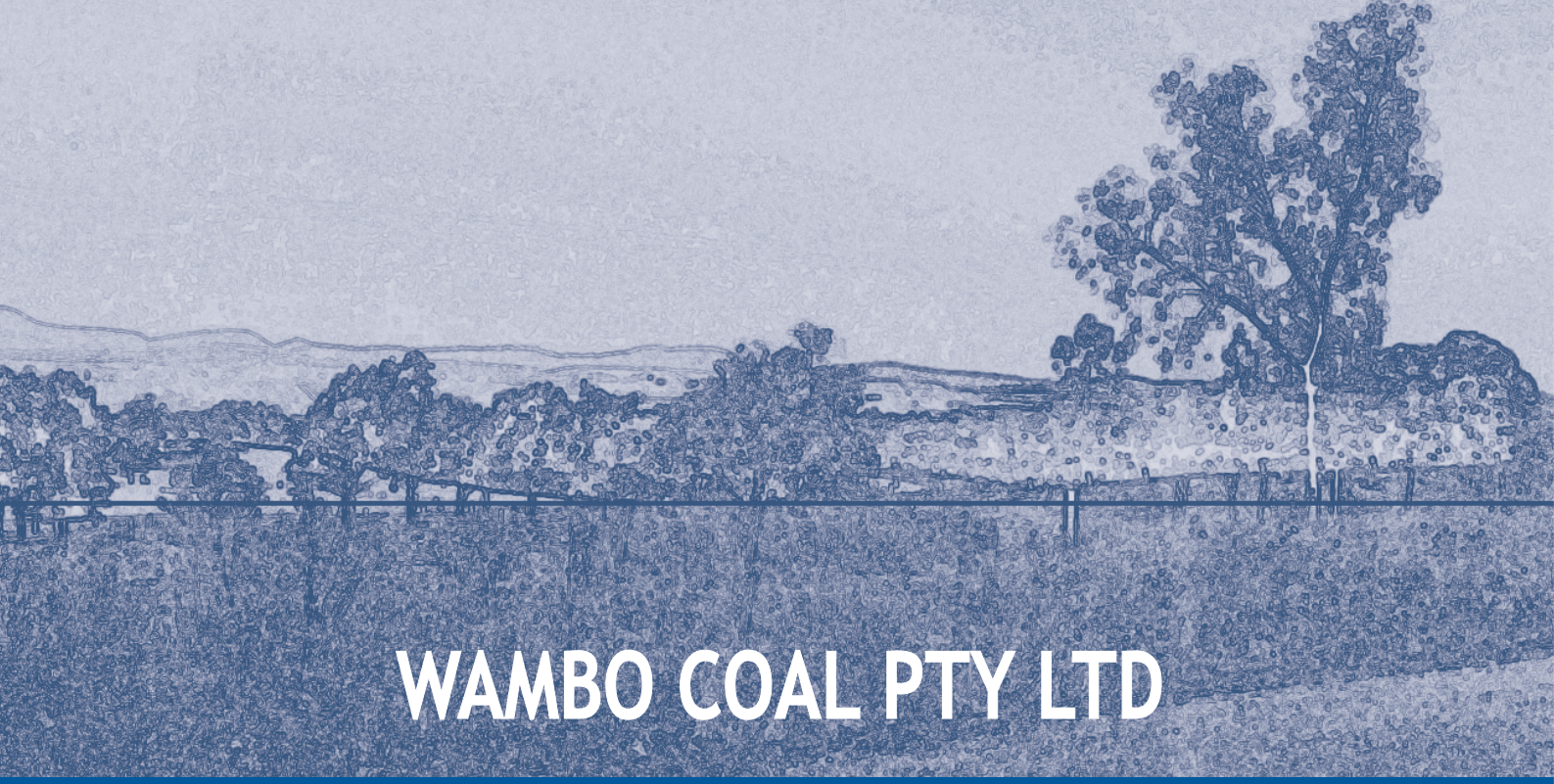

WAMBO COAL PTY LTD

NORTH WAMBO UNDERGROUND MINE

EXTRACTION PLAN
LONGWALLS 8 TO 10A

REPORT 4

SUBSIDENCE RISK ASSESSMENT

Peabody ENERGY

Operational Risk Mentoring
Practical Solutions for Operational Risk Management

For Wambo Coal Pty Ltd

North Wambo Underground Mine – Longwalls 8 to 10A Subsidence Risk Assessment - REPORT

Report Title:	North Wambo Underground Mine – Longwalls 8 to 10A Subsidence Risk Assessment Report
Client:	Troy Favell, Environment and Community Manager
By:	Peter Standish, Director and Principal Consultant
Team Session:	30th October 2014
Job:	ORMJ1408
Revision:	V2
Date:	1st April 2015

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DOCUMENT DISTRIBUTION AND CONTROL

Ref No.	ORMJ1408
Title	North Wambo Underground (NWU) Mine Longwalls 8 to 10A Subsidence Risk Assessment Report
General Description	This report summarises the results and recommended follow up actions from the study conducted into the NWU Longwalls 8, 9, 10 and 10A subsidence risk assessments. It reviews the various aspects and impacts of the potential effects of subsidence due to mining Longwalls 8 to 10A inclusive.
Key Supporting Documentation	AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines. MDG1010 – Minerals Industry Safety and Health Risk Management Guideline. EDG17 – Guideline for Applications for Subsidence Management Approvals. Development Consent DA 305-7-2003. Standish, Reardon et al – North Wambo Underground Mine Longwalls 7 to 10 Subsidence Risk Assessment Report (2014). Wambo Coal Pty Limited – Wambo Development Project Environmental Impact Statement (2003). Wambo Coal Pty Limited – Wambo Seam Underground Mine Modification Statement of Environmental Effects (2005). Wambo Coal Pty Limited – Wambo North Wambo Underground Mine Modification Environmental Assessment (2012). Wambo Coal Pty Limited – Wambo North Wambo Underground Mine Longwall 10A Modification Environmental Assessment (2014).

Versions

Rev	Date	Description	Created By	Checked
0	18/12/2014	Draft report issued for client and team review	P Standish	J Webster
1	16/02/2015	Finalised report with team comments included	P Standish	J Webster
2	01/04/2015	Revised to incorporate shortened commencing end of Longwall 10A	P Standish	J Webster

Distribution List of Latest Version

No	User	Position
1	Wambo Coal Pty Ltd	Troy Favell
2	Resource Strategies	Joanna Webster
3	Operational Risk Mentoring	Records

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1 EXECUTIVE SUMMARY

Wambo Coal Mine is an open cut and underground coal mining operation located approximately 15 kilometres (km) west of Singleton, near the village of Warkworth, New South Wales (NSW). The Wambo Coal Mine is owned and operated by Wambo Coal Pty Limited (WCPL), a subsidiary of Peabody Energy Australia Pty Limited. The North Wambo Underground Mine is a component of the approved Wambo Coal Mine. The North Wambo Underground Mine commenced in 2005 and involves extraction of coal by longwall mining methods from the Wambo Seam.

A Subsidence Management Plan (SMP) for Longwalls 1 to 6 at the North Wambo Underground Mine (WCPL, 2006) was approved by the Department of Primary Industries – Mineral Resources on 11 December 2006.

An Extraction Plan for Longwalls 7 to 10 at the North Wambo Underground Mine was approved by the Department of Planning and Infrastructure on 4 July 2014.

Longwall 10A has been included within the approved North Wambo Underground Mine extent. This risk assessment report has been prepared to support an updated Extraction Plan application for Longwalls 8 to 10A at the North Wambo Underground Mine (noting that extraction of Longwall 7 is complete).

This work follows on from team based risk assessments facilitated by Safe Production Solutions P/L which were completed in October 2012, and October 2013.

The earlier team sessions identified risks related to: European Heritage items; Built Features (particularly powerlines and Wambo South Water Dam); subsidence impacts on overlying streams (Surface water impacts – quality and quantity), archaeological sites, and; impacts on neighbouring property access during subsidence of tracks.

The team based risk assessment undertaken in October 2014 highlighted:

- Impacts on the right of way in favour of several private properties.
- Surface water impacts – particularly around the confluence of Wambo and Stony Creeks.
- Un-detected changes in groundwater conditions.
- Re-activation of subsidence cracking when mining below existing Whybrow seam workings (sitting above the Wambo seam).

All identified risks have risk treatment plans (Appendix 1). These risks have been assessed by the team to be as low as reasonably practicable (ALARP) or tolerable after the effective implementation of the identified controls and actions.

Additional recommendations were made by the teams and these are included in Table 1. The teams understood that WCPL will track and review these actions – updating this Risk Assessment as required, and confirm the adequacy of the identified controls.

Following the team workshop, the commencing (i.e. south-western) end of Longwall 10A was shortened by 245 metres compared to the layout considered by the team in October 2014. It is considered that no changes to the risk rankings are required as the change in longwall layout would result in a reduction in environmental impact and the subsequent environmental risks.

1.1 *Consolidated Action Plan*

The following table presents consolidated follow up actions identified during the risk assessment workshops conducted in October 2012, October 2013 and October 2014. Actions were re-evaluated and additional actions identified during each risk assessment workshop.

Table 1: Consolidated Action Plan

ID	Session	Ref	Description	Responsible	Due	Comment
A1	1	IS007	Complete proposed monitoring bore installation over LWs 7 and 8.	NWU Technical Services Superintendent	19/12/2012	Complete.
A2	1	IS056	Complete monitoring of the fixed points and provision of sufficient slack in any affected mine dewatering discharge pipelines.	WCPL Technical Site Services Coordinator	30/3/2013	Complete.
A3	1	IS061	Review implications for the identified scarred tree proximate to the edge of subsidence in accordance with the approved Salvage and Management Programme.	WCPL Environment and Community Manager	30/3/2013	Complete - Covered by approved Salvage and Management Programme.
A4	1	IS097	Establish a register of WCPL items which could potentially be impacted by subsidence (add to services plan).	NWU Technical Services Superintendent	30/11/2012	Complete - Included in BFMP.
A5	1	IS066 IS094	Review Site Water Management Plan to consider the implications of changed surface relative levels (RLs) and surface storage capacities.	WCPL Environment and Community Manager	30/3/2013	Complete.
A6	1	IS067 IS092	Develop an Ausgrid liaison process to develop mitigation measures well ahead of subsidence effects being experienced.	WCPL Technical Site Services Coordinator	30/11/2012	Complete - in BFMP.
A7	1	IS068	Confirm surface storage capacity to take water from Whybrow seam dewatering and that the installed infrastructure will be sufficient.	NWU Technical Services Superintendent	3/1/2013	Complete.
A8	1	IS075	Complete the establishment of the inrush control zone in the Inrush Management Plan for adjacent Wambo seam workings and dewatering strategy for the old workings. [This should follow quantification of the risks with known quantities and pressure of water and integrity of the barrier.]	NWU Technical Services Superintendent	30/3/2013	Complete.

