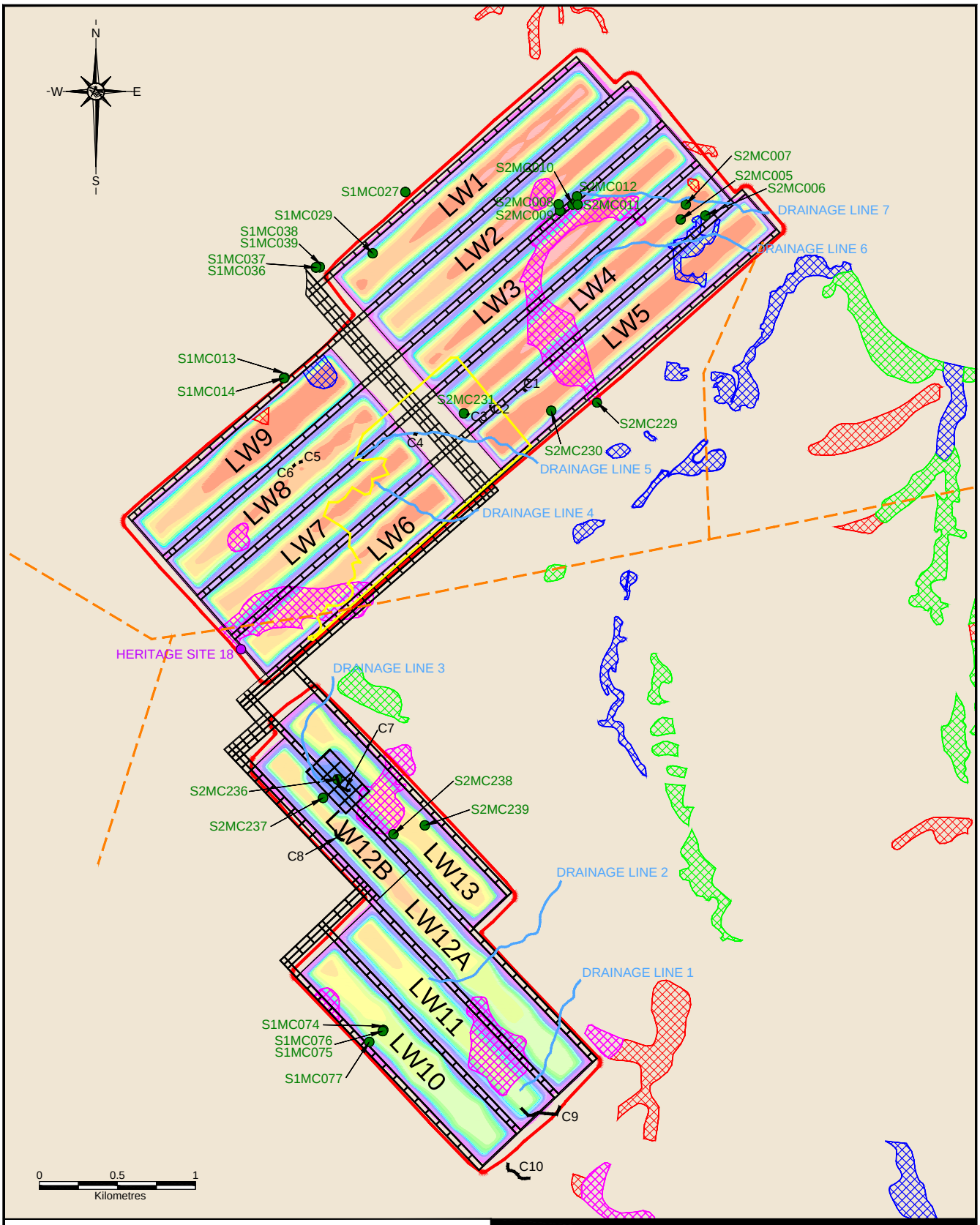
A number of small drainage lines have been identified above the longwalls and within the Subsidence Study Area. Some of these drainage lines flow to the west and north towards Moolarben Creek and then flow into the Goulburn River near Ulan. The other drainage lines flow to the east towards Murragamba Creek and Wilpinjong Creek. For the purposes of the Subsidence Impact Assessment, a cliff has been defined as a continuous rockface having a minimum height of 10 m and a minimum slope of 2:1 (i.e. having a minimum angle to the horizontal of 63).

The locations of cliffs identified within the Subsidence Study Area area shown on **Figure 20**. The cliffs and overhangs have formed from sandstone. Details of the cliffs overall length, maximum height and maximum overhangs are provided on **Table 29**.

Some of these cliffs will be covered by the northern out of pit emplacement prior to the extraction of the UG1 longwalls.

The steep slopes are identified to highlight areas where existing ground slopes may be marginally stable. For the purposes of the subsidence impact assessment, a natural steep slope has been defined as an area of land having a natural gradient between 1:3 (i.e. a grade of 33%, or an angle to the horizontal of 18°) and 2 in 1 (i.e. a grade of 200%, or an angle to the horizontal of 63°).

The surface soils above the proposed longwalls generally consist of soils derived from sandstone, in varying stages of weathering and fracturing. The stability of these natural slopes varies depending on their soil or rock types, and in many cases, natural slopes can be stable at much higher gradients than 1 in 3, for example talus slopes in sandstone.



MOOLARBEN STAGE 2 PPR

Vertical Subsidence & Sensitive Surface Features

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Table 29
Details of Cliffs Identified within the Subsidence Study Area

ID	Approximate Overall Length (m)	Approximate Maximum Height (m)	Approximate Maximum Overhang (m)
C1	20	10	0
C2	20	15	0
C3	20	12	4
C4	20	15	5
C5	20	15	0
C6	20	10	0
C7	2 @ 50	10	6
C8	50	20	5
C9	100	20	7
C10	200	40	10

The majority of these existing natural slopes have been stabilised, to some extent, by trees and other natural vegetation. Some steep slopes are located within the footprint of the proposed Northern OOP emplacement area. These will therefore be covered before the extraction of the proposed longwalls.

There are records of two threatened bat species occurring within the Subsidence Study Area, including Large-eared Pied Bat (*Chalinolobus dwyeri*) and Greater Long-eared Bat (*Noctophilus timoriensis*).

The Large-eared Pied Bat resides predominantly in caves and rock overhangs. The Greater Long-eared Bat roosts in tree hollows in savannah type woodlands.

Critically Endangered Ecological Communities (CEECs) known as *White Box Yellow Box Blakely's Redgum Woodland and Derived Native Grasslands*, occur near the isolated tertiary basalt deposits above UG1 and UG2 and are shown in **Figure 20**. One CEEC will be partially impacted by the northern out of pit emplacement.

Public Utilities

Public utilities located within or surrounding the Subsidence Study Area include roads, drainage culverts, a powerline and telecommunication service.

There is one public road in use that passes through the Subsidence Study Area. Murragamba Road is an unsealed road that passes over the north east part of the UG1 Subsidence Study Area over proposed Longwalls 4 and 5. All other roads, including Carrs Gap Road, within the Subsidence Study Area are either unused roads or unsealed access roads that are used by local land owners.

The nearest point from the proposed longwalls to the Gulgong-Sandy Hollow Railway is approximately 330 m from the nearest edge of Longwall 5. At this location the rail track and culverts will not be subjected to measurable systematic mine subsidence ground movements.

There is one low voltage powerline within the Subsidence Study Area, passing over the installation face of proposed Longwalls 6 and 7 and the installation face of Longwall 5. The powerline is supported on timber poles.

The main underground copper cables within the Subsidence Study Area are located along Murragamba Road. Underground consumer lines may be present at locations where houses have been removed, however these would have been disconnected.

There is an optical fibre cable located along the northern side of Ulan-Wollar Road and the closest point of the cable to the proposed longwalls is approximately 240 m to the north-east of Longwall 5.

Mine Infrastructure

Some of the overburden materials from OC4 are proposed to be stockpiled in the Northern OOP emplacement area above portions of proposed UG1 Longwalls 3 to 8 (northern out of pit emplacement).

Based on the provided surface contours, the Northern OOP emplacement area over UG1 will be formed by Year 7 and, based on the scheduled years of extraction for each longwall, the proposed Longwalls 3 to 8 will be extracted afterwards during Years 8 to 14.

Other mine infrastructure above UG1 includes the Stage 2 ROM coal facilities, which are located at the south western end of Longwall 5, and conveyors between Stage 2 ROM coal facilities and Stage 1 ROM coal facilities.

The proposed final surface contours above and immediately to the south east of the UG1 longwalls will be those provided for Year 12 (**Figure 7**).

Items of Archaeological Significance

There are 21 archaeological sites (identified in both Stage 1 and Stage 2 archaeological assessments) that have been identified within the Subsidence Study Area, of which 17 are isolated finds or artefact scatters, and four have rock overhangs.

The locations of the archaeological sites within the Subsidence Study Area are shown in **Figure 20**.

4.12.3 Methodology

The predicted systematic subsidence parameters for the proposed longwalls at the project were made using the Incremental Profile Method, which was developed by MSEC, formally known as Waddington Kay and Associates. The method is an empirical model based on a large database of observed ground monitoring data from previous mining within the Southern, Newcastle, Hunter, and Western Coalfields of NSW.

The database includes observed incremental subsidence profiles, which are the additional subsidence profiles resulting from the extraction of each longwall within a series of longwalls.

It can be seen from the normalised incremental subsidence profiles within the database, that the observed shapes and magnitudes are reasonably consistent where the mining geometry and local geology are similar.

Subsidence predictions made using the Incremental Profile Method use the database of observed subsidence profiles, the proposed longwall geometries, local surface and seam information and geology. The method has a tendency to over-predict the systematic subsidence parameters (i.e. is slightly conservative) where the proposed mining geometry and geology are within the range of the empirical database. The predictions can be further tailored to local conditions were observed monitoring data are available close to the proposed mining area.

The predicted systematic subsidence parameters for the proposed longwalls were determined using the standard Incremental Profile Model for the Hunter, Newcastle and Western Coalfields based on available monitoring data from the Ulan Seam calibrated to local data. Modifications to the standard Incremental Profile Method have not been made for the presence of any thick massive strata units.

Further detail of the assessment methodology is provided in **Appendix I**.

4.12.4 Impacts

Maximum Predicted Subsidence Parameters for Proposed Longwalls

The maximum predicted total systematic subsidence due to extraction of the longwalls is 1,980 mm which is expected to occur over the middle of Longwall 3 after the extraction of Longwall 4.

The predicted total subsidence represents 62% of the extracted seam thickness. The maximum predicted total systematic tilt due to the longwalls is 95 mm/m (i.e. 9.5%) or a change in grade of 1 in 10, and is expected near the main gate of Longwall 9 after the extraction of Longwall 9.

