WAMBO COAL PTY LIMITED

SOUTH BATES EXTENSION UNDERGROUND MINE

EXTRACTION PLAN
LONGWALLS 17 TO 20

REPORT 4
SUBSIDENCE RISK ASSESSMENT

Peabody

Operational Risk Mentoring
Practical Solutions for Operational Risk Management

For Wambo Coal Pty Ltd

South Bates Extension Underground Mine – Longwalls 17 to 20 Subsidence Risk Assessment Report

Report Title:	South Bates Extension Underground Mine – Longwalls 17 to 20 Subsidence Risk Assessment Report
Client:	Wambo Coal Mine, Environment and Community Manager
By:	Peter Standish, Director and Principal Consultant
Team Session:	Team session – 1st February 2018
Job:	ORMJ1801
Revision:	V1
Date:	19th April 2018

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DOCUMENT DISTRIBUTION AND CONTROL

Ref No.	ORMJ1801
Title	South Bates Extension Underground Mine Longwalls 17 to 20 Subsidence Risk Assessment Report
General Description	This report summarises the results and recommends follow up actions from the study conducted into Longwalls 17 to 20 subsidence in relation to the South Bates Extension Underground Mine. It reviews the various aspects and impacts of the potential effects of subsidence due to mining Longwalls 17 to 20 inclusive.
Key Supporting Documentation	AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines. MDG1010 – Minerals Industry Safety and Health Risk Management Guideline. Wambo Coal Pty Limited – Wambo Development Project Environmental Impact Statement (2003). Wambo Coal Pty Limited – South Bates (Wambo Seam) Underground Mine Modification Environmental Assessment (2015). Wambo Coal Pty Limited – South Bates Extension Modification Environmental Assessment (2017). MSEC – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan for WYLW11 to WYLW13 in the Whybrow Seam and WMLW14 to WMLW16 in the Wambo Seam (2016). MSEC – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan Application for the South Bates Extension WYLW17 to WYLW20 (draft, unpublished). Operational Risk Mentoring – South Bates (Whybrow Seam) Underground Mine – Longwalls 11 to 13 Subsidence Risk Assessment Report (2015). Operational Risk Mentoring – South Bates Underground Mine – Longwalls 11 to 16 Subsidence Risk Assessment Report (2016). Wambo Coal Pty Limited – South Bates Underground Mine Extraction Plan Longwalls 11 to 16 (2017).

Versions

Rev	Date	Description	Created By	Checked
0	14/02/2018	Draft report issued for client and team review	P Standish	J Hinks
1	19/04/2018	Final report	P Standish	J Hinks

Distribution List of Latest Version

No	User	Position
1	Wambo Coal Pty Ltd	Peter Jaeger
2	Resource Strategies	Joanna Hinks
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 South Bates Underground Mine is a component of the approved Wambo Coal Mine and is approved for extraction in the Whybrow and Wambo Seams. Longwall extraction in the Whybrow Seam commenced in 2016. Longwall extraction from the Wambo Seam commenced in mid-2017.

An Extraction Plan for Longwalls 11 to 13 at the South Bates Underground Mine was approved by the Department of Planning and Environment on 9th February 2016. The revised Extraction Plan for Longwalls 11 to 16 was approved on 11th October 2017.

This risk assessment report has been prepared to support an Extraction Plan for Longwalls 17 to 20 in the Whybrow Seam at the South Bates Extension Underground Mine.

This work follows on from earlier team based risk assessments. The earlier team based risk assessments have highlighted:

- Groundwater issues – such as failure of the monitoring program to detect and respond to an impact on the groundwater system;
- Surface water – with issues related to the North Wambo Creek diversion and the open cut void;
- Flora and fauna – with potential undermining of Remnant Woodland Enhancement Program (RWEP) areas;
- Land impacts due to subsidence of major or minor cliff lines;
- Public safety – with potential for step cracking due to subsidence impacts on access tracks;
- Subsidence effects appear to be consistent with predictions made by Mine Subsidence Engineering Consultants (MSEC); and
- Experience of subsidence impacts as a result of Longwalls 11 to 14 indicates that the likelihood of some risks may not be as high as previously anticipated.