ID	Session	Ref	Description	Responsible	Due	Comment
A9	1	IS076	Develop an audit/monitoring process for the Homestead backfill project.	NWU Technical Services Superintendent	31/10/2012	Complete - Internal fortnightly status report implemented.
A10	1	IS086	Consider getting structural engineering review of Homestead Workshop prior to subsiding. [This should include reviewing the equipment held in this location and movement to an area not likely to be affected by mining.]	WCPL Technical Site Services Coordinator	30/3/2013	Complete.
A11	1	IS087	Review the condition of the portal seals to the Homestead workings prior to subsiding.	NWU Technical Services Superintendent	30/3/2013	Complete.
A12	1	IS039 IS093	Include communication with the Electrical Engineer in Charge in the BFMP.	NWU Technical Services Superintendent	30/11/2012	Complete - Included in BFMP.
A13	1	IS095	Review predicted subsidence and against drainage paths inside the Homestead pit shell.	NWU Technical Services Superintendent	30/3/2013	Complete.
A14	2	IS100	Check predicted subsidence for extending LW 9 and 10.	NWU Technical Services Superintendent	30/11/2013	Complete – included in the Subsidence Assessment.
A15	2	IS100	Consult GML regarding the affects if any on the Wambo Homestead Complex Mine Management Plan.	WCPL Environment and Community Manager	30/11/2013	Complete – no additional subsidence in the Wambo Homestead Complex curtilage.
A16	2	IS105	Review monitoring data from LW 5 to validate existing model.	WCPL Environment and Community Manager	30/11/2013	Complete – included in the Subsidence Assessment.
A17	2	IS106	Provide latest geological data for review.	NWU Technical Services Superintendent	30/11/2013	Complete – reviewed for Extraction Plan.
A18	2	IS110	Conduct a dam re-commissioning risk assessment and structural engineering assessment prior to re-commissioning.	NWU Technical Services Superintendent	At time	-
A19	2	IS114	Review the surface water ponding effects from leaving a pillar under the creek (including existing reports).	WCPL Environment and Community Manager	At time	Complete – addressed in the Subsidence Assessment.
A20	2	IS040	Check Telstra lines in proximity to LW 9 and 10 to verify.	NWU Technical Services Superintendent	30/11/2013	Complete – no Telstra lines present.

ID	Session	Ref	Description	Responsible	Due	Comment
A21	3	IS048 IS096	Confirm if there are any wells or bores in the vicinity of LW10A – with bore locations (and their decommissioning) unknown by the team of 30/10/14.	NWU Technical Services Superintendent	At time	Wells and bores are assessed under NWU Inrush Management Plan and Inrush Authority to Mine process.
A22	3	IS056	Review provision of slack for discharge and other lines over LW 10A.	NWU Technical Services Superintendent	31/1/2015	Complete
A23	3	IS068	Confirm greater intensity of monitoring or other strategy above Longwall 8b (to address potential failure of backfill in overlying Whybrow seam working).	NWU Technical Services Superintendent	31/1/2015	Complete – increased visual monitoring incorporated into Subsidence Monitoring Program
A24	3	IS078	Review additional piezometer holes.	WCPL Environment and Community Manager	31/1/2015	Complete – addressed in Attachment 2 of Extraction Plan
A25	3	IS117 IS120	Review location of LW10A in relation to previous grouting activities on Wambo Creek.	WCPL Environment and Community Manager	31/1/2015	Complete – outside angle of draw.
A26	3	IS010 IS119	Review monitoring bore requirements for LW 10A – particularly to the south near the boundary of the Mining Lease.	WCPL Environment and Community Manager	31/1/2015	Complete – in consideration of shortened commencing end of LW 10A
A27	3	IS121	Review piezometer triggers for Wambo Creek (P109).	WCPL Environment and Community Manager	31/1/2015	Complete – in consideration of shortened commencing end of LW 10A

2 DEFINITIONS

The following table provides guidance on terms used throughout this report.

Term	Explanation
ALARP	"As Low As Reasonably Practicable". The level of risk between tolerable and intolerable levels that can be achieved without disproportionate expenditure in relation to the benefit gained.
Aspect	A classification of risk normally applied to environmental matters. "Aspects" are best thought of as mechanisms of harm – or causes of loss. Typical aspects are: surface water contamination or loss; land changes, or; fauna/flora changes. Each of these aspects produces a subsequent environmental "impact".
BFMP	Abbreviation – Built Features Management Plan – a document to identify proposed management objectives and performance measures to manage potential subsidence impacts to public infrastructure and all classes of other built features within the Project area and surrounds.
Causal Pathway	A term used to describe the "flow" of events beginning from a root cause and leading to an unwanted outcome. The flow is typically causes prevented from becoming incidents by preventative controls and incidents reduced in severity by mitigating controls which lead to different severity outcomes. A causal pathway is a cause *to* failed preventative controls *to* incident *to* successful mitigating controls *to* outcome.
GWMP	Abbreviation – Ground Water Monitoring Program – a document defining an approach to monitoring groundwater conditions and potential changes due to potential subsidence impacts.
Hazard	A thing or a situation with potential to cause loss.
HAZOP	Method of analysing mining operations, plant or processes to identify potential causes of incidents and prompt for required controls. Guidance on the method is available in AS/IEC 61882-2003 Hazard and operability studies (HAZOP).
Impact	A result of risk normally used when considering environmental matters. Impacts are the end result of the realisation of an "aspect". For example – surface water changes have an impact that includes loss of habitat for water dwelling fauna and flora.
Incident	A step in the causal pathway which describes the point at which control of pathway is lost. System required preventative controls have failed or been circumvented when an incident occurs. An incident is NOT a risk as it should not be described as a consequence.
Inherent/Initial Risk	The risk associated with an unwanted event *before* any consideration of the existing controls is taken into account.
Inspection	A regular check of workplace equipment, working environment and practices, to identify hazards and deficiencies.
Instrument	Term used to describe either statute, standards, policies or other legal or corporate document which imposes obligations on the site and the personnel filling roles in the organisation.
Issue	Is used in the document to describe any point raised by the team or in the risk review process generally. An issue can be any of cause, hazard, incident, control, outcome (risk), requirement, background information or general point related to the subject area.
LMP	Abbreviation – Land Management Plan – A document outlining the management of potential environmental consequences due to potential subsidence impacts within the Project area and surrounds.
LW	Abbreviation – Longwall – the key method of secondary extraction considered.
NWU	Abbreviation – North Wambo Underground.
NWCSRS	Abbreviation – North Wambo Creek Subsidence Response Strategy.

Term	Explanation
Personnel	Includes all people working in and around the site (e.g. all contractors, sub-contractors, visitors, consultants, project managers, etc.).
Practicable	The extent to which actions are technically feasible, in view of cost, current knowledge and best practices in existence and under operating circumstances of the time.
Residual Risk	The risk associated with an unwanted event *after* consideration of the existing control measures is taken into account.
Review	An examination of the effectiveness, suitability and efficiency of a system and its components.
Risk	The combination of the potential consequences arising from a specified hazard together with the likelihood of the hazard actually resulting in an unwanted event.
Risk Management	The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring risk.
SGWRP	Abbreviation – Surface and Groundwater Response Plan.
SWMP	Abbreviation – Surface Water Monitoring Program.
WCPL	Abbreviation – Wambo Coal Pty Ltd.
WMP	Abbreviation – Water Management Plan.

3 INTRODUCTION

3.1 *Objectives and Deliverables*

The primary objectives of this risk assessment were to:

- Use the risk assessment to identify items to be addressed in the Extraction Plan (and related plans);
- Use the risk assessment as input into the preparation of the Extraction Plan for Longwalls 8 to 10A;
- Develop parameters for inclusion in other management plans;
- Involve a cross section of WCPL, subject matter experts, decision makers and key stakeholders in the issue (hazard) identification process;
- Prioritise identified issues;
- Determine the criticality of controls;
- Identify recommended actions for follow up; and
- Document the process and the results.

3.2 *Client*

The client for the risk assessment is Troy Favell, WCPL Environment and Community Manager.

3.3 *Scope*

On the 30th October 2014, a team consisting of WCPL technical and environmental staff and specialist consultants participated in a facilitated risk assessment workshop on Longwalls 8 to 10A inclusive. The scope of the workshop was:

> *"To conduct a risk assessment with an emphasis on identifying those subsidence impacts with high-risk levels and/or potentially severe consequences. To confirm that adequate risk treatment measures are applied such that the residual risk ranking is tolerable."*

The risk assessment workshop included:

- Establishing the context including review of supporting information and objectives;
- Identifying risks via a number of Risk Management techniques, including:
  - Brain storming;
  - Modified hazard and operability analysis; and
  - Gap analysis against the subsidence impact performance measures in the Development Consent (DA-305-7-2003) and the features that may be affected by underground coal mining listed in Appendix B of EDG17 – Guideline for Applications for Subsidence Management Approvals.
- Analysis of identified risks and nomination of key potential environmental issues; and
- Ranking of the risks, including consideration of mitigation measures.

This October 2014 risk assessment team studied and extended existing considerations to include implications of Longwall 10A in addition to Longwalls 8 to 10 which had not been fully considered by earlier teams.

3.4 *External Facilitation*

The team session on 30 October 2014 was facilitated by Dr Peter Standish of Operational Risk Mentoring – a company specialising in risk assessment and risk management processes.

3.5 *The Team*

The first team met on 10 October 2012 at the WCPL site, near Singleton, NSW. A team-based approach was utilised in order to take advantage of an appropriate mix of skills and experience to identify potential loss scenarios/issues relating to Longwalls 7 and 8.

A second team met on 2 October 2013 at the WCPL site to identify issues relating to subsequent longwall mining (Longwalls 9 and 10).

A third team met on 30 October 2014 at the WCPL site to identify issues relating to additional longwall mining (Longwall 10A). Details of the team members present during the latest risk assessment workshop and their relevant qualifications and experience is included in Table 2.

Table 2: Team Members

Name	Role	Qualifications and Experience	10/10/12	2/10/13	30/10/14
Peter Standish	Operational Risk Mentoring – Facilitator	PhD, B Eng (Hon), Dip Bus Mgt, Risk Analysis Trained. Certificate of Competence as a Manager; 33 years experience in underground and open cut mining operations with operating, managerial and contract management experience. Involved in facilitating risk assessments for 15 years.	✓		✓
Michael Millgate	WCPL – NWU Technical Services Superintendent	B Survey, Registered Mine Surveyor; over 10 years industry experience.	✓	✓	✓
Troy Favell	WCPL – Environment and Community Manager	B Sc (Ecology & Botany), over 5 years experience at the Wambo Coal Mine.	✓	✓	✓
Tim Britten	WCPL – Project Director South Wambo Underground	B Sc (Geol), M Eng (Geotech), Diploma in Coal Mine Strata Control and Ventilation, VO's ticket; over 20 years industry experience.	✓		✓
Mal Walker	WCPL – Chief Surveyor	B Survey, Statutory Surveyors Registration, over 30 years industry experience.			✓
James Barbato	Subsidence Engineer	B Eng (Civil),10 years experience as a subsidence engineer.	✓	✓	*In absentia*
Noel Merrick	Heritage Computing – Director	PhD (Groundwater Management), Grad Dip Data Proc, MSc (Research Geophysics), BSc (Physics), Grad Course in Hydrology; 40 years industry experience.	✓	✓	✓
Darrell Rigby	RPS Australia Asia Pacific – Archaeologist	B Arts (Archaeology & Palaeontology); over 10 years archaeological experience.	✓	✓	✓
Joanna Webster	Resource Strategies – Project Manager	B Eng (Env); 5 years experience environmental management and project approvals in resource industry.	✓	✓	✓

Team member "goals" were used to confirm that initial expectations of the team session were met – with the team members reflecting on these goals towards the end of the session.