The maximum predicted total systematic tensile and compressive strains resulting from the extraction of the longwalls are both greater than 50 mm/m and the associated minimum radii of curvatures are both less than 300 m.

Assessments for Natural Features and Items of Surface Infrastructure

Drainage Lines

The drainage lines are located across the Subsidence Study Area and are likely, therefore, to be subjected to the full range of predicted systematic subsidence and valley related movements. The predicted movements have been determined along seven drainage lines, which have been called DL1 to DL7 inclusive, and these drainage lines are shown in **Figure 20**.

The predicted profiles of systematic subsidence, tilt and strain along the alignments of Drainage Lines 1 to 7 resulting from the extraction of the proposed longwalls, are shown in **Appendix I**.

Assessed impacts to the drainage lines include potential ponding, erosion and fracturing and dilation of the bedrock in the bases of the drainage lines. Drainage lines located within the footprint of the northern out of pit emplacement will be stripped and filled in as part of the emplacement operations. A more detailed discussion of these impacts is provided in **Appendix I**.

Cliffs

Cliff site C7, which comprises rock art and is approximately 100 m long, is proposed to be protected by the provision of an unmined block of coal immediately below this cliff. Three cliffs, C2, C3 and C4 are located within the northern out of pit emplacement footprint and will be covered prior to longwall extraction. Cliff C10 is not located over the proposed longwalls and is outside the angle of draw line.

The maximum subsidence predicted values at each of the cliffs and overhangs within the Subsidence Study Area, at any time during or after the extraction of the proposed longwalls, is provided in **Table 30**.

The predicted values are the maximum values within a distance of 20 m from the identified extents of the cliffs that occur during or on completion of the extraction of the proposed Longwalls 1 to 13. The maximum predicted total subsidence at a cliff face is 1,790 mm at Cliff C3.

The maximum predicted total systematic tilt at the identified cliffs, resulting from the extraction of the proposed longwalls, is 55 mm/m (i.e. 5.5%) at Cliff C1, or a change in grade of 1 in 18. The maximum predicted systematic total tensile strain resulting from the extraction of Longwalls 1 to 13 of 40 mm/m is predicted to occur at Cliff C8, and the associated minimum radius of curvature is 0.4 km.

The maximum predicted systematic total compressive strain, resulting from the extraction of Longwalls 1 to 13 of 30 mm/m is predicted to occur at Cliff C1 and the associated minimum radius of curvature is 0.5 km. These predicted levels of ground movements are higher than the magnitudes of the observed and predicted subsidence induced ground subsidence, tilt, curvature and strain movements at other cliff sites at the time of known rock falls and, hence, rock falls can be expected at these cliff lines.

It is expected that cliff instabilities could occur on up to approximately 15% of the length of the exposed cliffs that are located over the proposed longwalls. It is possible that, given the increased length, height and overhang of Cliffs C8 and C9, that these cliffs would be most susceptible to cliff falls. Cliffs C8 and C9 are not visible from public roads or public vantage points and are positioned behind environmental bund walls, open cut pits and out of pit emplacement spoil heaps.

A summary of assessed impacts to the cliffs identified in the Subsidence Study Area is provided in **Table 29** and a more detailed discussion of these impacts is provided in **Appendix I**.

Table 30
Maximum Predicted Subsidence at Cliffs and Summary of Assessed Cliff Impacts

Cliffline	Location	Maximum Predicted Total Subsidence (mm)	Predicted Impact
C1	Over LW5, 20 m from tailgate	1240	Minor impact expected
C2	Over LW4, 15 m from maingate	460	Covered by out of pit emplacement
C3	Over LW4, 50 m from finishing end	1790	Covered by out of pit emplacement
C4	Over Solid coal, 30 m from LW7 finishing end	0	None - Beyond edges of Panels
C5	Over LW8, 90 m from maingate	1790	Minor impact expected
C6	Over LW8, 80 m from maingate	1770	Minor impact expected
C7	Over Solid coal, between LW12 and 13	80	None - Protected by sterilised coal
C8	Over LW12, 60 m from tailgate	1760	Rock falls likely
C9	Over LW11, commencing end	1360	Rock falls likely
C10	Over Solid coal, 90 m from LW10 commencing end	0	None - Beyond edges of Panels

Overhangs and Rock Ledges

Based on the maximum predicted tilts and strains, it is likely that fracturing of sandstone will occur as a result of the extraction of the longwalls and, hence, result in small rockfalls, particularly where the rock ledges or overhangs are marginally stable. It is noted that many of the exposed rocks are isolated from the parent rock by weathered bedding planes and joints and in such cases there would be a lower risk of fracturing of the rock and subsequent rock falls.

Steep Slopes

The maximum predicted total systematic tensile and compressive strains within the Subsidence Study Area are both greater than 50 mm/m and the associated minimum radii of curvatures are both less than 0.3 kilometres. These maximum predicted total systematic tensile strains at the steep slopes are likely to result in surface cracking. This surface cracking can be remediated, if necessary, by infilling with soil or other suitable materials, or by locally regrading and compacting the surface. With these remediation measures in place, it is unlikely that there would be any significant impact on the environment.

It is unlikely that mine subsidence would result in any large-scale slope failure, since such failures have not been observed elsewhere as the result of longwall mining.

Items of Archaeological Significance

Open sites containing artefact scatters and isolated finds can potentially be affected by cracking of the surface soils as a result of mine subsidence movements.

It is unlikely that the scattered artefacts or isolated finds themselves would be impacted by surface cracking. It is possible that, if remediation works to the surface areas around the archaeological sites was required after mining, these works could potentially impact on the archaeological sites.

Sites located within overhangs will be subject to similar impacts as described for the cliffs and overhangs, and artefact scatters and isolated finds can potentially be affected by rock falls. One site, Site ID S2MC231 is located within the northern out of pit emplacement footprint and if not salvaged will be covered during emplacement operations.

Items of Historical or Heritage Significance

The maximum predicted subsidence at the dry stone wall after the extraction of the proposed longwalls is 45 mm.

The maximum predicted systematic tilt at the heritage site is 3.3 mm/m (i.e. 0.3%), or a change in grade of 1 in 300. The maximum predicted systematic tensile and compressive strains at the heritage site are 2.1 mm/m and <1 mm/m respectively.

At these low levels of tilt and strain, the dry stone wall is unlikely to be subjected to any significant impact resulting from the extraction of the proposed longwalls. Potential impacts would most likely include loose stones that may become dislodged during mining.

Survey Control Marks

The predicted maximum horizontal movement at the Murragamba Trig Station resulting from the extraction of the proposed longwalls is approximately 500 mm. It will be necessary on the completion of the proposed longwalls, when the ground has stabilised, to re-establish this mark.

Roads and Rail

The Gulgong-Sandy Hollow rail line is approximately 330 m from the nearest edge of LW5 and is therefore outside the area predicted to be affected by surface subsidence effects. At this location the rail line will not be subjected to measurable systematic mine subsidence ground movements. MSEC has also considered the potential for far-field horizontal movements and upsidence and closure effects at this location. However, it predicts these effects will be small and unlikely to adversely impact on the rail line.

There are no sealed roads within the area that will be impacted by surface subsidence. Murragamba Road is located over the north-east part of Longwall 4 and Longwall 5 and Carrs Gap Road crosses directly over Longwall 6. Moolarben Coal Mines have requested that both roads be closed. Most of Murragmaba Road will be mined out as a result of OC4, however that part located over Longwall 4 and Longwall 5 will be retained and developed for use as the OC4 haul road.

It is expected that increased levels of ponding could occur along the roads and that cracking and rippling of the road surface will occur as a result of longwall extraction.

Both roads are unsealed and will be amenable to regrading and repair using standard road maintenance techniques.

Powerlines and Communication Cables

There is one low voltage electricity power line within the study area, passing over Carrs Gap at the commencing end of Longwall 6 and Longwall 7. This powerline will be terminated in the Moolarben Creek valley on the western side of Carrs Gap and therefore will not be impacted.

A telecommunications cable follows the alignment of Murragamba Road and this will be removed in consultation with Telstra as part of OC4. Hence, neither of these improvements will be impacted upon by subsidence.

There is an optical fibre cable located along the northern side of the Ulan-Wollar Road. The closest point of the cable to the longwalls is approximately 240 m from the north-east end of Longwall 5.

At this location, the optical fibre cable will not be subjected to measurable systematic mine subsidence ground movements. However, it may experience minor far-field horizontal movements and possibly upsidence and closure movements. These effects will be small and are unlikely to adversely impact on the optical fibre cable.

Fences and Farm Dams

There are a number of fences within the area of predicted surface subsidence. These could be affected by tilting of the fence posts and changes of tension in fence wires due to strain as mining occurs. MSEC predicts that some sections of fence will require repair or replacement. These will be repaired or replaced by MCM, where necessary.

Thirteen small farm dams have been identified within the area of predicted surface subsidence. These water retaining structures are no longer required for farming and hence the predicted change in freeboard, although only minor, is of no consequence.

It is expected that cracking and leakage of water could occur in the farm dams which are subjected to greater strains, although any loss of water would merely flow into the drainage line in which the dam was formed.

Northern OOP Emplacement Area

The Northern OOP emplacement area will be located above Longwalls 3 to 8 and will have side slopes with grades of up to 1 in 4 and slope heights up to 85 m.

The thickness of the Northern OOP emplacement area that will be placed over the UG1 longwalls will vary from 0 m around the periphery of the emplacement to a maximum thickness of approximately 65 m over the north-eastern corner of Longwall 6.

A vertical subsidence of approximately 1.9 m is predicted at the natural surface under the OOP emplacement area, following longwall mining in the vicinity of the base of Northern OOP emplacement area has been predicted. Additionally, it is expected that additional settlement would occur at the top of the northern OOP emplacement, as the proposed longwalls mine beneath it, due to the consolidation and lateral shifting of the out of pit emplacement. Research indicates that up to an additional 3 m of vertical settlement at the top of the Northern OOP emplacement could occur.

As a result, the combined maximum predicted total subsidence plus potential additional settlement of the Northern OOP emplacement area is estimated to be 4.9 m. The maximum predicted total tilts are 70 mm/m and maximum predicted total compressive and tensile strains are 40 mm/m and greater than 50 mm/m respectively.

The predicted subsidence at the natural ground surface and additional settlement of the emplacement area can initiate downhill slumping of the soils in the northern out of pit emplacement area.

Other factors such as the presence of natural steep ground slopes, and surface water ingress may increase the risk of downhill slumping of the sides of the emplacement area.

Longwall extraction will create depressions in the flat areas of the emplacement and surface cracks, which will increase the risk of water ingress into the emplacement soils during rain periods.

Access should be restricted to areas near slopes, particularly during the active subsidence period, until subsidence movements cease or the risk of slope failure is determined to be very low.