All identified risks have a Risk Treatment Plan (Appendices). 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.

Recommendations made by the team in the risk assessment workshops are included in Table 1. The team understood that WCPL will track and review these actions – updating this Risk Assessment Report as required, and confirm the adequacy of the identified controls.

With the application of the identified controls, the team consensus was that subsidence related impacts over Longwalls 17 to 20 could be managed at a tolerable level of risk.

1.1 *Consolidated Action Plan*

The following table presents consolidated follow up actions identified during the risk assessment workshop conducted in February 2018.

Table 1: Consolidated Action Plan

Ref	Process/Issue/Activity	Actions	Responsible	Status
SB012/ SB044	Unintended subsidence impacts resulting in rock instability of the Wollemi National Park escarpment and associated environmental consequences.	Review monitoring for Wollemi National Park escarpment, and augment if required.	Environment and Community Team	Complete – Subsidence Monitoring Program and Land Management Plan
SB071	Unanticipated subsidence remediation and/or rework of remediation required due to subsidence controls and/remediation implemented not meeting regulator expectations.	Consult with government to get agreement on methodology and approach. Incorporate outcomes of government consultation into business planning processes.	Environment and Community Team	Ongoing as part of Mining Operations Plan process
SB008	Failure of the monitoring program to detect and respond to an impact on the groundwater system.	Update groundwater program and Equis system as part of the Extraction Plan.	Environment and Community Team	Complete – Water Management Plan
SB010	North Wambo Creek Diversion damaged by subsidence (surface cracking along diversion directly above Longwall 17) resulting in inflow to workings and delay to operations.	Revise relevant assessment for Clause 33 notification process for Longwalls 17 to 20.	Technical Services Manager	To be completed as part of Clause 33 notification prior to extraction
SB026/ SB038	High wall or end wall instability or collapse of the Montrose West pit due to insufficient protection from subsidence impacts.	Technical Services to undertake appropriate geotechnical studies into the potential impact of subsidence on pit walls and mine landforms.	Technical Services Manager	To be completed as part of Clause 33 notification prior to extraction
SB028	Mine subsidence impacts on known items/open sites of Aboriginal heritage.	New AHIP Consent to be granted	Environment and Community Team	Complete – AHIP #C0003213 granted on 27 February 2018
SB050	Boundary faults and Redmanvale fault result in differences between modelled and observed groundwater drawdown (possibly conservative at a distance, but inaccurate locally).	Review potential influence of geological features on groundwater predictions.	Environment and Community Team	Complete – Technical Report 2

2 DEFINITIONS

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

Term	Explanation
AHIP	Abbreviation – Aboriginal Heritage Impact Permit.
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 – Groundwater 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.
SBU	Abbreviation – South Bates Underground Mine.

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.
RWEP	Abbreviation -Remnant Woodland Enhancement Program. Areas being managed by WCPL to help to conserve regional biodiversity, whilst enhancing the habitat available to flora and fauna.
SGWRP	Abbreviation – Surface and Groundwater Response Plan.
SWMP	Abbreviation – Surface Water Monitoring Program.
WCPL	Abbreviation – Wambo Coal Pty Limited.
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 the South Bates Extension Underground Mine Longwalls 17 to 20;
- 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 the WCPL Environment and Community Manager.

3.3 *Scope*

On the 1st of February 2018, a team consisting of WCPL technical and environmental staff and specialist consultants participated in a facilitated risk assessment workshop on South Bates Extension Underground Mine Longwalls 17 to 20 inclusive. The scope of the workshop was:

> *"To review the risk assessment previously completed for the South Bates Underground Mine, 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.*
>
> *To confirm that all risks and issues identified are relevant to the South Bates Extension Underground Mine."*

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 (Department of Mineral Resources, 2003)[1];
- Analysis of identified risks and nomination of key potential environmental issues; and
- Ranking of the risks, including consideration of mitigation measures.