4 ESTABLISH THE CONTEXT

4.1 *Project Context*

The North Wambo Underground Mine is a longwall coal mining operation owned and operated by WCPL, a subsidiary of Peabody Energy Australia Pty Limited. The North Wambo Underground Mine is a component of the approved Wambo Coal Mine (refer to Figure 1) and commenced in 2005.

A Subsidence Management Plan (SMP) for Longwalls 1 to 6 at the North Wambo Underground Mine (WCPL, 2006) was approved by the Department of Primary Industries – Mineral Resources on 11 December 2006.

Extraction of Longwalls 1 to 7 is complete.

An extraction Plan for Longwalls 7 to 10 was lodged in February 2014 and subsequently revised in June 2014. This Extraction Plan was approved by the NSW Department of Planning & Environment on 4 July 2014.

Extraction of Longwall 7 was completed in January 2014. Extraction of Longwall 8 was completed in July 2014. Extraction of Longwall 9 was completed in December 2014. Extraction of Longwall 10 is currently underway.

This risk assessment report has been prepared to support an Extraction Plan application for Longwalls 8 to 10A inclusive at the North Wambo Underground Mine.

More information on the mine and its operation can be found on the company's website at: www.peabodyenergy.com.au.

Following the team workshop, the commencing (i.e. south-western) end of Longwall 10A was shortened by 245 metres compared to the layout considered by the team in October 2014. The layout considered by the team at the workshop is provided in Figure 2 and the revised layout is shown in Figure 3.

It is considered that no changes to the risk rankings are required as the change in longwall layout would result in a reduction in environmental impact and the subsequent environmental risks.

4.2 *Risk Management and Organisational Context*

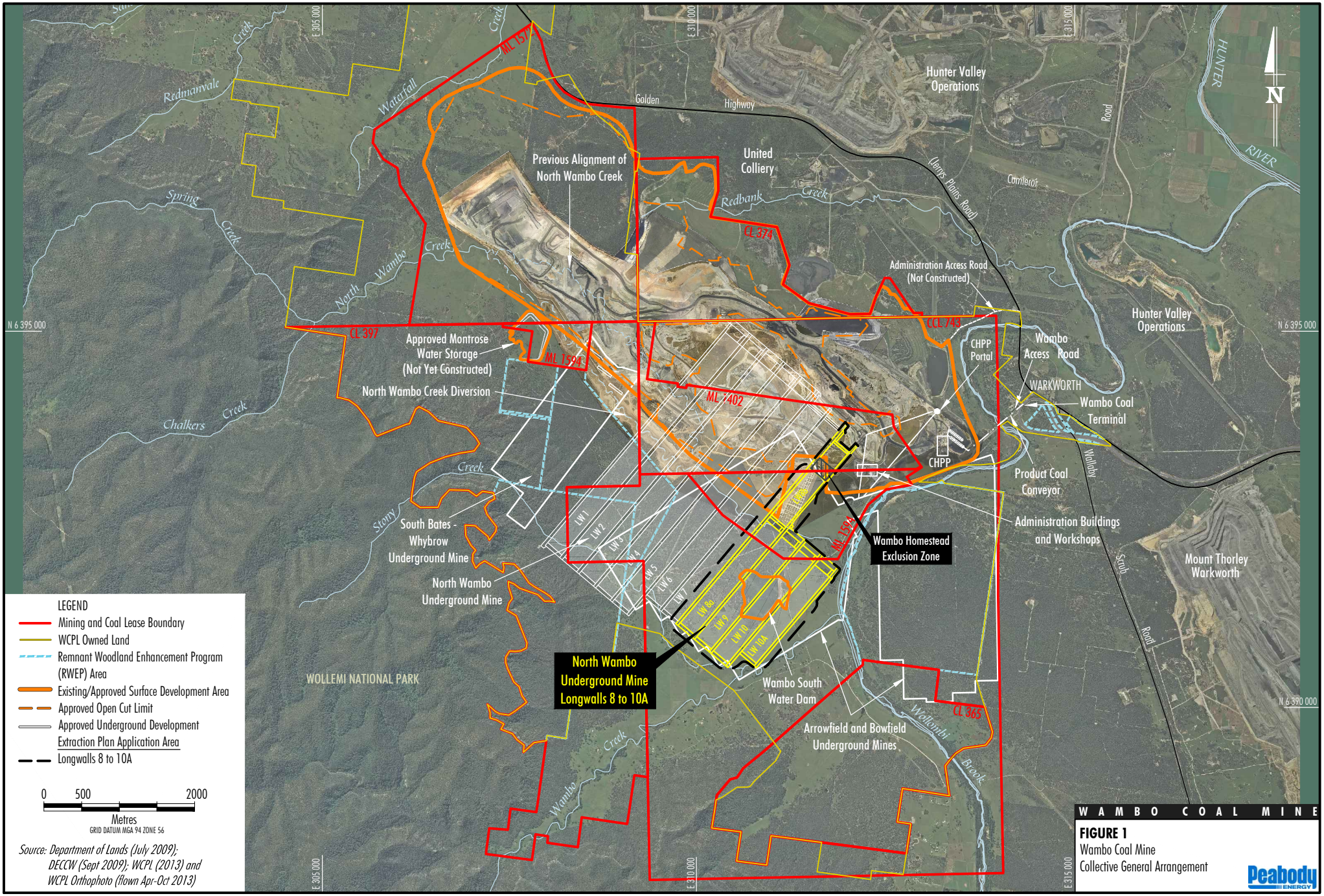
The development consent outlines a range of performance measures regarding the potential consequences of subsidence risks posed by mining. These subsidence impact performance measures are shown in Table 3.

Table 3: Performance Measures

Feature	Subsidence Impact Performance Measure
Wollombi Brook	Negligible impact. Controlled release of excess site water only in accordance with EPL requirements.
Wollemi National Park	Negligible subsidence impacts. Negligible environmental consequences.
Warkworth Sands Woodland Community	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
White Box, Yellow Box, Blakely's Red Gum, Woodland/Grassy White Box Woodland Community	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Wambo Homestead Complex	Negligible impact on heritage values, unless approval has been granted by the Heritage Branch and/or the Minister.
All built features	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.
Public Safety	No additional risk.

The extraction plan review process involved the following key steps:

1. Risk Assessment for Longwalls 7 and 8 conducted on 10 October 2012;
2. Extraction Plan for Longwalls 7 and 8 approved on 16 May 2013 for Longwall 7;
3. North Wambo Underground Mine Modification for Longwalls 9 and 10 was approved on 8 July 2013;
4. Extraction Plan for Longwalls 7 and 8 approved on 24 September 2013 for Longwall 8;
5. Risk assessment including Longwalls 9 and 10 – conducted on the 2 October 2013;
6. Revise Extraction Plan for Longwalls 7 to 10 – lodgement in June 2014;
7. Risk assessment including Longwall 10A – conducted on 30 October 2014; and
8. Revise Extraction Plan for Longwalls 8 to 10A – lodgement early 2015.