Stage 2 ROM Coal Facility and Conveyor

The Stage 2 ROM Coal Facility will be located above the south western end of Longwall 5 at the southern end of the conveyors. Provision should be made for adjustments or repair of any mine infrastructure located above the proposed longwalls to accommodate the predicted subsidence parameters and to ensure that safety and serviceability is maintained.

Highwall of the Open Cut Mine

It is possible that some horizontal movement of the highwalls could occur towards the open pit due to relaxation of in situ stresses in the strata as they are undermined. It would therefore be prudent to monitor the highwalls as the longwalls are mined.

4.12.5 Management and Mitigation

A Subsidence Management Plan (or contemporary equivalent) will be developed to ensure that safety and serviceability are maintained during the operation of the Preferred Project. This will include the following:

- A subsidence monitoring program for all surface features situated above the longwalls, including detailed monitoring of:
    - Surface subsidence above the longwall panels;
    - Soil slumping and erosion on steep slopes;
    - Rock falls and cliff stability;

  - Surface water ponding;
  - Surface cracking;
  - The impact of surface subsidence on sensitive natural surface features, including the Aboriginal rock art site (S2MC236), drainage lines, threatened/protected species and C/EECs; and
  - The impact of underground mining and mine subsidence on any overlying aquifers and on surface water quality and quantity draining off the area of underground mining.
- Management strategies for the safe placement of spoil and to maintain the stability of the steep slopes of the Northern OOP emplacement area;
- Regular settlement and movement monitoring of the Northern OOP emplacement area using appropriate technology;
- Regular surface crack repair and remediation of the ground surface to ensure that adequate surface water drainage is maintained;
- Adjustment or repair to any mine infrastructure located above the proposed longwalls to accommodate the observed subsidence movements and to ensure that safety and serviceability is maintained; and
- A program to ensure the stability of the open cut highwalls is maintained for the duration of underground mining.

4.13 ABORIGINAL ARCHAEOLOGY AND CULTURAL HERITAGE

4.13.1 Background

An Aboriginal Archaeological and Cultural Heritage Impact Assessment was carried out by Archaeological Risk Assessment Services (ARAS) as part of preparation of the Stage 2 EA. A review of this assessment and an additional survey was undertaken by AECOM (see **Appendix J**) as part of the RTS to review proposed management measures in light of the Preferred Project.

This assessment is an addendum to the assessment carried out by ARAS and as such it does not contain any environmental, ethnographic and historical background information.

The assessment prepared for the Preferred Project has considered all relevant RTS subsequent to the submission of the Stage 2 EA.

As a result of the changes proposed under the Preferred Project, changes were required to the management measures for a small number of sites. This section outlines the proposed modifications to management measures and **Appendix J** provides details regarding the additional assessment, figures indicating the locations of identified sites and the proposed management measures for all Aboriginal sites identified at MCC.

4.13.2 Methodology

The Aboriginal heritage review involved the following:

- An updated AHIMS search was undertaken for the Project Boundary due to the length of time that has elapsed since the ARAS survey took place (2008). This survey revised the AHIMS search to confirm the current status and validity of the archaeological sites recorded and also identify wether additional sites had been recorded for the project area both prior to and post the 2008 assessment;
- A desktop study to review previous archaeological heritage sites identified as part of the ARAS report to identify any changes to impacts and suggested management measures as a result of the Preferred Project (see **Appendix J**);
- Consultation with Aboriginal groups and individuals in relation to the revised impacts and suggested management measures; and
- Revision of proposed management strategies in light of comments received from the Aboriginal community.

Community Consultation

The original Aboriginal stakeholder engagement program for the Stage 2 EA was conducted in accordance with the draft Guidelines for *Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005a) and the *Interim Community Consultation Requirements for Applicants* (DEC 2004).

Following its release in April 2010, consultation for the Preferred Project has been conducted in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a).

All registered stakeholder groups who were consulted as part of the Stage 2 EA were consulted in relation to the Preferred Project. Wellington Valley Wiradjuri Aboriginal Corporation (WVWAC) were not registered during the consultation for the State 2 EA however did register an interest after this time and have been included in all consultation since registering.

A list of all Aboriginal stakeholder groups consulted with as part of the Preferred Project is presented in **Table 31**.

A letter was sent to all registered stakeholders on the 22 March 2011 providing details of the activities associated with the Preferred Project and seeking comments on the proposed changes. Following this, an invitation to a meeting at site was issued in relation to the Preferred Project with 10 stakeholders attending on 7 April 2011.

The meeting was to provide a background to the Stage 2 EA and the need for the Preferred Project, identify potential impacts to items of Aboriginal heritage and outline suggested management and mitigation measures as well as providing Aboriginal stakeholders with a forum to raise any issues they may have.

One written comment was received in relation to the impacts of Aboriginal heritage items associated with the Preferred Project. Murong Gialinga Aboriginal and Torres Strait Islander Corporation requested that site S2MC231 and site S2MC111 be excavated during the salvage to determine if there were any additional artefacts associated with these sites.

A further letter was sent to all five registered Aboriginal stakeholders on 10 May 2011 confirming the potential impacts to all sites to be impacted at the MCC. The letter also addressed Murong Gialinga Aboriginal and Torres Strait Islander Corporation's comments indicating that sites S2MC231 and S2MC111 will be excavated and noted that these works will be detailed in an Aboriginal Heritage Management Plan (AHMP).

It further explained that the AHMP would be developed in consultation with the Aboriginal community following the grant of Project Approval.

All groups were requested to provide any additional comments regarding the content of the letter however no further comments were received.

Table 31
Aboriginal Stakeholder Groups

Ref	Aboriginal Stakeholder Group
1	Mudgee Local Aboriginal Land Council
2	Murong Gialinga Aboriginal and Torres Strait Islander Corporation
3	Secretary (Warrabinga)
4	Member (North East Wiradjuri)
5	Wellington Valley Wiradjuri Aboriginal Corporation

4.13.3 Impact Assessment

Aboriginal heritage sites identified within and adjacent to the Project Boundary are presented on **Figure 21**. The locations, type, density and management measures of all sites are presented in **Appendix J**.

Layout changes associated with the Preferred Project which will affect impacts on Aboriginal heritage items are demonstrated on **Figure 21** and include:

- Minor changes to the OC4 footprint resulting in a greater length of Murragamba Creek being maintained in its existing state;
- Construction of the Northern OOP emplacement area instead of the southern and south western OOP emplacement areas;
- Minor widening of the OC4 haul road route;
- Construction of dams associated with the diversion of Murragamba and Eastern Creeks; and
- Construction of conveyors and Stage 2 surface facilities for alternative transport of coal.

An additional field survey was undertaken to target areas where impacts have been modified and where survey had not previously been undertaken by ARAS (2008).

The areas were:

- Stage 2 Surface Facilities;
- Southern portion of the modified Haul Road; and
- South eastern boundary of the OOP emplacement area.

In addition the following areas/sites were visited to validate their significance, heritage values and/or the proposed management measures:

- Site S2MC231 – Rock overhang within the Northern OOP Emplacement area;
- Site S2MC229 – Rock shelter adjacent to;
- The Red Hills Management Area; and
- The Murragamba Creek Management Area.

The survey did not identify additional sites, but did identify the Stage 2 Surface Facilities area as an area of high archaeological potential. It is recommended that archaeological test excavations and salvage, where required, be undertaken in accordance with the Aboriginal Heritage Management Plan (AHMP) to be developed in consultation with Aboriginal community stakeholders.

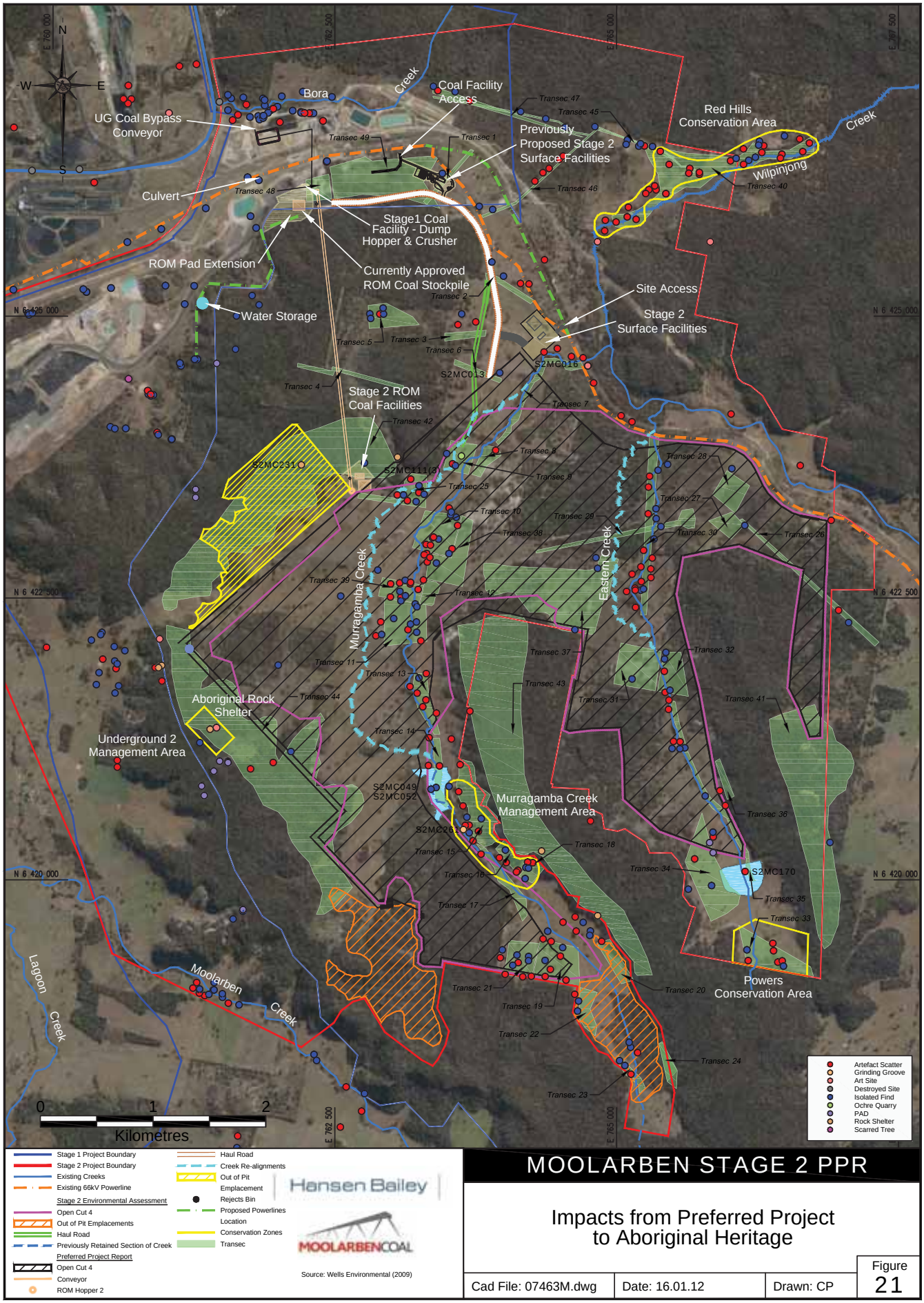
The Management Areas were confirmed as being of high archaeological significance and as being suitable areas for management and conservation for the proposed impacts.