[1] It is noted that although this Guideline no longer applies, it still provides a list of features that aid in hazard identification.

3.4 *External Facilitation*

The team sessions were facilitated by Dr Peter Standish of Operational Risk Mentoring – a company specialising in risk assessment and risk management processes.

3.5 *The Team*

The team met on 1st February 2018 at the WCPL site, near Singleton, NSW. A team-based approach was utilised in order to incorporate an appropriate mix of skills and experience to identify the potential loss scenarios/issues relating to Longwalls 17 to 20. Details of the team members and their relevant qualifications and experience are shown in Table 2.

Table 2: Team Members

Name	Affiliation and Role	Qualifications and Experience
Steve Peart	Manager - Environment and Community - WCPL	B Env Sc, 12 years mining experience.
Mark Cook	Manager - Health, Safety and Training	36 years experience and formal qualifications in safety and health.
Nicole Dobbins	Environmental Adviser – WCPL	B Sc (Environment Biology) and over 15 years experience in environmental management and project approvals in the resource industry.
Peter Jaeger	Senior Environmental Advisor - WCPL	B Env Sc, Grad Cert Agri Business, over 10 years in energy sector.
James Barbato	Subsidence Engineer - MSEC	B Eng (Civil) and PhD, 14 years experience as a subsidence engineer.
Joanna Hinks	Project Manager - Resource Strategies	BE (Environmental); 10 years experience environmental management and project approvals in resource industry.
Matthew Copeland	Project Manager - Resource Strategies	BE (Civil and Geotechnical); 3 years experience environmental management and project approvals in resource industry.
Peter Standish	OpRM / Facilitator	35 years mining industry experience and facilitating risk assessments for 15 years. Formal mining qualifications including a B Eng (Hon) and PhD.

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.

At the conclusion of the session the team confirmed that their goals had been largely met – apart from completing the required follow up activities.

4 ESTABLISH THE CONTEXT

4.1 *Project Context*

Wambo Coal Mine is an open cut and underground coal mining operation located approximately 15 km west of Singleton, near the village of Warkworth, NSW. The Wambo Coal Mine is owned and operated by WCPL, a subsidiary of Peabody Energy Australia Pty Limited.

A range of open cut and underground mine operations have been conducted at the Wambo Coal Mine since mining operations commenced in 1969. Mining under the Development Consent (DA 305-7-2003) commenced in 2004 and currently both open cut and underground operations are conducted.

The South Bates Underground Mine is a component of the approved Wambo Coal Mine, located north-west of the completed North Wambo Underground Mine (see **Figure 1**). The South Bates Underground Mine is approved for extraction in the Whybrow Seam (Longwalls 11 to 13) and the underlying Wambo Seam (Longwalls 14 to 16).

The South Bates Extension Underground Mine is also a component of the approved Wambo Coal Mine, located north-west of the South Bates Underground Mine (see **Figure 1**). The South Bates Extension Underground Mine is approved for extraction in the Whybrow Seam (Longwalls 17 to 25).

At the time of the February 2018 workshop, extraction of Longwalls 11 to 13 and Longwall 14 had been completed, and extraction in Longwall 15 was scheduled to commence. Extraction from Longwalls 17 to 20 is anticipated to commence in late 2018.

This risk assessment report has been prepared to support an updated Extraction Plan for Longwalls 17 to 20 in the Whybrow Seam at the South Bates Extension Underground Mine.