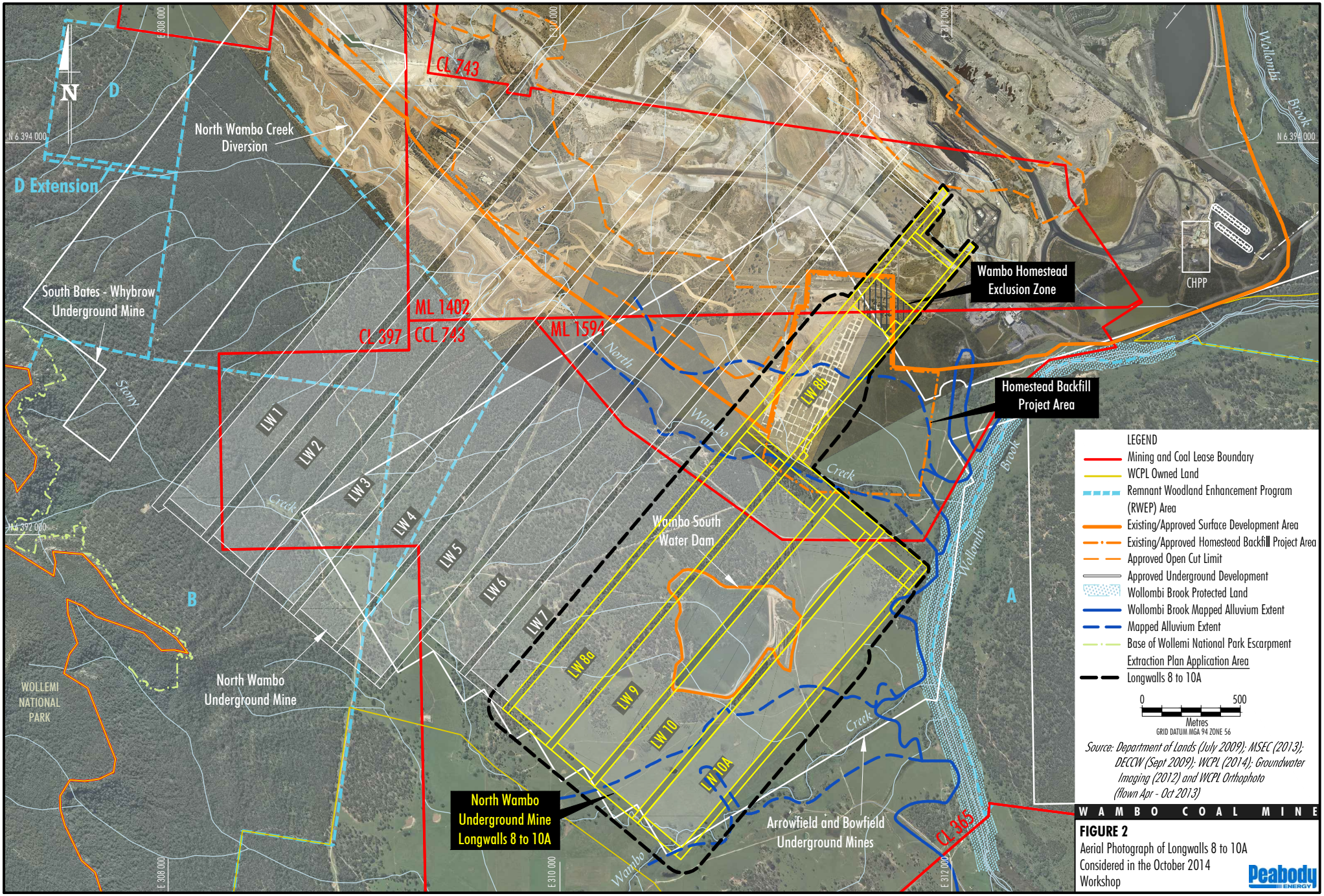


WAMBO COAL MINE

FIGURE 1
Wambo Coal Mine
Collective General Arrangement

Peabody ENERGY

WAM-09-15_EP LW8-10A_Risk_102B



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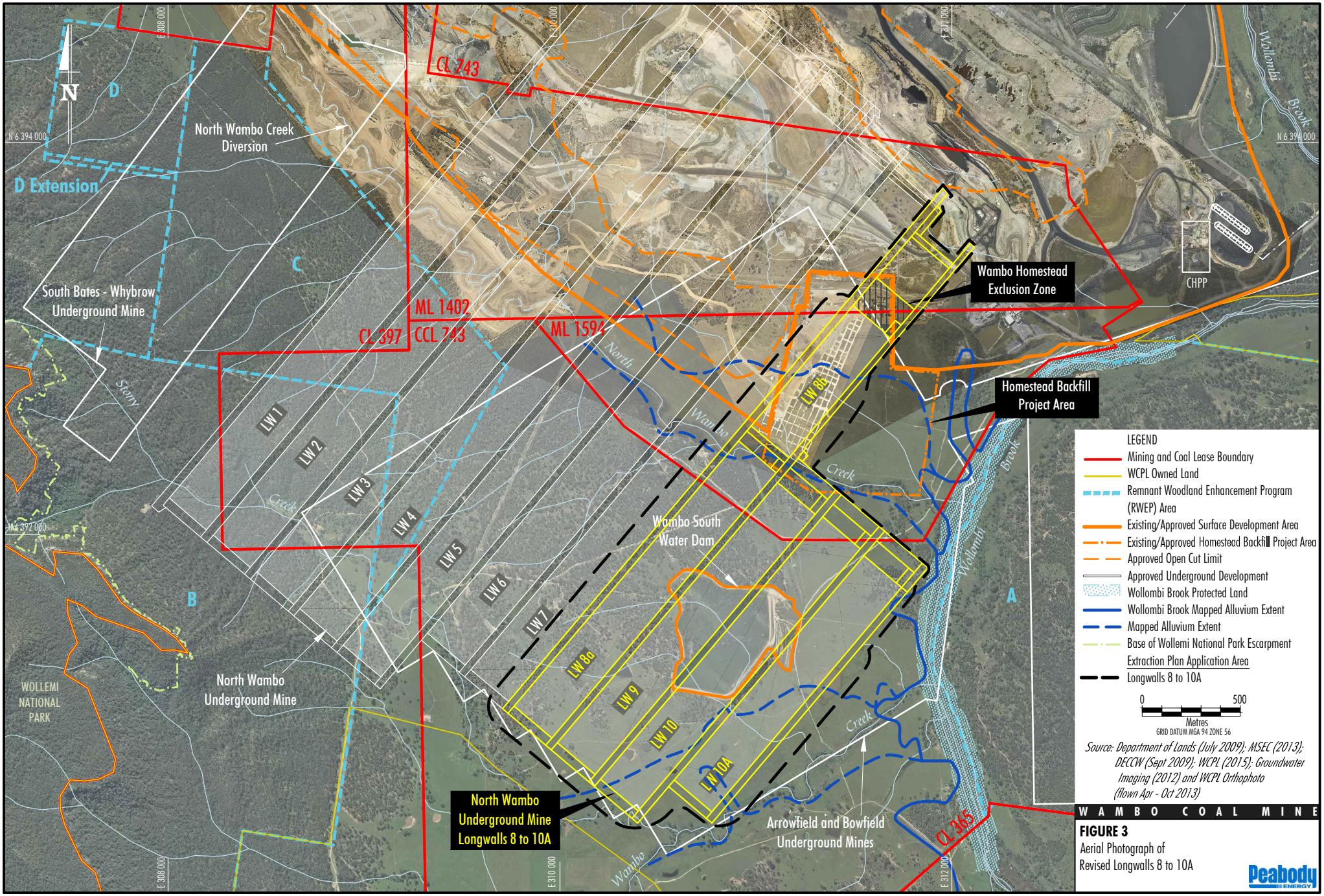


WAM-09-15_EP LW8-10A_RISK_103A

The assessment of risks has also referred to:

- Relevant criteria defined by statutory requirements;
- Community consultation findings;
- Requirements by local and state government agencies with responsibilities in the area;
- Structural tolerances of man-made surface structures;
- Operational licenses of public utilities which may be affected by subsidence in the proposed mining area;
- Relevant guidelines published by the NSW Government;
- Previous observations/information collected in the area; and
- Other relevant information made available to the team.

4.3 *Key Assumptions*

The identification of key assumptions is a critical part of the risk assessment process – forming the basis for many engineering/project decisions. It is important that these assumptions are validated and reviewed as part of the risk management process. Key assumptions applied during the risk assessment process were:

- The risk assessment relates to the extraction of Longwalls 8 to 10A inclusive at the North Wambo Underground Mine only;
- All commitments made in approval documentation (e.g. the *Wambo Development Project Environmental Impact Statement*) or controls currently allocated to a work stream were taken to be "planned controls";
- Risk ranking was undertaken on the basis of consequences being in excess of approved levels and in consideration of remediation;
- Inrush Prevention and Management is still in place for LW 9, 10 and 10A;
- No installation of new infrastructure (e.g. gas bores);
- Wambo South Water Dam will be re-used after mining;
  - Wambo South Water Dam will be dewatered (but may still have some residual water left in the dam);
  - Re-commissioning will be under a separate review/risk assessment; and
- Removal/disposal of the water from the dam and the overlying workings will be managed appropriately.

5 METHOD

5.1 *Key Steps*

The key steps in the risk assessment process were:

1. Background analyses on the subsidence issues and experiences for the North Wambo Underground Mine;
2. Facilitation of a scoping session (developed by Resource Strategies and communicated to Operational Risk Mentoring) with decision making personnel to discuss scope material, and to confirm the risk analysis process and key outcomes sought;
3. Facilitation of a team-based analysis to evaluate and treat risks, comprising:
    a. an open discussion with the team on "what do we want to achieve" in relation to the analysis;
    b. presentation by Troy Favell on the subsidence experiences at North Wambo Underground Mine;
    c. brainstorming (writing) to capture general issues;
    d. review of earlier Risk Assessment studies;
    e. modified HAZOP - reviewing an aerial photo view of the mine to identify potential surface features which could contribute to/be affected by subsidence;
    f. cross mapping to the applicable subsidence impact performance measures in the Development Consent and surface and sub-surface features that may be affected by underground coal mining in Appendix B of EDG17 to confirm all items have been addressed;
    g. prioritisation (of identified items) – through a voting system conducted by the team;
    h. risk ranking of the outcomes shown in the confirmed risk and control chart;
    i. identification of planned (existing) and additional controls to mitigate risk levels to a tolerable state; and
    j. generation of an action plan to complete the identified additional controls;
4. Complete draft report to AS/NZS ISO 31000:2009 standard for review by personnel;
5. Finalise the report and issue as a controlled copy for ongoing use; and
6. Update the report based on the second and third team reviews, including:
    a. Overview of new aspects and impacts;
    b. Identification of aspects and impacts specific to LW 9, 10 and 10A;
    c. Review and update controls and risk rankings in the Risk treatment Plan considering LW 8 to 10A inclusive; and
    d. Identify any new additional actions (recommendations).

6 IDENTIFYING HAZARDS AND ISSUES

6.1 *Background Analysis of Documents*

The various documents listed in the References section were reviewed to determine the nature of specific threats and controls identified for the operation.

6.2 *Brain Writing*

Brain writing is a technique based on the work of de Bono (who built on the work of Alex Faickney Osborne) and is intended to promote creative thought amongst a group of people. As applied by Operational Risk Mentoring, the process involves:

1. Quiet reflection – where individuals write their thoughts on the subject onto paper or card(s);
2. Group discussion – with each person in the team taking a turn to read out one of their issues – and then refinement of each issue based on input from other team members who had similar items on their list; and
3. Key word association (where relevant) to identify additional Issues for the register based on connection with the subject.

6.3 *Modified HAZOP*

An aerial photograph of the mine was used to identify potential subsidence impacts – with key word prompts connected with the various aspects of potential harm. The output from this process was added to the over-arching risk register from the team session (shown in Table 6).

6.4 *Statute and Guideline Cross Map*

The main guidance information considered comprised:

- Subsidence impact performance measures in the Development Consent (DA 305-7-2003); and
- Surface and sub-surface features that may be affected by underground coal mining listed in Appendix B of EDG17 – Guideline for Applications for Subsidence Management Approvals.

These documents provided a range of points which were considered by the team and used to generate additional issues (hazards or controls) for consideration.

7 ANALYSE RISK

Analysis of identified issues requires the stakeholders to determine the risk that the identified threat poses to the organisation or the importance of the potential control. Risk is the product of the consequence and the likelihood of the event occurring with and without controls in place.

Risk analysis involves determining the consequences or impact of a potential event occurring in combination with the likelihood of that event occurring. The result is a "level of risk" defined by the following.

Level of Risk = Consequence x Likelihood

The elements of risk level determination are as follows:

1. Consider the causal pathway – the balance between the intensity and frequency of the cause(s) and the preventative controls in place to prevent them from becoming incidents;
2. Identify existing mitigating control strategies and tactics that act to minimise negative outcomes from an incident;
3. Determine the consequences of the outcome reached by the causal pathway – with a negative impact or an opportunity. Where appropriate, the causal pathway considered should identify the dimension upon which is impacted (e.g. outcome is related to harming people, natural environment, property, process continuity, etc.);
4. Determine the likelihood of the outcome being reached – giving balance to the cause, preventative and mitigating controls for a negative consequence or positive opportunity occurring. Likelihood is defined as the product of the probability of the event occurring and the overall exposure to the event;
5. Estimate the level of risk of an outcome by combining the consequence and likelihood rankings using the risk matrix; and
6. Identify and consider any uncertainties in the estimates, validate these where appropriate.

This technique was applied to reach the risk scores shown in Table 6. Note that in some instances the risk levels were not scored – which flows from guidance including:

- Uncertainty – if the causal pathway cannot be clearly described – any estimation of risk levels would be misleading, and the matter should be referred as an action to the Client to more clearly determine the level of risk;
- Being Control Related – where an issue such as failing to follow a procedure or a detection system not functioning are identified. In this case it is impossible to generate a meaningful risk score , as it requires the combination of the probability of the control failing AND the causal pathway being "traversed" at the same instant in time – which is rarely assessable in a team environment; and
- Being Undefined – where a causal pathway has no clear outcome, and so no meaningful risk score can be assigned.

Priority issues identified by the team are shown in Table 4.

7.1 *Prioritisation*

The key potential hazards/issues were identified through a "voting" system whereby team members were assigned a number of "votes" to allocate to what they considered to be the key hazards/issues.

Based on Operational Risk Mentoring's review of fatality and incident data, comparing the number of root causes implicated in losses against the number identified in predictive analyses, a division of 90:10 is indicated. That is 90% of the losses arise as a result of 10% of the issues (root causes etc.)[1].

Some 10% of the total number of points raised were then issued to the team members as "votes" which they could allocate against the various individual points.

[1] This division is more pronounced than that determined by Vilfredo Pareto in 1906 - and the taxonomy of this difference has not been researched at this stage. The team generally acknowledged that the items given priority in the process plausibly represented the vast majority of the potential risk/reward in the subject area.

The results of this output are shown in Table 4, ordered by descending vote frequency with the nominated aspect area included. This provided a method for the team to identify and sort initial concerns at an early stage. The resulting level of risk is summarised in the Risk Treatment Plan in Appendix 1.