An Aboriginal Heritage Information Management System (AHIMS) search was undertaken for the Project Boundary and a buffer of approximately 500 m on 16 November 2011. An updated archaeological impact assessment was undertaken for the 471 identified sites within the Project Area, which includes the sites identified by ARAS that have subsequently been registered. Of this number, 56 fall outside the Project Boundary and have been assessed in relation to potential disturbance via vibration and blasting only.

The Preferred Project will directly impact 148 sites and indirectly impact 11 sites. This represents 15 additional sites to be affected by the Preferred Project to the original proposal. These include 13 sites of low significance, one medium and one high. Additionally, 29 sites which were proposed to be affected within the Project Boundary will now remain in situ as part of the Preferred Project. This includes 15 sites of low significance, seven medium and seven high. A further 312 sites, identified in surrounding areas, will not be impacted by the Project.

Of these, 62 will be conserved within four Management Areas. As part of the Preferred Project, therefore, a total of 14 fewer sites are proposed to be disturbed.

Appendix J provides a summary of all previously identified Aboriginal sites located within and adjacent to the Project Boundary, notes their significance, the predicted impact of the Preferred Project on each site and the recommended management measure.



MOOLARBEN STAGE 2 PPR

Impacts from Preferred Project to Aboriginal Heritage

Cad File: 07463M.dwg	Date: 16.01.12	Drawn: CP	Figure 21

Figure 21 provides a comparison between the Preferred Project and Stage 2 EA OC mine plans. It also indicates proposed Aboriginal heritage management and conservation areas. Some vegetation enhancement works will be undertaken in accordance with the Stage 1 Biodiversity Offsets Strategy within the Red Hills Conservation Area in accordance with the Land Disturbance Protocol outlined in **Section 4.10**, but will not occur within the boundaries of the identified sites.

4.13.4 Management and Mitigation

MCM will develop an AHMP in consultation with Aboriginal community stakeholders. The AHMP will be guided by specific policies and procedures to manage Aboriginal archaeological sites within the Project Boundary. The AHMP will be developed consistent with **Appendix J** and be periodically reviewed in consultation with Aboriginal stakeholders and OEH.

4.13.5 Summary

The Aboriginal heritage report in Section 5.9 of the Stage 2 EA concluded that a total of 258 Aboriginal heritage sites were identified within the Project Boundary in the ARAS Report.

An AHIMS search determined there were 415 sites within the Project Boundary and 56 in the immediate vicinity, a total of 471 archaeological sites. As the Project Boundary encompasses Stage 1, 144 of these sites were identified during the Stage 1 and are managed through the Stage 1 Approval and the current AHMP. The Preferred Project will directly impact on ten Stage 1 sites, and new management measures have been proposed. No Stage 1 sites will be indirectly impacted.

The Preferred Project will have a direct impact on 148 sites (including the ten identified Stage 1 sites) and has the potential to indirectly impact on 11 sites. A total of 312 will be preserved, with 62 of these located in the proposed Management Areas.

In consideration of the mitigation and management measures committed in **Section 4.13.4** when compared to the Project assessed in the Stage 2 EA, the Preferred Project minimises its impacts to Aboriginal heritage and provides an opportunity for increased preservation of Aboriginal sites, specifically along Murragamba Creek. As a consequence of the design changes for the Preferred Project there will be a reduction in impacts to 14 archaeological sites from the previously proposed project.

4.14 NON-ABORIGINAL HERITAGE

A non-Aboriginal Heritage Assessment was carried out by Heritas as part of preparation of the Stage 2 EA.

The Preferred Project non-Aboriginal heritage impacts, mitigation and management practices are consistent with those outlined in Section 5.10 of the Stage 2 EA. Heritage items identified within the Stage 2 Project Boundary, their assessed significance and potential impact are summarised in **Table 32**. The three identified heritage objects and sites within the footprint of OC4 will need to be removed to facilitate mining.

A Heritage Management Plan will be prepared and implemented by MCM for the MCC non-Aboriginal heritage in consultation with MWRC, prior to carrying out any construction or mining activities that may directly impact the integrity of identified non-Aboriginal heritage items. The Heritage Management Plan will include a program for archival recording of the identified heritage sites and will be integrated with the Stage 1 (non-Aboriginal) Heritage Management Plan.

Table 32
Summary of Non - Aboriginal Heritage Items

Item No.	Item Name	Significance	Impact Status
8	Murragamba School Site	Local – moderate	High – within OC4
9	Farm Site	Local – high	High – within OC4
11	Farm Site	Local – moderate	High – on boundary of OC4
18	Carrs Gap Road Stone Wall	Local – moderate	High* – on boundary of UG1
35	House Site	Local – intrusive (does not meet the criteria for listing at local level due to various alterations and additions)	High – on boundary of OC4
36a	House Site	Local – high	High – on boundary of OC4 and UG1
36b	Grave and/or Burial Site	Local – high	High – on boundary of OC4 and UG1
37	House Site	Local – moderate	High – within OC4
55	Water Trough and Spring Fed Well	Local – high	Low/nil – outside area of perceived impact – possible indirect impact by draining of water
56	Water Trough and Spring Fed Well	Local – high	Low/nil – outside area of perceived impact – possible indirect impact by draining of water
57	Feed Trough	Local – moderate	High – adjacent to proposed road re-alignments

** The subsidence report for Stage 2 (see Appendix I) indicates that only a minor impact will occur.*

4.15 SOILS AND LAND CAPABILITY

A soil, rural land capability and agricultural suitability assessment was carried out by JAMMEL Environmental & Planning Services as part of preparation of the Stage 2 EA.

The Preferred Project soil, rural land capability and agricultural suitability impacts, mitigation and management practices are consistent with those outlined in Section 5.11 of the Stage 2 EA.

The Stage 2 EA determined the potential impacts to soils associated with Stage 2 include:

- Exposure of soils to increased erosion and offsite sediment transport through vegetation stripping and general site disturbance activities;
- Physical disturbance of soils leading to increased erosion during mining activities;
- Removal and disposal of bulk soils leading to loss of topsoil resources during general earth works, excavation or mining;
- Physical, chemical and biological alteration due to poor handling, stockpiling and management;
- Contamination from hydrocarbon or other chemical spills during general earth works and mining activities, and exposure and release of existing soil contaminants from unknown past agricultural practices (such as sheep dips); and
- Poor landscape reconstruction and rehabilitation leading to erosion and offsite sediment transport during site rehabilitation and over the long term post closure.

A detailed Erosion and Sediment Control Plan (ESCP) will be prepared to manage erosion and soils in all open cut mining and infrastructure disturbance areas, in consideration of the known dispersive nature of the soils. The ESCP will form part of the Water Management Plan for the MCC.

In accordance with the 'Managing Urban Stormwater: Soils and Construction Volume 1' (Landcom 2004) and 'Volume 2E Mines & Quarries Guidelines' a target design storm of a 50 year recurrence 1 hour duration rainfall event has formed the basis for sizing sediment dams.

4.16 TRANSPORT

A road and rail transport assessment was carried out by Sinclair Knight Merz Pty Ltd as part of preparation of the Stage 2 EA. Transport impacts, mitigation and management practices, as presented in the Stage 2 EA, are consistent with those of the Preferred Project and are outlined in Section 5.12 of the Stage 2 EA.

The Stage 2 EA predicted total traffic volume will increase due to Stage 2 by 8% on Ulan-Cassilis Road, 6% on Cope Road and 23% on Ulan-Wollar Road. The Ulan-Wollar Road increase is considered to be mostly mining traffic with the greatest number of traffic movements occurring at shift change over.

As part of the Preferred Project, an additional site access intersection is proposed approximately 4.7 km east of the junction between Ulan–Cassilis Road and Ulan–Wollar Road (**Figure 2**). This will provide access to the relocated Stage 2 surface facilities located at the northern extent of OC4.

This minor amendment will not result in any additional traffic movements and will divide assessed traffic between two site entries.

A Section 138 application under the Roads Act will be required to be made to the relevant roads authority for the relocation of the Ulan–Wollar Road which shall include detailed designs of the two proposed intersections.

The following management measures will be implemented during construction and operation of the Preferred Project:

- Access along all public roads will be maintained at all times, with the exception of the local farm roads proposed to be closed;
- Where temporary road closures are required for road works, detours will be constructed around the worksite. Where it is not possible to provide a two-way detour, portable traffic signals will be used to regulate traffic flow in each direction;
- The movement of heavy vehicles, and in particular over-sized loads, will be arranged so as to minimise disruption to traffic during school bus times;
- A Traffic Management Plan will be established for the management of vehicles within and on roads heading to and from the Stage 2 Project Area, including managing the movement of over-sized vehicles, road diversions and closures, parking, pedestrians, and refuelling areas;
- Vegetation will be cleared to the west of the proposed access points on Ulan-Wollar Road to improve sight distances;
- Application will be made to MWRC to reduce the speed limit on Ulan-Wollar Road in the vicinity of the proposed access points to 70 km/hr with regulatory and advisory signs as appropriate;
- Appropriate bunding will be implemented to reduce the impact of headlight glare from mine vehicles on passing motorists on Ulan-Wollar Road (see Section 5.13 of the Stage 2 EA);
- Fuel, stores and explosives will be delivered outside of school bus service hours and peak traffic times, where possible;

- Early morning and evening shift changes will be outside school bus service times, and where feasible will be offset from existing Ulan Coal Mine and Wilpinjong Mine shift change over times to minimise peak traffic loads on the road network;
- A total financial contribution of $2.25 Million will be made by MCM to MWRC for local road upgrades and maintenance as part of its commitments for Stage 1;
- This contribution is to help partly fund local road safety improvements. Additional road maintenance contributions will be derived from the Stage 2 based on the proportional increase in additional employees required for Stage 2 (see Section 5.14 of the Stage 2 EA); and
- MCM will work with MRWC, UCML and Wilpinjong Coal Mine to generally improve road safety and traffic management on the local road network.

It is expected that these traffic management measures will improve the general road safety on local roads and minimise any potential traffic impacts that may arise from the Preferred Project.