Table 4: Priority Issues

Ref	Process/Issue/Activity	Votes	Aspect Type
IS112	Potential subsidence effects on the right-of-way (road) in favour of several private properties.	5	Community
IS121	Environmental/subsidence impacts on Wambo Creek (in particular the confluence area with Stony Creek and the potential for erosion).	5	Surface Water
IS078	Failure of the monitoring program to detect and respond to an impact on the groundwater system.	4	Groundwater
IS116	Potential for changes in alignment of Wambo and Stony Creeks above LW 10A.	4	Surface Water
IS120	Potential for LW 10A to reactivate subsidence cracking which required historic repairs to Wambo Creek over Whybrow workings panel 9 and 9A.	4	Surface Water
IS002	Environmental consequences associated with water flow and quality changes in Stony Creek (including changes to channel stability) resulting from subsidence impacts associated with the extraction of LWs 8 to 10A.	2	Surface Water
IS009	Reduced base flow to Wambo Creek (also known as South Wambo Creek) resulting from a lowering of the water table associated with the extraction of LWs 8 to 10A (predominantly LW 10A).	2	Surface Water
IS014	Reduced groundwater user access to hard rock groundwater supply due to a lowering of the water table associated with the extraction of LWs 8 to 10A - particularly considering the near neighbour effects.	2	Groundwater
IS022	(Temporary) Loss of capacity of water storage in the Wambo South Water Dam due to fracturing to the water storage floors resulting from extraction of LWs 8 to 10A.	2	Surface Water
IS039/ IS093	Subsidence impacts to WCPL powerlines resulting from the extraction of LWs 8 to 10A (in particular the Wambo South Water Dam powerlines).	2	Business
IS083	Erosion and geomorphological impacts on North Wambo Creek above predicted impacts.	2	Surface Water
IS099	Failure to gain approval of the Extraction Plan resulting in production delays.	2	Business
IS118	Potential fracturing in sandstone outcrops adjacent to Wollombi Brook.	2	Land/Heritage
IS024	A change in flood regimes or extent of potential inundation due to subsidence resulting from the extraction of LWs 8 to 10A.	1	Surface Water
IS026	Mine subsidence impacts due to the extraction of LWs 8 to 10A on riparian vegetation of Stony Creek resulting in environmental consequences.	1	Flora/Fauna
IS048/ IS096	Structural damage to wells and bores close to the mine footprint (including old United Mine gas bores).	1	Infrastructure
IS061	Mine subsidence impacts on items of known Aboriginal heritage.	1	Heritage
IS068	Interaction of Wambo Seam fractured zone with overlying Whybrow Seam fractured zone resulting in increased water make in the overlying Whybrow working and potentially into the Wambo seam underground workings.	1	Groundwater
IS076	Failure of timing or effectiveness of Homestead backfill project (grouting of historic Homestead workings in the Whybrow Seam). Ranked on the basis of delays in production while the project is completed.	1	Business
IS110	Wambo South Water Dam – potential impact on the integrity of the dam wall.	1	Infrastructure

Ref	Process/Issue/Activity	Votes	Aspect Type
IS117	Potential for increased erosion in Wambo and Stony Creeks resulting in potential changes in downstream water quality.	1	Surface Water
IS119	Potential for impacts on groundwater users or baseflow as a result of drawdown effects from dewatering in the Whybrow Seam.	1	Groundwater

7.2 *Referred Issues*

Issues raised during the risk assessment workshop brainstorming that were outside the scope of the risk assessment were considered to be 'referred issues'. Referred issues identified were either control, technical assessment or regulatory approval issues.

No specific, additional, referred issues were generated during considerations of Longwalls 8 to 10A. Referred issues identified during previous risk assessment workshops are shown in Table 5.

Table 5: Referred Issues

Description of Issue	Justification
Maintain offset from Wollombi Brook.	Outside the scope of the risk assessment (control related).
Install monitoring bore in the alluvium of North Wambo Creek over LW8.	Outside the scope of the risk assessment (control related).
Implement trigger levels in bores surrounding LWs 7 and 8.	Outside the scope of the risk assessment (control related).
Re-compact or infill surface cracking of soil.	Outside the scope of the risk assessment (control related).
Prediction of height of fracturing above Wambo Seam workings.	Outside the scope of the risk assessment (technical assessment issue).
Mine Subsidence Board interest in ownership and impact on surface features and structures.	Outside the scope of the risk assessment (regulatory issue).
Continuous implementation of compensation or other agreements with neighbours.	Outside the scope of the risk assessment (control related).
Dam Safety Committee approval required for extraction within the Notification Area of the Wambo South Water Dam and North-East Tailings Dam.	Outside the scope of the risk assessment (regulatory issue).

8 ASSESS RISK

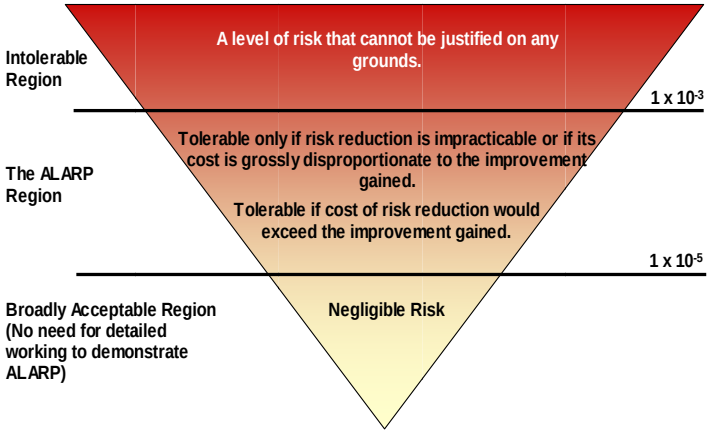
8.1 *Risk Acceptability and Risk Criteria*

The 'tolerability' of a risk is the willingness to live with a risk to secure benefits, on the understanding that the risk is being properly controlled (HB 203:2006 – *Environmental Risk Management – Principles and Process*). Legislation and good practice is targeted to reduce risk to *"As Low as Reasonably Practicable"* (ALARP). ALARP is often interchanged with *"As Low as Reasonably Achievable"* (ALARA).

The purpose of risk criteria is to allow the organisation to clearly define unacceptable levels of risk, or conversely the level of risk which is acceptable or tolerable. In essence the risk criterion enables the organisation to prioritise actions proposed to control the risk during the risk assessment – leading to the development of the risk treatment plan.

The ALARP principle, as represented in the diagram below, was developed to assist in the definition of the acceptability of risk and to demonstrate that an organisation has done all that is considered to be practical in reducing the level of exposure to a risk. More often this is done qualitatively rather than as a quantitative probability as shown on the right hand side of the diagram presented in Figure 4. A risk may be considered to be tolerable in the ALARP zone if the cost of removing the risk is disproportionate to the benefits gained.

Figure 4: Risk Criteria "ALARP"



8.2 *Risk Ranking*

The risk ranking likelihood, consequences and risk matrix considered by the team during the ranking process are outlined in the Appendices. The risk treatment plan in Appendix 1 shows the risk ranking results. The teams took into account cumulative impacts throughout all loss scenarios.

9 TREAT RISKS

A systems approach to the treatment of risks involves consideration of three aspects:

1. Areas of intervention (Prevention, Monitoring, Mitigation, Response/Recovery);
2. Wheel of Safe Production (Nertney Wheel); and
3. Sequence of Barriers (Hierarchy of Controls).

Additional information is provided in the Appendices.

Selection of controls to reduce the likelihood of the risks associated with the topic under review were made with due regard to their prospective reliability. That is, installing engineering modifications is a superior control to relying on operator training efforts. As part of the process, existing controls are assessed and recommendations for amendments or additions made where these existing controls are deemed unacceptable or inadequate.

Further, the prospective reliability of the controls identified as issues were also reviewed. These controls were qualitatively reviewed by considering their position on the hierarchy of controls, the ability to detect any deterioration in the control and the ability to mitigate this deterioration.

9.1 *Risk Treatment Plan*

The risk treatment plan in Appendix 1 shows the risk evaluation results.

10 MONITOR AND REVIEW

10.1 *Nominated Coordinator*

The nominated coordinator is the WCPL Environment and Community Manager (Troy Favell). The coordinator should encourage all parties who attended the risk assessment team session to review this report and the identified hazards/ issues – commenting as needed.

The nominated coordinator should also:

1. Review the report to confirm the accuracy of the material recorded from the team session;
2. Provide feedback to the parties who attended the risk assessment on any decisions which may be different from team expectations/recommendations raised on the day; and
3. Monitor the completion of the additional actions to confirm there is close out of each action.

10.2 *Implementation Review Plan*

It is important to confirm the controls and actions identified are appropriately managed. The expectation of the team was that:

1. Appropriate personnel would be allocated for implementation of recommended actions in a timely manner for completion;
2. Assumptions are validated; and
3. Action items would be appropriately resourced and implemented.

WCPL can make modifications to the recommended actions, but these should be done in light of the risk management framework. Where a change is required, the basis for the change and a desktop review to assess if the risk of the underlying hazard remains tolerable is required.

10.3 *Communication and Consultation*

Communication and consultation form an integral part of the risk management process. It is the Client's responsibility to confirm that this report is shared with all participants involved in the process and other stakeholders as appropriate throughout the life cycle of the study subject area.

10.4 *Concluding Remarks*

A significant goal of the risk assessment process was to identify and analyse the subsidence related hazards with rigour. The desired outcome was to prevent losses to people, equipment, the environment and consequential business by evaluating the causal pathways and developing recommended controls for inclusion into an action plan.

This outcome was achieved by following the risk assessment process described within this document.

Ongoing review will be needed to manage the additional controls identified, and to ensure that subsequent risk management activities are conducted as required.

Dr Peter Standish would like to thank all personnel – particularly Joanna Webster and Troy Favell who arranged the session and resources provided – and other team members who contributed to the risk assessment.

11 REFERENCES

Department of Mineral Resources (2003) *EDG17 – Guideline for Application for Subsidence Management Approvals.* Rev 3.

Department of Mineral Resources (2011) *MDG1010 – Minerals Industry Safety and Health Risk Management Guideline.*

Safe Production Solutions (2012) *North Wambo Underground Mine – Longwalls 7 and 8 Subsidence Risk Assessment.*

Safe Production Solutions (2013) *North Wambo Underground Mine – Longwalls 7 to 10 Subsidence Risk Assessment.*

Wambo Coal Pty Limited (2003) *Wambo Development Project Environmental Impact Statement.*

Wambo Coal Pty Limited (2005) *Wambo Seam Underground Mine Modification Statement of Environmental Effects*.

Wambo Coal Pty Limited (2006) *Wambo Development Project – North Wambo Underground Mine Subsidence Management Plan.*

Wambo Coal Pty Limited (2012) *North Wambo Underground Mine Modification Environmental Assessment.*

Wambo Coal Pty Limited (2013*) North Wambo Underground Mine Extraction Plan for Longwalls 7 and 8.*

Wambo Coal Pty Limited (2014) *North Wambo Underground Mine Longwall 10A Modification Environmental Assessment.*

12 APPENDICES

12.1 *Risk Treatment Plan*

The following risk treatment plan was developed during the third team session, building on updated information and risk rankings developed during previous team sessions. Specific aspects and impacts associated with Longwall 10A were included at the end of the table to easily assess the change (i.e. adding Longwall 10A). Changes made by the third team are *italicised* with comments where appropriate.

The table is ordered by Aspect group and Priority.