4.17 VISUAL AMENITY AND LANDSCAPE

A visual and landscape assessment was carried out by O'Hanlon Design Pty Ltd as part of preparation of the Stage 2 EA.

The southern and south-western OOP emplacements have been relocated to a single Northern OOP emplacement, reducing potential visual impacts from the Munghorn Gap Nature Reserve.

MCM will implement the following measures to reduce the visibility of the open cut mining areas, the OOP emplacement areas and the infrastructure elements from the various publicly accessible viewpoints:

- Rehabilitation will be progressively undertaken to replace the existing native vegetation that will be removed as part of the mining process;
- Other cleared and degraded areas within MCM owned land will be revegetated to create a post-mining landscape with a greater proportion of native vegetation;
- A Landscape Management Plan including a ROMP (see **Section 4.10**) will be prepared to guide rehabilitation and revegetation efforts, and a Final Void Management Plan will be prepared to guide the final landform of the OC4 void;
- Existing vegetation will be retained around the new infrastructure areas and on road fringes of OC4 where it is not required to be thinned / cleared for safety purposes; and
- Bunding and planting along the edge of Ulan-Wollar Road in areas where it abuts OC4 however does not reduce visibility at the site access intersections.

MCM will implement the following measures to mitigate adverse night lighting impacts:

- Light columns and low brightness floodlights will be installed at a height of less than 15 m within the infrastructure areas. These will have horizontal floodlight bodies with floodlight reflectors designed to provide sharp light cut-off and restrict stray light;
- Horizontal wall mounted lights with low brightness will be used to light areas around the workshop and adjacent hardstand areas;
- All floodlights will be shielded in the open cut area to the maximum extent practicable; and
- Lighting will be screened to viewers where possible but will always be selected to initially meet safe working practices.

The visual impacts, mitigation and management practices from the Preferred Project are consistent with those presented in Section 5.13 of the Stage 2 EA.

4.18 SOCIAL AND ECONOMIC

4.18.1 Background

A socio-economic assessment was conducted to assist in the preparation of the Stage 2 EA.

Socio-economic impacts, mitigation and management practices of the Preferred Project are consistent with those presented in Section 5.14 of the Stage 2 EA and further discussed in **Section 6.6**.

Additional consultation has been carried out during the preparation of the PPR including with the CCC, Aboriginal stakeholder groups, government authorities and local landowners (as described in **Section 2.3**).

Additional consideration has been given to social impacts associated with the Preferred Project including consideration of the consultation carried out subsequent to submission of the Stage 2 EA and submissions received to further reduce impacts on and maximise benefits to the community due to the Preferred Project.

4.18.2 Issue Summary

As a result of the above consultation the main concerns identified relate to a number of environmental aspects as shown in **Table 6** and in **Appendix A,** and the following cumulative issues associated with mining:

Mudgee / Gulgong

- 'Boom and bust' population changes;
- Strain on community services;
- Housing pressures; and
- Timing of financial contributions to MWRC.

Ulan and Surrounds

- Increased pressures and decreased safety on roads;
- Property values;
- Noise, dust and blasting;
- Visual amenity;
- Population loss and loss of social cohesion;
- Tank water quality; and
- Loss of local community services in Ulan (e.g. the Rural Fire Service (RFS) and Ulan Public School).

4.18.3 Mitigation and Management

MCM will develop a Social Engagement and Issue Response Strategy designed to continue to facilitate and develop open and transparent communications between MCM and stakeholders.

In addition, MCM will enter into the agreed Voluntary Planning Agreement (VPA) with MWRC (**Appendix B**). Each is discussed further below.

Social Engagement and Issue Response Strategy

The Social Engagement and Issue Response Strategy will provide separate focus for Ulan and surrounds and the larger centres of Mudgee and Gulgong. The Social Engagement and Issue Response Strategy will aim to facilitate communications between MCM, the local and wider community, neighbouring industry, MWRC and government authorities in a structured context which will provide MCM with the tools to identify areas of need in the community and subsequently to develop robust community projects which provide support in the areas identified.

Appropriate focus will be placed on identifying concerns of the local Ulan and surrounding area residents to ensure that benefits from the MCC are returned to the community experiencing the most direct impacts wherever possible.

The Social Engagement and Issue Response Strategy will consider:

- Key stakeholders;
- Mechanisms and regularity for consultation with key stakeholders;
- Tools to engage (e.g. newsletter, open days, surveys, face to face meetings, CCC);

- New employee incentive programs to reside locally permanently;
- Community assistance programs (including sponsorship, apprenticeships, traineeships);
- Local hire policy for non-skilled positions to assist in improving local skilled labour force;
- Regular training and awareness program on traffic interactions on Ulan road with road users;
- Internal policy on car pooling and consider providing a bus from Mudgee to coincide with shift changes; and
- Utilisation of local goods and service providers where practical.

While the Social Engagement and Issue Response Strategy will be the key to identifying areas of concern for the community, the investment in social strategies will occur largely through the VPA with MWRC.

Voluntary Planning Agreement

MCM has developed a VPA for Stage 2 in consultation with MWRC which provides financial support in areas identified through the Social Engagement and Issue Response Strategy.

MCM's contributions to MWRC in order to assist in the facilitation of community infrastructure directly related to the MCC in accordance with Section 93F(2) of the EP&A Act will equate to a total of $5.915 Million for Stage 1 and 2 combined. The Stage 2 VPA includes a monetary contribution of $1.365 Million to be paid to MWRC, which has been advertised and agreed to by MWRC.

It is anticipated that focus areas for support of residents from Ulan and surrounds will be:

- Investment in improving local roads;
- Employee road safety and awareness training;
- Encouraging car pooling and consideration of running a bus to coincide with shift changes;
- Best practice environmental management; and
- Community services and facilities (e.g. the Rural Fire Service and Ulan Public School).

Additional Mitigation and Management

MCM is committed to supporting the neighbouring community and will provide this support though making available fire fighting personnel and equipment in the event of a fire.

MCM will also focus areas of social impact mitigation for the Mudgee / Gulgong area, in consultation with MWRC where appropriate, through:

- Encouraging permanent relocation of employees to the Mudgee / Gulgong area through incentive schemes;
- Provision of monetary support to community services and facilities with emphasis on medical, education and childcare facilities;
- Improvements to local infrastructure including roads and airport; and
- Training and employment strategies with a focus on local hires, and relocation of skilled workers to the Mudgee / Gulgong area.

4.19 HAZARDOUS AND RISKS

A hazards analysis was carried out by Sinclair Knight Merz Pty Ltd as part of preparation of the Stage 2 EA. The Preferred Project potential hazard impacts, mitigation and management practices are consistent with that proposed in Section 5.15 of the Stage 2 EA.

The hazard and consequence analysis concluded that all identified hazards in the surface mine and pit top facilities do not have the potential to impact off-site due to the application of buffer zones around the open cut workings, and the location of the site explosives magazine well clear of the site boundary.

The impact of bushfires that start on non-MCM land but affects MCM land requires management, as detailed below. However, of more concern is the potential increase in ignition sources due to Stage 2 as a result of undertaking routine construction and operational activities such as the use of machinery in vegetated lands or the undertaking of hot works under inappropriate conditions.

The increase in incidence of accidental or deliberate human-related ignition sources may result in social, economic and ecological impacts to the mine and adjoining areas.

A number of risk reduction management and hazard mitigation strategies and site emergency responses have been prepared and include:

- The potential incidents listed in the Hazard Analysis will be included in the Site Emergency Response Plan, along with other incidents identified to have on-site impact to mine equipment and personnel;
- During the regular emergency response drills, conducted as part of the Emergency Rescue Team (ERT) exercises, the hazards will be included in the drill exercises to ensure ERT readiness;
- Fire in vehicles would be a potential hazard on-site, and fire growth has the potential to result in serious damage to occupants and vehicles. All vehicles on-site will be fitted with at least one dry powder type extinguisher. Larger vehicles will carry at least one 9 kg dry powder extinguisher and smaller vehicles at least one 4.5 kg dry powder extinguisher; and
- All staff, contractors and visitors will be required to comply with relevant legislation to ensure that the MCC is a safe place to work and visit.

An integrated bushfire management plan will be developed and implemented for the MCC. This will include the establishment of fire management zones and perimeter roads or management tracks.

The availability of fire suppression assets such as water carts, dozers and static water storages will be defined in relation to the needs of local fire management organisations (i.e. NPWS and Rural Fire Service) to maximise the control of unplanned bushfire events.

Both these management strategies will consider the management regimes prescribed for Goulburn River National Park and Munghorn Gap Nature Reserve to ensure maximum consistency with the conservation objectives for these areas.

4.20 WASTE

A waste assessment was carried out as part of preparation of the Stage 2 EA.

The Preferred Project waste impacts, mitigation and management practices are consistent with those determined in Section 5.16 of the Stage 2 EA.

Waste generated by the Preferred Project will include general rubbish; sewage from offices, workshops and bathhouses; scrap timber from pallets and boxing; waste batteries and tyres; waste oil and filters; and empty drums and scrap metals. Some of these wastes will be recyclable. MCM will develop and implement a Waste Management Plan for general waste for the MCC.

Preferred Project mining operations will also lead to the generation of overburden waste rock, and the processing of Stage 2 coal will lead to the generation of coarse rejects and tailings from the CHPP. These waste materials will be managed and disposed of on site.

4.21 LAND USE

A rural land capability and agricultural suitability assessment was carried out by JAMMEL as part of preparation of the Stage 2 EA. Land use impacts, mitigation and management practices for the Preferred Project are consistent with those in Section 5.17 of the Stage 2 EA.

The predominant land use impacts associated with the Preferred Project will be the progressive loss of Class 3 agricultural land due to the mining and subsequent rehabilitation of Stage 2, and the progressive loss of areas of native vegetation due to mining.

All currently cleared areas within the Murragamba and Eastern Creek valleys, including areas within and outside the disturbance area, will be revegetated.

The objective for the post- mining land use is to create a landscape of natural woodlands and grasslands as detailed in **Section 4.10**. Hence the Preferred Project will result in the permanent loss of low class agricultural lands in these valley floor areas.

However, the rehabilitation and revegetation initiatives that will be implemented in these areas will improve the quality of the land compared to its current condition, and increase the ecological and biodiversity values of the land.

4.22 REHABILITATION

A Rehabilitation strategy was outlined in Section 5.18 of the Stage 2 EA. Rehabilitation commitments are consistent with those provided in Section 5.18 of the Stage 2 EA. Additionally, in response to a request from DP&I, MCM has prepared a revised Rehabilitation Strategy for the Preferred Project which is reproduced in **Appendix K**.

The revised Rehabilitation Strategy outlines the rehabilitation objectives and principles to be applied to the Preferred Project.

In addition, the revised Rehabilitation Strategy provides information on the approach that will be adopted in rehabilitating the post-mining landscape to achieve a stable, natural looking, vegetated and ecologically diverse post-mining landscape.

The revised Rehabilitation Strategy will be further revised and incorporated into a ROMP for the MCC to the approval of relevant regulators.

The overall rehabilitation objective for the Preferred Project is to restore mine-disturbed land to a naturally vegetated state using appropriate endemic species to improve biodiversity and general environmental outcomes in the area, post-mining. In addition to rehabilitating mine impacted areas, MCM will also improve existing degraded and cleared land within its ownership outside the mine disturbance footprint.

The specific rehabilitation objectives for the Preferred Project include:

- Creating a natural, stable and well drained post-mining landform that is visually consistent with surrounding areas;
- Creating a self sustaining and ecologically diverse post-mining landscape that is compatible with the conservation values of the adjacent Munghorn Gap Nature Reserve and Goulburn River National Park;
- Revegetating and enhancing remnant vegetation on non-mined land under MCM's control with endemic native species so as to increase the amount of native woodlands;
- Creating wildlife corridors and habitat links between existing remnant vegetation in the Munghorn Gap Nature Reserve, Goulburn River National Park and other surrounding areas by increasing the continuity of woodland vegetation;
- Maintaining the diversity and genetic resource of flora currently existing within the locality;
- Maintaining and enhancing habitat for native fauna;
- Realigning and rehabilitating Murragamba and Eastern creeks to be hydraulically and geomorphologically stable and ecologically diverse;
- Rehabilitating degraded riparian areas along Wilpinjong Creek and along Murragamba and Eastern creeks downstream from mined areas within the Stage 2 Project Boundary;
- Reinstating subsidiary surface drainage;
- Improving soil condition and native seed bank;
- Preventing soil erosion and sedimentation;
- Providing access for monitoring and adaptive management, control of competitive native and exotic flora and fauna species and suppression of fires; and

- Progressing towards meeting closure and post-mining land use objectives (to be developed in consultation with stakeholders and described in a detailed Mine Closure Plan) in a timely and cost effective manner.

To achieve these objectives, MCM will:

- Progressively rehabilitate mined areas as soon as practical following completion of mining;
- Temporarily rehabilitate and revegetate degraded areas ahead of mining to improve soil structure, organic content, nutrient levels and native seed bank, where practicable;
- Progressively divert, realign and rehabilitate Murragamba and Eastern creeks to maintain and enhance creek aquatic and riparian ecological function and connectivity;
- Develop and implement a detailed land management and rehabilitation plan which aims to improve local biodiversity values and restore key ecological function; and
- Develop a monitoring and maintenance program to guide rehabilitation success and provide continual improvement to meet the long-term post-closure land use objectives.

All cleared and disturbed land under MCM's control will be rehabilitated with native open woodland, shrub land and grass species, including endemic C/EEC species further detailed in **Section 4.10**.

A conceptual final landform demonstrating the connectivity between neighbouring mine rehabilitation and offset strategies with the MCM offset strategy and site rehabilitation is provided in **Figure 19**.

4.23 MINE CLOSURE

Mine closure was considered as part of preparation of the Stage 2 EA. Mine closure intentions for the Preferred Project are consistent with those outlined in Section 5.19 of the Stage 2 EA.

The objective for mine closure is to leave the MCC in a condition that is safe, stable and limits further environmental impacts so that mining tenements can be relinquished for alternative land uses.

Prior to the completion of Stage 2 mining operations, an integrated Mine Closure Plan will be developed for the MCC in consultation with the relevant authorities and stakeholders. This will address the key issues of safety, environmental issues, financial expectations and future land uses.

5 REVISED STATEMENT OF COMMITMENTS

MCM commits to the operational controls outlined in **Section** 4 of this PPR for all activities associated with Stage 2 (as modified by this PPR).

Table 33 summarises the major aspects of the Stage 2 (as modified by this PPR) and summarises the key proposed management and mitigation measures to apply to the MCC. This Statement of Commitments replaces that presented in the Stage 2 EA.

Table 33
Preferred Project Statement of Commitments

Ref	Commitment	Section
	Mining Operations	
1.	MCC will extract coal at a combined rate of up to 17 Mtpa ROM coal comprising up to 13 Mtpa ROM coal from open cut operations (up to 8 Mtpa ROM coal from Stage 1 OC's and up to 12 Mtpa ROM coal from Stage 2 OC) and up to 4 Mtpa from UG mines for 24 years, generally in accordance with the Stage 2 EA and this PPR.	**3**
2.	MCM will ensure its existing Stage 1 excavator and haul truck fleet is suitably attenuated by the end of 2012 and all new mining fleet bought to site will be fully attenuated before being operated to ensure MCC noise levels at private receivers are maintained below PSNC.	**4.4**
3.	MCM will seek the appropriate licences and approvals as relevant to the Preferred Project and listed in **Table 5**.	**4**
	Environmental Management	
4.	MCM will revise the Stage 1 Environmental Management System to incorporate the MCC. This will be carried out in consultation with relevant regulators (and the Aboriginal community where relevant) as required by the Project Approval, and may require revision or preparation of: • Environmental Monitoring Program; • Air Quality and Greenhouse Gas Management Plan (including energy savings actions); • Spontaneous Combustion Management Plan; • Noise Management Plan; • Blast Management Plan; • Water Management Plan (including groundwater and surface water); • Creek and Aquatic Rehabilitation Plan; • Rehabilitation and Offset Management Plan (including Land Disturbance Protocol, Final Void Management and Mine Closure); • Subsidence Management Plan; • Aboriginal Heritage Management Plan; • Non Aboriginal Heritage Management Plan; • Erosion and Sediment Control Plan; • Social Engagement and Issue Response Strategy; • Bushfire Management Plan; and • Waste Management Plan.	**4**

Ref	Commitment	Section
	Air Quality	
5.	MCM will utilise technologies and initiatives as discussed in **Section 4.1.4** to achieve the air quality outcomes described in **Table 14** of this PPR.	**4.1**
	Greenhouse Gas	
6.	MCM will undertake regular revision of energy efficiency initiatives as discussed in **Section 4.2.3** to ensure that Scope 1 greenhouse gas emissions per tonne of product coal are kept to the minimum practicable level.	**4.2**
	Noise and Blasting	
7.	MCM will conduct extensive field studies over a six month period to the approval of OEH and DP&I to confirm that the calibration factor applied to its noise model is appropriate. Should the additional calibration and monitoring show that a calibration factor is not appropriate, MCM will seek agreements or acquire privately owned properties predicted to receive levels above acquisition criteria, to the satisfaction of DP&I.	**4.4**
8.	MCM will implement noise control and management measures as listed in **Section 4.4.4** to achieve the PPR predicted noise levels at private receivers as listed in **Table 17** and **Table 18**.	**4.4**
9.	MCM will restrict coal extraction and coal haulage in OC2 and OC3 to the day period only.	
10.	MCM will work cooperatively with neighbouring mines to develop a blast monitoring system which is representative of the closest sensitive receivers to ensure compliance with the relevant blast criteria.	
	Water Resources	
11.	MCM will implement the water management and mitigation measures as discussed in this PPR.	**4.6, 4.7** and **4.8**
12.	In the event that it is demonstrated that water levels in existing landholder bores decline as a consequence of the Project, MCM will seek to determine the cause of the impact through engagement of a hydrogeologist who will recommend an appropriate action response plan.	
13.	MCM will continue to monitor groundwater impacts on surrounding privately owned bores. In the event that it is demonstrated that water levels in existing landholder bores decline as a consequence of the Project, leading to an adverse impact on water supply, the supply will be substituted by MCM in consultation with the landholder.	
14.	MCM will develop a surface water monitoring program to quantify the streamflow and water quality characteristics within Murragamba and Eastern Creeks for existing conditions prior to mining of the creek lines.	
15.	Collated groundwater monitoring data will be reviewed annually to assess the impacts of the MCC on the groundwater environment and to compare observed impacts with those predicted from groundwater modelling.	**4.6**
16.	Groundwater modelling post-audit will be carried out 2 years (and 5 yearly thereafter) after commencement of Stage 2 production. Should any groundwater review or post-audit indicate a significant variance from the model predictions, an appropriate response will be implemented in consultation with NOW, DP&I and OEH.	**4.6**

Ref	Commitment	Section
17.	MCM will endeavour to implement an integrated monitoring program for the MCC, with UCML and Wilpinjong Coal Mine for data-sharing.	**4.6**
18.	MCM commits to realign and reconstruct the mined sections of Murragamba Creek and Eastern Creek to be geomorphologically, hydraulically and ecologically sound, to the satisfaction of the OEH.	**4.9**
	Ecology	
19.	MCM will implement the ecological management and mitigation measures described in **Section 4.10** of the PPR**.**	**4.10** and **4.11**
20.	MCM will progressively rehabilitate mined areas with a focus on the re-establishment of Box Gum Woodland.	
21.	MCM will establish the Biodiversity Offset Strategy as described in this PPR to initially maintain and ultimately improve ecological values.	
	Aboriginal Archaeology and Cultural Heritage	
22.	The salvage and the protection of all known Aboriginal objects within the Project Boundary will be managed in accordance with **Appendix J** of this PPR developed in consultation with the local Aboriginal community and OEH.	**4.12**
23.	MCM will manage the Aboriginal conservation zones as outlined in this PPR.	
	Traffic and Transport	
24.	Early morning and evening shift changes will be outside school bus service times, and where feasible will be offset from existing Ulan and Wilpinjong mine shift changes over time to minimise peak traffic loads on the road network.	**4.16**
25.	MCM will work with MRWC and Ulan and Wilpinjong coal mines to generally improve road safety and traffic management on the local road network.	
	Visual	
26.	Rehabilitation will be carried out on disturbed areas as soon as practical after disturbance with emphasis on bunding and the OOP emplacement area.	**4.17**
27.	Infrastructure lighting will consist of horizontal lights with hoods and louvers in elevated and exposed areas utilising low brightness lights to the level necessary for operational and safety requirements to minimise adverse night lighting impacts.	
	Community	
28.	MCM will implement the VPA as agreed with MWRC for Stage 2 of the MCC.	**4.18**
29.	MCM will consult with the community, neighbouring industry and government authorities in relation to the MCC.	
30.	MCM will employ appropriately qualified persons residing in the MWRC area where feasible. MCM will also provide traineeships for young people residing in the MWRC area.	
	Reporting	
31.	MCM will prepare an Annual Review (which summarises monitoring results and reviews performance) and distribute it to the relevant regulatory authorities and the MCM CCC.	**4**

6 CONCLUSION

6.1 OVERVIEW

In 2008, MCM lodged PA 08_0135 under Part 3A of the EP&A Act with the Minister for Planning for the development and operation of Stage 2 of the MCC comprising OC4, UG1 and UG2 and associated infrastructure.