Table 6: Risk Treatment Plan

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
1. Natural Features										
IS001	Environmental consequences associated with water flow and quality changes in North Wambo Creek (including changes to channel stability) resulting from subsidence impacts associated with the extraction of LWs 8 to 10A.	-	Surface Water	Grouting of historic Homestead workings in the Whybrow Seam. Monitoring and management measures in accordance with the Water Management Plan (WMP) - including the Surface Water Monitoring Program (SWMP), Groundwater Monitoring Program (GWMP), Surface and Groundwater Response Plan (SGWRP) and North Wambo Creek Subsidence Response Strategy [NWCSRS] [part of the SGWRP]). *LW10A Review: Consequence increased, thus risk ranking changed from D 4 21 to D 3 17. Still ALARP.*	Env	D	3	17	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS002	Environmental consequences associated with water flow and quality changes in Stony Creek (including changes to channel stability) resulting from subsidence impacts associated with the extraction of LWs 8 to 10A.	2	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Historic (Longwalls 1 to 5) observations of no significant impact. *LW10A Review: Based on historical observations consequence was reduced, thus risk ranking changed from D 4 21 to D 5 24.*	Env	D	5	24	-	-
IS003	Environmental consequences associated with water flow and quality changes in Wollombi Brook (including changes to channel stability) resulting from subsidence impacts associated with the extraction of LWs 8 to 10A.	-	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Assessment against the performance indicators developed for Wollombi Brook as described in the WMP, and implementation of any required mitigation measures. *LW10A Review: Consequence reduced, thus risk ranking changed from E 4 23 to E 5 25.*	Env	E	5	25	-	-
IS004	Induced leakage from Stony Creek resulting from a lowering of the water table associated with the extraction of LWs 8 to 10A.	-	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). *LW10A Review: Risk ranking changed from D 4 21 to E 4 23.*	Env	E	4	23	-	-
IS005	Induced leakage from Wollombi Brook resulting from a lowering of the water table associated with the extraction of LWs 8 to 10A (predominantly for LW10A).	-	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Assessment against the performance indicators developed for Wollombi Brook as described in the WMP, and implementation of relevant mitigation measures. (Ranked according to the demonstrated performance of NW U/G). *LW10A Review: Risk ranking changed from D 4 21 to E 5 25.*	Env	E	5	25	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS006	Reduced base flow to North Wambo Creek upstream of LWs 7 and 8 resulting from a lowering of the water table associated with the extraction of LWs 8 to 10A (predominantly LW8 and 9).	-	Surface Water	Monitoring and management measures (LW8 pillar) in accordance with the WMP (including the SWMP, GWMP, SGWRP and NWCSRS). *LW10A Review: Risk ranking changed from D 4 21 to C 5 22. Still ALARP.*	Env	C	5	22	-	-
IS007	Induced leakage from North Wambo Creek over LW 8 due to a lowering of the water table and/or connective cracking.	-	Surface Water	Grouting of historic Homestead workings (for LW7 and 8) in the Whybrow Seam as per the Grouting Options Paper. Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP, SGWRP and NWCSRS). *LW10A Review: Risk ranking changed from D 4 21 to D 5 24.*	Env	D	5	24	-	-
IS009	Reduced base flow to Wambo Creek (also known as South Wambo Creek) resulting from a lowering of the water table associated with the extraction of LWs 8 to 10A (predominantly LW10A).	2	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP).	Env	D	4	21	-	-
IS010	Impacts to groundwater users and/or a change in the beneficial use category of alluvial groundwater due to a change in groundwater level and/or quality associated with subsidence due to the extraction of LWs 8 to 10A - particularly considering the near neighbour.	-	Groundwater	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP, SGWRP and NWCSRS). Maintenance of existing water agreements with potentially affected groundwater users (i.e. neighbouring private landholders).	Env	D	4	21	Review monitoring bore requirements for LW 10A - particularly to the south near the boundary of the Mining Lease.	WCPL Environment and Community Manager (31/1/2015)

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS011	Impacts to groundwater users and/or a change in the beneficial use category of the hard rock groundwater due to a change in groundwater level and/or quality associated with subsidence due to the extraction of LWs 8 to 10A - particularly considering the near neighbour effects.	-	Groundwater	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Maintenance of existing water agreements with potentially affected groundwater users (i.e. neighbouring private landholders).	Env	D	4	21	-	-
IS014	Reduced groundwater user access to hard rock groundwater supply due to a lowering of the water table associated with the extraction of LWs 8 to 10A - particularly considering the near neighbour effects.	2	Groundwater	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Maintenance of existing water agreements with potentially affected groundwater users (i.e. neighbouring private landholders). *LW10A Review: In consideration of make good provisions and use of groundwater source, risk ranking changed from D 4 21 to D 5 24.*	Env	D	5	24	-	-
IS016	A change in land surface slope and preferential pathways for rainfall infiltration resulting from fracturing to the land surface caused by the extraction of LWs 8 to 10A.	-	Groundwater	Monitoring in accordance with the Subsidence Monitoring Program and Land Management Plan (LMP). Management and mitigation of impacts to land in general in accordance with the LMP (e.g. rehabilitation of subsidence troughs).	Env	C	5	22	-	-
IS018	Improved shallow groundwater quality in the fractured zone above LWs 8 to 10A where fracturing occurs to land surface - a beneficial impact (so not risk ranked).	-	Groundwater	Monitoring and management measures in accordance with the WMP (including monitoring of water quality in accordance with the GWMP). *Believed that this is a beneficial aspect so no risk ranking was applied.*	-	-	-	-	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS019	Improved shallow hard rock groundwater quality beneath the alluvium resulting from mining induced loss of water from the alluvium - a beneficial impact (so not risk ranked).	-	Groundwater	Monitoring and management measures in accordance with the WMP (including monitoring of water quality in accordance with the GWMP). *Believed that this is a beneficial aspect so no risk ranking was applied.*	-	-	-	-	-	-
IS021	Potential subsidence impacts on natural dams and ponds associated with the extraction of LWs 8 to 10A (excluding Wambo South Water Dam).	-	Surface Water	Monitoring in accordance with the Subsidence Monitoring Program and LMP. Management and mitigation of impacts to land in general in accordance with the LMP (e.g. remediation of surface cracks). Dams/ground tanks managed by removal of water and rehabilitation post mining. *LW10A Review: Risk ranking changed from D 4 21 to C 4 18 - still ALARP.*	Env	C	4	18	-	-
IS022	(Temporary) Loss of capacity of water storage in the Wambo South Water Dam due to fracturing to the water storage floors resulting from extraction of LWs 8 to 10A.	2	Surface Water	Monitoring in accordance with the Subsidence Monitoring Program, LMP and Built Features Management Plan (BFMP). Management and mitigation of impacts to land in general and water storage dams in accordance with the LMP and BFMP respectively. *LW10A Review: Risk ranking changed from D 4 21 to B 5 19 - still ALARP.*	Bus	B	5	19	-	-
IS023	Far-field subsidence impacts resulting in rock instability of the Wollemi National Park Escarpment	-	Flora/Fauna	Monitoring and management in accordance with the Biodiversity Management Plan for LWs 7 and 8 (BMP) including assessment against performance indicators developed for the Wollemi National Park and implementation of relevant mitigation measures.	Env	E	5	25	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS024	A change in flood regimes or extent of potential inundation due to subsidence resulting from the extraction of LWs 8 to 10A.	1	Surface Water	Monitoring in accordance with the Subsidence Monitoring Program and LMP. Management and mitigation of impacts to land in general in accordance with the LMP (e.g. rehabilitation of subsidence troughs). The controls were developed in consideration of the limited impacts observed during extraction of LWs 1 to 5 (e.g. limited ponding over LWs 1 to 5 and small losses of water observed in alluvial material). *LW10A Review: Risk ranking changed from D 4 21 to D 3 17 - still ALARP.*	Env	D	3	17	-	-
IS025	Mine subsidence impacts due to the extraction of LWs 8 to 10A on riparian vegetation of North Wambo Creek resulting in environmental consequences.	-	Flora/Fauna	Monitoring and management measures in accordance with the BMP and WMP.	Env	D	5	24	-	-
IS026	Mine subsidence impacts due to the extraction of LWs 8 to 10A on riparian vegetation of Stony Creek resulting in environmental consequences.	1	Flora/Fauna	Monitoring and management measures in accordance with the BMP and WMP.	Env	D	5	24	-	-
IS027	Mine subsidence impacts due to the extraction of LWs 8 to 10A on riparian vegetation of Wollombi Brook resulting in environmental consequences.	-	Flora/Fauna	Monitoring and management measures in accordance with the BMP and WMP. Assessment against the performance indicators developed for Wollombi Brook as described in the WMP, and implementation of relevant mitigation measures.	Env	D	5	24	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS028	Subsidence impacts and surface disturbance due to the extraction of LWs 8 to 10A resulting in loss of habitat for threatened species *(including consideration of Acadia Pendula)*.	-	Flora/Fauna	Monitoring and management measures in accordance with the BMP, LMP and Subsidence Monitoring Program. Management and mitigation of impacts to land in general in accordance with the LMP (e.g. remediation of surface cracks). *LW10A Review: Based on the potential presence of Acacia Pendula above Longwall 10A, risk ranking changed from D 5 24 to C 4 18 - still ALARP.*	Env	C	4	18	-	-
IS032	Subsidence impacts and surface disturbance due to extraction of LWs 8 to 10A resulting in long-term loss of native vegetation.	-	Flora/Fauna	Monitoring and management in accordance with the BMP and LMP. Mitigation of impacts to land in general in accordance with the LMP. *LW10A Review: Risk ranking changed from D 5 24 to E 5 25.*	Env	E	5	25	-	-
IS078	Failure of the monitoring program to detect and respond to an impact on the groundwater system.	4	Groundwater	Documentation and execution of the WMP (including the SWMP, GWMP, SGWRP and NWCSRS). Assessment of impacts during development of the Extraction Plan. Development of realistic triggers that can be readily monitored. Clear allocation of roles and responsibilities in the management plans.	Env	D	4	21	Review additional piezometer holes.	WCPL Environment and Community Manager (31/1/2015)
IS083	Erosion and geomorphological impacts on North Wambo Creek above predicted impacts.	2	Surface Water	Grouting of historic Homestead workings in the Whybrow Seam as per Grouting Options Paper. Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP, SGWRP and NWCSRS). *LW10A Review: Risk ranking changed from D 4 21 to B 5 19 - still ALARP.*	Env	B	5	19	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS114	Pillar left in LW8 under the North Wambo Creek – leading to a change in subsidence profile which leads to changes in ponding locations on the surface.	-	Land	Subsidence monitoring program. Bed and Bank Stability Monitoring Program. Monitoring and management in accordance with the WMP (including the SWMP, GWMP, SGWRP and NWCSRS).Note: There are existing ponding areas - the location may change. *LW10A Review: Based on completion of actions identified in the previous team workshop, risk ranking changed from B 5 19 to D 4 21.*	Env	D	4	21	-	-
2. Public Utilities										
IS067 IS092	Subsidence impacts to the 11 kV Ausgrid powerline located within the LW 8 to 10A Application Area resulting from the extraction of LWs 8 to 10A.	-	Infrastructure	Monitoring and management measures in accordance with the AABFMP to be prepared in consultation with Ausgrid. Note: Powerline decommissioned.	-	-	-	-	-	-
3. Public Amenities										
-	No public amenities were identified that could be potentially impacted by subsidence from the extraction of LWs 8 to 10A.	-	-	-	-	-	-	-	-	-
4. Farm and Land Facilities										
IS043 IS085	Subsidence impacts resulting in injury to livestock due to the extraction of LWs 8 to 10A.	-	Land	Monitoring and management measures in accordance with the LMP, including: notification of agistees of areas of longwall mining and active subsidence; and exclusion of agistment grazing from areas where surface cracking presents a reasonable risk to people and/or livestock. *LW10A Review: Risk ranking changed from D 4 21 to D 5 24.*	Bus	D	5	24	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS044	Mine subsidence impacts resulting in long-term loss of agricultural productivity due to the extraction of LWs 8 to 10A.	-	Land	Monitoring in accordance with the Subsidence Monitoring Program and LMP. Management and mitigation measures for land in general in accordance with the LMP.	Bus	E	5	25	-	-
IS045	Mine subsidence impacts to fences on WCPL owned land resulting from extraction of LWs 8 to 10A.	-	Business	Monitoring and management measures in accordance with the LMP. Remediation of subsidence impact on fences following completion of active subsidence.	Bus	D	4	21	-	-
IS046	Mine subsidence impacts resulting in loss of storage in farm dams *(and other earthen water storages)*.	-	Business	Monitoring and management measures in accordance with the LMP.	Bus	D	4	21	-	-
IS079	Potential impacts on neighbouring properties and activities. Ranked based on reputational damage arising from a complainant.	-	Community	Community liaison processes - with notification of any commencement of mining operations at Community Consultative Committee meetings. *LW10A Review: Risk ranking changed from A 5 15 to E 5 25.*	Rep	E	5	25	-	-
IS112	Potential subsidence effects on the right-of-way (road) in favour of several private properties.	5	Community	Right-of-Way Management Plan including: notification of landholder when the right-of-way is subject to active subsidence. Signage for entering active subsidence zone. Subsidence monitoring program (ground and visual). Repairs as required. *LW10A Review: Based on experience at site and the measures implemented, the likelihood of an incident of this magnitude is considered to be lower, thus risk ranking changed from B 5 19 to D 5 24.*	Env	D	5	24	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
5. Industrial, Commercial and Business Establishments.										
IS035	Subsidence impacts to unsealed gravel access roads and tracks resulting from the extraction of LWs 8 to 10A.	-	Business	Monitoring and management and mitigation measures in accordance with the LMP and BFMP. *LW10A Review: Based on experience at site and the measures implemented, the likelihood of an incident of this magnitude is considered to be lower, thus risk ranking changed from C 4 18 to D 4 21.*	Bus	D	4	21	-	-
IS039 IS093	Subsidence impacts to WCPL powerlines resulting from the extraction of LWs 8 to 10A (in particular the Wambo South Water Dam powerlines).	2	Business	Monitoring, management and mitigation measures in accordance with the LMP and BFMP (e.g. structural review of cables, bracing of power poles with stays, inspection regime, protection settings, and installation of rollers [which are a primary mitigating control to reduce the impact)]. *LW10A Review: Risk ranking changed from C 4 18 to E 4 23.*	Bus	E	4	23	-	-
IS040	Subsidence impacts to WCPL telecommunication lines (overhead/underground) resulting from the extraction of LWs 8 to 10A.	-	Business	Monitoring, management and mitigation measures in accordance with the LMP and BFMP (e.g. bracing of poles for overhead lines with stays).	Bus	D	4	21	-	-
IS048 IS096	Structural damage to wells and bores close to the mine footprint (including old United Mine gas bores).	1	Infrastructure	Known location of all wells and bores. Assessment of wells/bores prior to extraction and, dependent on conditions, decommission and seal prior to extraction and sealing as per EDG01 guidelines. Ability to re-install required monitoring and dewatering bores. Wells and bores are assessed under NWU Inrush Management Plan and Inrush Authority to Mine process.	Bus	D	4	21	Confirm if there are any wells or bores in the vicinity of LW 10A - with bore locations (and their decommissioning) unknown by the team of 30/10/14.	NWU Technical Services Superintendent (At time)