If approved, Stage 2 would operate with and utilise the surface facilities of the adjoining Stage 1 as a single, integrated open cut and underground coal mine known as the MCC.

The Stage 2 EA also supported an application for the modification to PA 05_0117 (M3) in respect of Stage 1 to facilitate the operation of Stage 1 and Stage 2 as the MCC. This would authorise Stage 1 accepting, processing and loading coal from Stage 2 operations as well as extending the life of the Stage 1 approval to coincide with the life of Stage 2.

MCM also seeks the determination of EPBC Referral (No 2008/4444).

6.2 STAGE 2 APPLICATION

PA 08_0135 and the supporting Stage 2 EA sought approval for, and assessed the environmental and social issues related to Stage 2 in accordance with the EP&A Act and in response to the Stage 2 DGRs.

The Stage 2 proposal generally comprised the following:

- Employment of an additional 122 staff above the 317 to be employed within Stage 1;
- Mining life of 27 – 28 years;
- Recovery of up to 13 Mtpa of product coal (approximately 17 Mtpa ROM) from Stage 1 and Stage 2;
- OC 4 within the Murragamba Valley;
- UG 1 and UG 2;
- Supporting facilities and infrastructure integrated with those approved in Stage 1;
- Relocation of Ulan-Wollar Road, Carrs Gap and Murragamba Road;
- The partial relocation of Murragamba and Eastern Creeks;
- The rehabilitation and revegetation of disturbance areas; and
- Offset of impacts to Threatened biodiversity.

6.3 ASSESSMENT OF STAGE 2 APPLICATION

The Stage 2 application was placed on public exhibition and considered by the relevant agencies as well as selective independent peer review by experts appointed by DP&I.

The review and assessment process identified some areas where, without changing the essential nature of Stage 2 or the resultant MCC, changes could result in better environmental outcomes.

The result of this environmental assessment process is the Preferred Project and this PPR. The PPR is a 'stand alone' document describing and assessing the Preferred Project, its effects, as well as the relationship to the originally proposed Stage 2. The PPR describes its environmental effects and environmental gains achieved by the adoption of the Preferred Project as compared to the originally proposed Stage 2 and the resultant MCC.

6.4 THE PREFERRED PROJECT

Table 8 of this PPR provides a detailed analysis of the changes proposed to the Stage 2. The material environmental outcome improvements achieved by the Preferred Project, as compared to Stage 2 are as follows:

- Amendments to the footprint of OC4 to minimise impacts to C/EEC;
- Relocation of two proposed southern OOP emplacements to a northern location, thereby significantly reducing impacts to C/EEC;

- Deferral of the timing of and reduction to the extent of the relocation of Murragamba Creek thereby materially reducing impacts on the creek;
- Relocation of the stage 2 ROM coal facilities to a location closer to OC4 reducing noise and dust;
- Installation of conveyors to transfer coal and rejects to / from the existing CHPP reducing noise and dust; and
- Other minor amendments to locations of items of infrastructure within a defined Project Disturbance Boundary.

6.5 ENVIRONMENTAL ASSESSMENT AND OUTCOMES

6.5.1 Approach

In assessing the Preferred Project, key environmental impact assessments were revisited and reconsidered in the context of the Preferred Project. Further, the potential cumulative effects of the operation of the MCC in an environment that now includes cumulative impacts potentially arising due to recent planning approvals at the adjacent UCML and Wilpinjong Coal Mine have been considered.

6.5.2 Air Quality

The air quality assessment in Section 5.1 of the Stage 2 EA concluded *"Dust criteria are predicted to be exceeded at five privately-owned residences … Dust (and/or noise) criteria were predicted to be exceeded at each of these premises in Stage 1 and as a result these land owners all have acquisition rights under the Stage 1 Project Approval.*"

In addition to the mitigation and management measures proposed in the Stage 2 EA, the Preferred Project proposes the conveyor transfer of ROM coal from OC4 and increased dust suppression and best practice measures for control of dust emissions.

The Preferred Project minimises its environmental impact in relation to air quality. **Section 4.1.3** of this PPR concludes that the air quality criteria will not be exceeded at any privately owned receiver which is not already subject to acquisition upon written request under the existing Stage 1 PA 05_0117.

6.5.3 Greenhouse Gas

Section 5.2 of the Stage 2 EA predicted combined Scope 1, 2 and 3 annual emissions of 29,585,000 (t CO2-e). The Scope 3 emissions assessment is included despite the fact that they are only an estimate based on assumptions which will be unlikely to be correct as the coal will be burnt by others as part of other development in a manner and at a time which is not known to MCM.

Section 4.2.2 of this PPR predicts, on the basis of the above assumptions, annual average emissions of 23,701,709 (t CO2-e). The 5,883,291 (t CO2-e) reduction in CO2-e emissions from the Preferred Project result not only from the use of site specific methane data and an improved resource definition but also from the mitigation and management measures stipulated in **Section 4.2.3** of this PPR.

6.5.4 Noise

Section 4.1.3 of this PPR predicts that PSNC may be exceeded under a worst case modelling scenario at up to 29 private residences due to operation of the MCC. This revised prediction has been generated based upon the extensive utilisation of noise monitoring, modelling and mine planning undertaken since the Stage 2 EA was prepared utilising real data from Stage 1 operations.

Consideration of the Preferred Project alone results in exceedance of the PSNC at 13 residences (zero significant, 10 minor and three moderate) and zero significant properties over greater than 25% of contiguous land in a single land ownership. All other privately owned receivers predicted to experience impacts greater than PSNC, are as a result of Stage 1 operations or the combined operation of the MCC.

The noise assessment re-evaluated the MCC and determined that two properties had a potential to receive significant exceedances, 11 properties moderate impacts and 16 properties minor exceedances of relevant criteria due.

MCM is seeking noise compensation agreements with all neighbours which have been predicted to experience significant and moderate impacts.

6.5.5 Blasting

A blast impact assessment has been carried out and confirmed that blasting effects from the Preferred Project are not predicted to change from those predicted in the Stage 2 EA. A Blast Management Plan is proposed which will assist in the mitigation and management of blasting impacts.

6.5.6 Groundwater

The groundwater model has been recalibrated to incorporate the changes to the mine plan associated with the Preferred Project and UCML EA and also to incorporate comments received during the exhibition of the Stage 2 EA and from the independent peer review.

6.5.7 Surface Water

Additional information has been provided to address submissions received during the exhibition of the Stage 2 EA and from the independent peer review.

6.5.8 Water Balance

The operation of Stage 1 has enabled the calibration of the water model used for the Stage 1 EA and Stage 2 EA. Further investigation of the production capacity of the Northern Borefield and entry into a water sharing agreement with the adjoining UCML has provided further security in relation to the deficit predicted in the Stage 2 EA water balance.

Consistent with the Stage 2 EA, in the unlikely event that insufficient water is available from any of the above sources; mining operations will be adjusted to meet the available water supplies. This would be achieved either by adjusting the mine production schedule.

6.5.9 Creek Realignment

The design of the realignment of Murragamba and Eastern Creeks described in **Appendix G** results in the avoidance of the relocation of 2.7 km Murragamba Creek as compared to that proposed in the Stage 2 EA.

The avoidance of this section of creek allows for the conservation of additional C/EEC and Aboriginal heritage sites. The extent of the Aboriginal Heritage Conservation Zone located on Murragamba Creek is able to be extended to encompass further sites as a result of the site layout changes.

The revised design of the realignment, which results from changes to the mining sequence of OC4, has resulted in the deferment of the realignment of Murragamba Creek for up to seven years. The change in mine sequence in OC4 will also provide additional time for the stabilisation of the creek diversion prior to reinstating flows.

6.5.10 Ecology

The Preferred Project will avoid impacts to 33.5 ha of Box Gum Woodland and Derived Native Grassland C/EEC along with other reduced impacts to remnant vegetation to that proposed in the Stage 2 application.

The new Preferred Project Biodiversity Offset Strategy described in **Appendix H** will achieve an offset ratio of five hectares to each hectare of C/EEC proposed to be disturbed and an offset ratio of three hectares to each hectare of native vegetation proposed to be disturbed. This is a material increase in offsets compared to the Stage 2 EA proposals of two hectares to each hectare of C/EEC proposed to be disturbed; and one hectare to each one hectare of native vegetation proposed to be disturbed.

The Biodiversity Offset Strategy proposed as part of this PPR implements all reasonable and feasible measures to avoid, mitigate and compensate impacts to ecology.

Redesign of OC4 has lead to a direct reduction in 33.5 ha in impacts to the Boxgum Woodland and Derived Native Grassland C/EEC along with other reduced impacts to native vegetation.

The continued implementation of the Land Disturbance Protocol as part of the ROMP will ensure avoidance and mitigation measures are employed in the longer term.

Three individual properties and areas of land surrounding the Preferred Project totalling 3,516 ha are proposed as compensation for the 902 ha proposed to be disturbed.

These comprise 620 ha of C/EEC Box Gum Woodland and Derived Native Grassland which achieves the overall Biodiversity Offset Strategy goals of 5:1 for C/EEC and 3:1 for native vegetation. This will ensure the improvement of biodiversity in the region in the medium to long term.

6.5.11 Subsidence

The Subsidence Impact Assessment has been revised in consideration of the Preferred Project. Generally, subsidence effects remain unchanged from those assessed in the Stage 2 EA with the exception of the location of the Northern OOP emplacement area located above UG1 rather than the previously proposed south-western OOP emplacement area located above UG2.

6.5.12 Aboriginal Archaeology and Cultural Heritage

Section 5.9 of the Stage 2 EA concluded that a total of 258 Aboriginal heritage sites were identified within the Project Boundary in the ARAS Report. Of these Aboriginal heritage sites, 194 occur within the proposed Project Disturbance Boundary.

Amendments to the footprint of OC4 and the Murragamba Creek diversion have resulted in a net reduction in the impact to 14 Aboriginal heritage sites of which seven are of high significance and seven are of medium significance.

The reduction in the extent of the relocation of Murragamba Creek also provides an increased opportunity for preservation of Aboriginal objects, specifically along Murragamba Creek.

Consultation was undertaken with the local registered Aboriginal community in relation the changes to impacts. Requests for further excavation during salvage for particular sites have been included in the management measures described in this PPR.

6.5.13 Non - Aboriginal Heritage

There is no change to the assessment of effects on non Aboriginal Heritage due to the Preferred Project.

6.5.14 Soils and Land Capability

The assessment of Soils and Land Capability in the Stage 2 EA remains unchanged.

6.5.15 Transport

The Preferred Project makes a minor change to the site access but that has no material effect on the transport assessment in the Stage 2 EA.

6.5.16 Visual Amenity and Outcome

The visual amenity of the Preferred Project remains unchanged.

6.5.17 Rehabilitation and Mine Closure

The PPR has advanced the proposal for mine rehabilitation by the adoption of a best practice and revised rehabilitation strategy that will result in a more uniform approach to the rehabilitation of the whole of the MCC. Proposals as to mine closure remain unchanged.

6.5.18 Social

The PPR describes the social engagement that occurred in the development of this PPR which has lead to improved identification, strategies for and responses to social issues.

6.5.19 Voluntary Planning Agreement

MCM has undertaken further consultation with stakeholders since the preparation of the Stage 2 EA. This will be utilised to develop a Social Engagement and Issue Response Strategy.

In addition to the $4.55 Million committed under the VPA for Stage 1 and for which payments commenced with the first shipments of coal and continue, the agreement with the MWRC is for a VPA under which MCM will pay a lump sum amount of $1.365 Million.

This VPA to MWRC will assist in the provision of public amenities or public services, affordable housing or transport or other infrastructure directly related to the Preferred Project.

6.5.20 Commitments

MCM has reviewed the project commitments made by it as to the manner in which it will operate Stage 2 and the MCC in the event that approval is granted to ensure that the MCM is operated in the best manner practical.

6.6 JUSTIFICATION

6.6.1 Economics

The Stage 2 EA reported on the Socio-economic benefits that would be derived for the community from the operation of the Stage 2 development as part of the MCC. These are summarised as follows:

- Construction expenditure of $120 Million (in 2008 dollar values);
- The construction of Stage 2 (with Stage 1) will stimulate additional regional production and consumption of $260 Million, providing a total benefit to the region of $584 Million;
- Annual revenue of $780 Million from the MCC when Stage 2 is operating at full capacity will stimulate further regional production and consumption of approximately $731 Million, providing a total annual benefit of $1.5 Billion;
- Tax revenues during the construction of the MCC will be approximately $54 Million. This will consist of $29 Million of income tax, $9 Million from indirect taxes, $8 Million from company tax and payroll tax of approximately $8 Million. This is 2.8 times greater than the 2006 estimated benefit of Stage 1 alone;
- When Stage 2 is operating at full capacity, it is estimated that Federal Government tax revenue from the MCC will be $98 Million. This will consist of $60 Million of income tax, $19 Million from indirect taxes and $20 Million from company tax. State Government revenue from payroll tax is estimated to be $17 Million and coal royalties approximately $47 Million. The total public sector benefit will therefore be approximately $146 Million;
- Over the life of the mine, Stage 2 will increase the expected total of tax revenue by 55% compared to Stage 1 alone and will provide an approximate three-fold increase in royalty revenues;
- Employment opportunities, focusing on opportunities for locals, which will generate wealth impacts allowing individuals and families to enhance their quality of life;
- The MCC will directly employ 220 construction workers. A further 184 full-time positions will be indirectly generated through increased production and consumption;
- At the peak of the operational phase, Stage 2 will potentially generate an additional 120 full time positions (in addition to Stage 1 positions). In total, the MCC will employ up to 439 people directly. Additional regional production and consumption will generate a further 847 and 585 jobs respectively, an induced employment benefit of 1,432 jobs; and
- Payments to MWRC under the proposed VPA will offset any increase in the demand for their services.

The Preferred Project will deliver economic benefits at regional, state and federal levels as well as to other stakeholders which equate to a total annual benefit of $1.5 Billion (Stage 2 EA 2009).

6.6.2 Environmental

The environmental issues identified in the exhibition and assessment of Stage 2 has been addressed. The operation of the MCC with Stage 2 operated as proposed as the Preferred Project achieves material beneficial environmental enhancements from that which was originally proposed in the Stage 2 EA.

The environmental effects have been identified with certainty in compliance with the precautionary principle.

The design of the development maximises the recovery of the valuable coal resource in a manner and with controls that ensure that the environmental costs have been accepted and provided for in the design and the operational methods.

This PPR has considered the potential impacts of the Preferred Project in relation to the existing environment, regulatory framework (in accordance with the latest guidelines) and in consideration of all potential cumulative impacts and adopts best practice mitigation and management.

6.7 SUMMARY

The exhibition and assessment of the Stage 2 EA identified a number of environmental issues. These issues have been addressed by this Preferred Project resulting in a number of material environmental enhancements and reductions in environmental effects.

The Preferred Project has been designed and assessed in accordance with the principles of 'ecologically sustainable development' being 'intergenerational equity', 'value pricing', maintenance of 'biodiversity' and the 'precautionary principle'.

This PPR demonstrates that the modifications made in response to regulators and community submissions to the Stage 2 EA, have minimised its environmental impacts and provides improved environmental outcomes, yet remain consistent with that proposed in the Stage 2 EA.

The Preferred Project maximises the recovery of coal while minimising the environmental effects.

In securing the environmental benefits the Preferred Project remains materially the same as the originally proposed Stage 2 achieving the same resource recovery and level of production despite the environmental enhancements.

Consequently, the economic benefits remain the same while the environmental effects are, in a number of areas, materially reduced.

MCM also seeks approval under Section 133 of the EPBC Act for Stage 2. This PPR also supports the Section 133 Application under the EPBC Act. MCM believes that this PPR has demonstrated that the Preferred Project satisfies the 'substantially the same development' requirement and addresses the additional ecological mitigation requirements of SEWPaC.

This PPR provides additional information to enable the NSW Minister for DP&I and SEWPaC to determine the Project Application 08_0135 and EPBC Referral (No 2008/4444), respectively as sought.

7 ABBREVIATIONS

Abbreviation	Description
ANZECC	Australian and New Zealand Environment and Conservation Council
ARAS	Archaeological Risk Assessment Services
CCC	Stage 1 Community Consultative Committee
C/EEC	Critically Endangered Ecological Community and Endangered Ecological Community
CHPP	Coal Handling and Preparation Plant
dBA	The peak sound pressure level, expressed as decibels (dB) and scales on the 'A-weighted' scale, which attempts to closely approximate the frequency response of the human ear
DP&I	NSW Department of Planning and Infrastructure (formerly DoP)
DTIRIS	Department of Trade and Investment, Regional Infrastructure and Services
EA	Environmental Assessment
EEC	Endangered Ecological Community
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	Environmental Protection Licence
ESD	Ecologically Sustainable Development
ha	Hectare
HVAS	High Volume Air Sampler
INP	*NSW Industrial Noise Policy 2000*
LA_1	The noise level exceeded for 1% of the time
LA_{10}	A noise level exceeded for 10% of the time
LA_{90}	Commonly referred to as the background noise, this is the level exceeded 90% of the time
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period
Mbcm	Million bank cubic metres
MCC	Moolarben Coal Complex (Stage 1 and Stage 2 combined)
MCM	Moolarben Coal Mines Pty Limited
MCP	Moolarben Coal Project
ML	Mining Lease
Mt	Million tonnes
Mtpa	Million tonnes per annum
MWRC	Mid-Western Regional Council
OC	Open Cut
OEH	Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water)
OOP	Out of Pit
PM_{10}	Particulate Matter <10 microns

Abbreviation	Description
PPR	Preferred Project Report
Project Boundary	Project Application Boundary
PSNC	Project specific noise criteria
RBL	Rating Background Level
Receiver	Private property adjacent the Project Boundary containing a receiver
RL	Reduced Level
Roads Act	*Roads Act 1993*
ROM	Run of Mine
ROMP	Rehabilitation and Offset Management Plan
RTA	NSW Roads and Traffic Authority
RTS	Responses to Submissions
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities (formally Commonwealth Department of Environment, Water, Heritage and the Arts)
Stage 1	Stage 1 of the Moolarben Coal Project
Stage 1 EA	Stage 1 Environmental Assessment
Stage 2	Stage 2 of the Moolarben Coal Project
Stage 2 EA	Stage 2 Environmental Assessment
TEOM	Tapered Element Oscillating Microbalances
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total Suspended Particulates
UCML	Ulan Coal Mine Limited
UG	Underground
VPA	Voluntary Planning Agreement
WSA	Water Sharing Agreement
WVWAC	Wellington Valley Wiradjuri Aboriginal Corporation
ZOA	Zone of Affectation

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9 STUDY TEAM

Section	Component / Role	Team Member and Company	
Project Management			
	General Manager – Moolarben Coal	Frank Fulham	Moolarben Coal
	Manager Environment and Community	Steve Peart*	
	Approvals Manager	Michael Moore**	
	Technical Services Manager	Bruce Birchall	
PPR Management			
	Project Director	Dianne Munro	Hansen Bailey
	Project Manager	Belinda Hale	
	Project Coordinator	Jason Martin	
PPR Sections			
1	Overview	Dianne Munro	Hansen Bailey
2	Background	Belinda Hale	
3	Preferred Project	Belinda Hale	
4	Impacts, Management and Mitigation	Jason Martin and Belinda Hale	
5	Statement of Commitments	Dianne Munro	
6	Conclusion	Dianne Munro	
7	Abbreviations		
8	References		
9	Study Team		
Appendices			
Appendix A	Table of Submissions	-	Moolarben Coal
Appendix B	Stakeholder Consultation	Steve Peart Belinda Hale	Moolarben Coal Hansen Bailey
Appendix C	Air Quality Impact Assessment	Judith Cox and Phillip Henschke	PAEHolmes
Appendix D	Environmental Noise Assessment	Jeremy Welbourne and Tony Welbourne	Global Acoustics
Appendix E	Groundwater Impact Assessment	Peter Dundon, Craig Schultz, Katarina David and Andrew Fulton	RPS Aquaterra

Section	Component / Role	Team Member and Company	
Appendix F	Supplementary Surface Water Investigations Including Water Balance Modelling	Chris Thomas and Andrew Morris	Worley Parsons
Appendix G	Concept Design for Proposed Diversions of Murragamba and Eastern Creeks	Chris Thomas and Andrew Morris	Worley Parsons
Appendix H	Biodiversity Offsets Strategy	Dr David Robertson and Arianne Weiss	Cumberland Ecology
Appendix I	Subsidence Impact Assessment	Peter DeBono	Mine Subsidence Engineering Consultants
Appendix J	Aboriginal Archaeology and Cultural Heritage Addendum	Susan Lampard Luke Kirkwood	AECOM
Appendix K	Rehabilitation Strategy	-	Moolarben Coal (reviewed by Hansen Bailey)
Legal Advice provided by Sparke Helmore Drafting and Graphics Design by Pegasus Technical Pty Limited and Graphics Design			

**Steve Peart left MCM in September 2011. Following Steve's departure, Phil English of Minespex has been Acting Environment Community Relations Manager*

***Michael Moore is the Approvals Manager at Yancoal Australia's Ashton Coal Mine*