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS054 IS082	Mine subsidence impacts resulting in slope instability of waste rock emplacements (applies to LW8 to 10).	-	Safety	Monitoring and management in accordance with the Slope Stability Management Plan. Communication protocols with weekly meetings and interaction between underground and surface operations. Signage on any access tracks/roads likely to be affected. Ranking based on operating experience with undermining dumps with limited impacts (and implementation of exclusion zones).	Per	E	3	20	-	-
IS055	Mine subsidence impacts resulting in damage to rehabilitated areas.	-	Flora/Fauna	Monitoring and management in accordance with the Slope Stability Management Plan and LMP. Remediation of subsidence impacts in accordance with the Rehabilitation Management Plan. *LW10A Review: Risk ranking changed from D 5 24 to D 4 21 - still ALARP.*	Env	D	4	21	-	-
IS056	Mine subsidence impacts to WCPL mine dewatering pipeline.	-	Business	Monitoring and management in accordance with the Subsidence Monitoring Program and BFMP. Monitoring and flow monitors on all pipe lines. Continuous (SCADA) monitoring of pump and pipeline conditions. Monitoring of the fixed points and provision of sufficient slack in any affected mine dewatering discharge pipelines There will be no to negligible water in the South Wambo Dam so there will be no pumping at the time anyway.	Bus	E	5	25	Review provision of slack for discharge and other lines over LW 10A.	NWU Technical Services Superintendent (31/1/2015)
IS057	Mine subsidence impacts to haul roads resulting in disruption of operations.	-	Business	Monitoring and management in accordance with the Subsidence Monitoring Program and the BFMP. Signage on any haul roads likely to be affected. *LW10A Review: Risk no longer relevant as extraction of LW 7 is complete.*	-	-	-	-	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS065	Wambo South Water Dam damaged by subsidence resulting in discharge of dirty water, delay to operations or inrush to workings.	-	Business	Monitoring and management in accordance with Prescribed Dam Management Plan under the BFMP. Compliance with all necessary Dam Safety Committee approvals. Inrush Management Plan involving reduction of dam water levels when subsidence effects are proximate. Surface Water Management Plan with dam capacities available for water storage for site operations.	Bus	D	4	21	-	-
IS066 IS094	Other water management infrastructure (pipelines, roads, pumps and dewatering bores) damaged by subsidence (in particular the Wambo South Water Dam water pipelines over LW10A).	-	Business	Monitoring and management in accordance with the Subsidence Monitoring Program and BFMP.	Bus	D	4	21	-	-
IS074	Exploration activities affected by subsidence.	-	Safety	Communication protocols with weekly meetings and interaction between underground and exploration personnel. Ground disturbance protocols. There will be very limited surface exploration work expected hence the relatively low likelihood and consequence.	Per	E	4	23	-	-
IS081	Instability of the highwall in the Homestead pit as a result of subsidence impacts.	-	Safety	Monitoring and management in accordance with the Slope Stability Management Plan. Provision of 15 metre separation barriers around any affected highwalls. Barrier pillar between high wall and longwalls (appropriately engineered). *LW10A Review: Risk no longer relevant as extraction of LW 7 is complete.*	-	-	-	-	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS086	Subsidence impact on the old Homestead workshop (previously subsided) resulting in a safety incident.	-	Safety	Monitoring and management in accordance with the BFMP. *LW10A Review: Risk no longer relevant as Homestead Workshop removed.*	-	-	-	-	-	-
IS087	Subsidence impact resulting in a loss of integrity of the portal seals to the Homestead workings.	-	Safety	Removal of water against the portal seals prior to subsiding. Consideration of Inrush Management. Backfill as per Grouting Options Paper. *LW10A Review: Risk no longer relevant as extraction of LW 7 is complete.*	-	-	-	-	-	-
IS089	Impact on steel-cased dewatering bore holes to the Whybrow Seam.	-	Infrastructure	Monitoring and management in accordance with the BFMP.	Per	E	5	25	-	-
IS090 IS091	Subsidence impacts on site all weather access road to southern area resulting in inability to access critical infrastructure.	-	Business	Monitoring and management in accordance with the BFMP, including road signage, inspections and internal notification.	Bus	D	4	21	-	-
IS095	Subsidence impacts on surface drainage leading to flooding in the Homestead pit.	-	Safety	Inspection and monitoring processes as part of the BFMP. Design of the Homestead Pit drainage system such that no changes to the drainage paths inside the Homestead Pit shell. *LW10A Review: Based on additional studies conducted, risk ranking changed from E 2 16 to D 4 21.*	Per	D	4	21	-	-
IS097	Subsidence impacts to active services lines over LWs 8 to 10A resulting in delays in production.	-	Business	Monitoring and management in accordance with the BFMP Site Services Plan.	Bus	C	5	22	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS110	Wambo South Water Dam – potential impact on the integrity of the dam wall.	1	Infrastructure	Dams Safety Committee approval required for mining within the notification area. Staged dewatering program (so dam effectively empty when mining underneath). Subsidence monitoring program (includes survey points on the dam wall and visual inspections of the dam wall). Note: the dam is a re-usable asset however if the preventative controls are not effective, the loss of the dam will not significantly impact on the operation. *LW10A Review: Based on further work conducted and additional longwalls, risk ranking changed from C 4 18 to A 4 10.*	Bus	A	4	10	-	-
6. Areas of Archaeological and/or Heritage Significance										
IS060	Greater than negligible impact on heritage values of the Wambo Homestead Complex.	-	Heritage	Monitoring and management measures and monitoring outlined in the Wambo Homestead Complex Mine Management Plan approved by the Heritage Council.	Env	D	4	21	-	-
IS061	Mine subsidence impacts on items of known Aboriginal heritage.	1	Heritage	Salvage Programme approved as part of Consent #2222 under section 90 of the National Parks and Wildlife Act 1974. Due diligence undertaken as part of surface disturbance permits (including site inspections). Monitoring of the scarred tree. Reasonable depth of cover in this area so impact mitigated (reduced).	Env	D	4	21	-	-
IS064	Mine subsidence impacts on items of unknown Aboriginal heritage.	-	Heritage	Archaeological surveys previously undertaken for LWs 8 to 10A. Due diligence undertaken as part of surface disturbance permits (including site inspections).	Env	D	4	21	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS069	Stud Master's Cottage (Wambo Homestead Complex) compromised by subsidence from LW 7.	-	Heritage	Management measures and monitoring outlined in the Wambo Homestead Complex Mine Management Plan approved by the Heritage Council, including review of stabilisation options and trenching around the cottage. Grouting of historic Homestead roadways in the Whybrow Seam directly beneath cottage as per the Grouting Options Paper. Ranking based on predicted impacts - conservative estimate of subsidence and a slight structural impact (less than 5% increase in pillar loading). *LW10A Review: Risk no longer relevant as extraction of LW 7 is complete.*	-	-	-	-	-	-
IS070	Additional subsidence/pot hole failures over the Homestead workings near the Wambo Homestead Complex.	-	Heritage	Management measures and monitoring outlined in the Wambo Homestead Complex Mine Management Plan approved by the Heritage Council. Grouting of historic Homestead roadways in the Whybrow Seam directly beneath Stud Master's Cottage as per the Grouting Options Paper. *LW10A Review: Consequence of failure considered greater, risk ranking changed from D 4 21 to D 3 17 - still ALARP.*	Env	D	3	17	-	-
IS071	Non-compliance with requirements of the Heritage Council approval of the section 60 application.	-	Heritage	Audit and review process of management measures and monitoring outlined in the Wambo Homestead Complex Mine Management Plan.	Env	D	4	21	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
7. Items of Architectural Significance.										
-	Items of architectural significance were determined to be covered by the risk identified in 6. Areas of Archaeological and/or Heritage Significance.	-	-	-	-	-	-	-	-	-
8. Permanent Survey Control Marks										
-	No current survey control marks were identified that could be potentially impacted by subsidence from the extraction of LWs 8 to 10A.	-	-	-	-	-	-	-	-	-
9. Residential Establishments										
-	No residential establishments were identified that could be potentially impacted by subsidence from the extraction of LWs 8 to 10A.	-	-	-	-	-	-	-	-	-
10. Other										
IS068	Interaction of Wambo Seam fractured zone with overlying Whybrow Seam fractured zone resulting in increased water make in the overlying Whybrow working and potentially into the Wambo seam underground workings.	1	Groundwater	Dewatering of Homestead workings in the Whybrow Seam prior to extraction. Management measures and monitoring outlined in the Inrush Management Plan.	Bus	D	4	21	Confirm greater intensity of monitoring or other strategy above Longwall 8b (to address potential failure of backfill in overlying Whybrow seam working). Review site storage capacity for required dewatering volumes.	NWU Technical Services Superintendent (31/1/2015).

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS075	Impact on adjacent historic workings in the Wambo Seam (predominantly related to LW8B).	-	Safety	Geotechnical assessment on barrier to old Wambo mine workings and establishment of inrush control zone in the Inrush Management Plan. Old Wambo mine workings dewatered. *LW10A Review: Based on team review, risk ranking changed from E 5 25 to D 5 24 - still ALARP.*	Per	D	5	24	-	-
IS076	Failure of timing or effectiveness of Homestead backfill project (grouting of historic Homestead workings in the Whybrow Seam). Ranked on the basis of delays in production while the project is completed.	1	Business	Project management of backfilling – includes monitoring/audit process. Ability to drill holes with camera surveys to confirm effectiveness (tried and proven technology). Piezometers installed for early detection of depressurisation of near surface aquifers. Installation of seals to prevent egress of water from Homestead workings down dip. *LW10A Review: Homestead backfill project more progressed, thus higher degree of certainty and risk ranking changed from A 4 10 to D 4 21.*	Bus	D	4	21	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS084	Unauthorised access to the active subsidence area from the right-of-way, resulting in a safety incident.	-	Community	Management measures outlined in the Public Safety Management Plan, including appropriate signage. Note: The intent of this risk is that despite warnings and management of affected roads, a member of the public still accesses the area resulting in an accident. The controls as specified are appropriate for the level/severity of road damage which is controllable. The unknown influence is human error. *LW10A Review: Based on experience to date and inclusion of an additional longwall, the risk ranking was changed from C 5 22 to D 4 21.*	Saf	D	4	21	-	-
IS098	Failure to implement the approved Extraction Plan.	-	Business	Clear allocation of roles and responsibilities for implementing the Extraction Plan. Internal auditing process. Regular reporting to regulatory agencies.	Bus	D	4	21	-	-
IS099	Failure to gain approval of the Extraction Plan resulting in production delays.	2	Business	Consultation with regulators during preparation of the Extraction Plan. Identification of schedule of works for applying for the Extraction Plan approval. *LW10A Review: Not ranked as this is an internal business approval risk, not a subsidence risk.*	-	-	-	-	-	-

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS113	LW 10A mined before LW8B potentially leading to the Extraction Plan not being approved at the right time.	-	Business	Internal mine plan process and schedule. Consultation with regulators during revision of the Extraction Plan. Identification of schedule of works for applying for Extraction Plan approval.Note: Ranked on basis of production delay. *LW10A Review: The team reviewed the production implications and changed the risk ranking from D 3 17 to D 4 21.*	Bus	D	4	21	-	-
11. Introduction of LW10A - Specific Aspects and Impacts										
IS115	Environmental consequences associated with increased ponding above Longwall 10A.	-	Surface Water	Implement monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Undertaken remediation where required.	Env	D	3	17	-	-
IS116	Potential for changes in alignment of Wambo and Stony Creeks above LW 10A.	4	Surface Water	Implement monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Undertaken remediation where required.	Env	D	5	24	-	-
IS117	Potential for increased erosion in Wambo and Stony Creeks resulting in potential changes in downstream water quality.	1	Surface Water	Implement Bed and Bank Stability Monitoring Plan. Implement monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Undertaken remediation where required.	Env	Not ranked in the workshop. Covered by MSEC for revised LW 10A			Review location of LW10A in relation to previous grouting activities on Wambo Creek.	WCPL Environment and Community Manager (31/1/2015)
IS118	Potential fracturing in sandstone outcrops adjacent to Wollombi Brook.	2	Land/Heritage	Controlled by location outside of angle of draw.	Saf	C	5	22	-	-
IS119	Potential for impacts on groundwater users or baseflow as a result of drawdown effects from dewatering in the Whybrow Seam.	1	Groundwater	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Maintenance of existing water agreements with potentially affected groundwater users (i.e. neighbouring private landholders).	Env	B	5	19	Review monitoring bore requirements for LW 10A - particularly to the south near the Mining Lease.	WCPL Environment and Community Manager (31/1/2015)

Ref	Process/Issue/Activity	Votes	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom/By When
IS120	Potential for LW 10A to reactivate subsidence cracking which required historic repairs to Wambo Creek over Whybrow workings panel 9 and 9A.	4	Surface Water	Implement monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Undertaken remediation where required. Develop TARP consistent with approach for the North Wambo Creek Subsidence Response Strategy.	Env	D	5	24	Review location of LW10A in relation to previous grouting activities on Wambo Creek.	WCPL Environment and Community Manager (31/1/2015)
IS121	Environmental/subsidence impacts on South Wambo Creek (in particular the confluence area with Stony Creek and potential for erosion).	5	Surface Water	Monitoring and management measures in accordance with the WMP (including the SWMP, GWMP and SGWRP). Remediation where required.	Env	D	5	24	Review piezometer triggers for Wambo Creek (P109).	WCPL Environment and Community Manager(31/1/2015)

12.2 *Systems Approach to Risk Treatment*

Areas of intervention

Controls need to be considered through their area of intervention. Controls can act to:

- **Prevent:** Preventative controls act in the causal pathway to stop incidents from occurring. A preventative control is typically aimed at the root causes of an incident – e.g. by designing out the risk, using a different process or providing multiple hard barriers between causes (energy sources) that cause situations to operate as required by the organisation; or
- **Mitigate a Loss:** Where mitigating controls act to limit the outcome of any incident – and typically operate in layers of protection such as:
  - **First Response:** Which react quickly to minimise the consequence of a loss event. Typical examples are engineered crash devices, pumping systems or first aid capacity; and
  - **Restore/Recovery:** Where the controls restore the system to the best possible state after an incident – such as limiting a fatal accident to a serious injury or a major environmental incident to a significant incident. Mitigating controls include emergency response capability and contingency measures.

Wheel of Safe Production (Nertney Wheel)

To achieve safe production (centre of the wheel), certain key groups shown in the figure below need to be considered:

Figure 5: Wheel of Safe Production

The following is a general description of the groups within the wheel:

Competent People and Safe Work Practices

- Appropriately selected and appointed personnel, who are;
- Trained/educated in the procedures and practices required in their role, and are;
- Adequately supervised and mentored; and
- Have discipline processes supported in a just culture.

Fit For Purpose Equipment

- Designed or selected to meet the known operating conditions;
- Introduced to site to confirm standards are met;
- Included in maintenance regimes to maintain the equipment to manufacturer specifications;
- Regularly proof tested (safety functions); and
- Withdrawn from service if standards are not met and addressed through a reporting and breakdown system.

Controlled Work Environment

- Physical environment such as the weather, hot/cold, dust, noise;

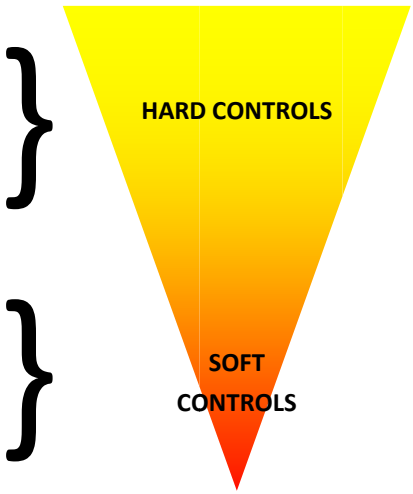
- Management such as rosters, time of work, communication, shift changes, systems generally;
- Policies;
- Planned inspections; and
- Audits and reviews.

Sequence of Barriers (Hierarchy of Controls)

Additional controls were developed throughout the hazard identification section of the risk assessment with a focus on the hierarchy of controls as depicted in Figure 6.

Figure 6: Hierarchy of Control

1. Eliminate the Hazard
2. Substitute/Minimise
3. Engineering Control
   - Redesign
   - Enclose
   - Isolate
4. System Controls
   - Safe Work Procedures
   - Training
   - Warning Devices
5. PPE (last line of defence)



12.3 *Risk Ranking Tables*

Table 7: Qualitative Measures of Likelihood

Rank (L)	Likelihood	Description
A	Almost Certain	Happens often.
B	Likely	Could easily happen.
C	Possible	Could happen and has occurred elsewhere.
D	Unlikely	Hasn't happened yet but could.
E	Rare	Conceivable, but only in extreme circumstances.

Table 8: Qualitative Measures of Consequence

Ref (C)	Consequence	Comment
1	Extreme environmental harm	e.g. widespread catastrophic impact on environmental values of an area.
2	Major environmental harm	e.g. widespread substantial impact on environmental values of an area.
3	Serious environmental harm	e.g. widespread and considerable impact on environmental values of an area.
4	Material environmental harm	e.g. localised and considerable impact on environmental values of an area.
5	Minimal environmental harm	e.g. minor impact on environmental values of an area.

Table 9: Quantitative Measures of Maximum Reasonable Consequence to Assets/Business

Ref (C)	Consequence
1	More than $1 billion (B) loss or production delay.
2	$100M to $1B loss or production delay.
3	$5M to $100 million (M) loss or production delay.
4	$250 thousand (k) to $5M loss or production delay.
5	Less than $250k loss or production delay.

Table 10: Risk Ranking Table

Consequence (C)	Likelihood (L)					
		A	B	C	D	E
	1	1 (H)	2 (H)	4 (H)	7 (M)	11 (M)
	2	3 (H)	5 (H)	8 (M)	12 (M)	16 (L)
	3	6 (H)	9 (M)	13 (M)	17 (L)	20 (L)
	4	10 (M)	14 (M)	18 (L)	21 (L)	23 (L)
	5	15 (M)	19 (L)	22 (L)	24 (L)	25 (L)

Notes:

L = Low; M = Moderate; H = High

Risk Numbering:

1 = highest risk, 25 = lowest risk

Legend:

	Broadly Acceptable
	ALARP – As low as reasonably practicable
	Intolerable

12.4 *About Your Report*

Your report has been developed on the basis of your unique and specific requirements as understood by Operational Risk Mentoring and only applies to the subject matter investigated.

We have endeavoured to accurately gather information from observations, document reviews and from site personnel. Analysis has been conducted using the best methods of risk engineering science known to the author(s) and should represent a useful suite of information on which the site can base subsequent actions.

Even with all these efforts made it is possible that errors may exist in the document or that the recommendations may not be fully effective in avoiding unwanted risks.

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