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

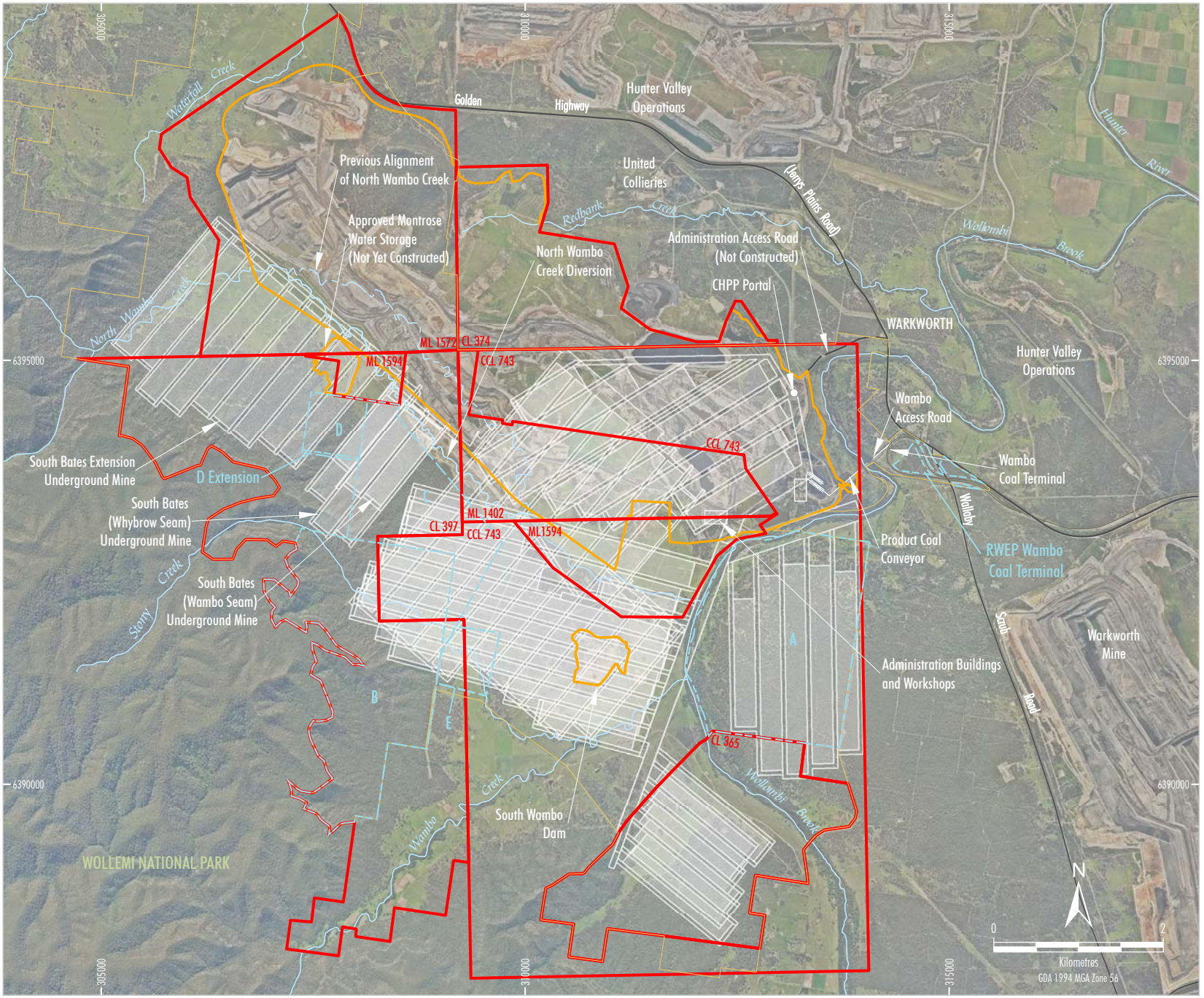
4.2 *Risk Management and Organisational Context*

The Development Consent (DA 305-7-2003) 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 subsidence impacts. Negligible environmental consequences. Controlled release of excess site water only in accordance with EPL requirements.
Low level cliffs	Minor environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing that in total do not impact more than 5% of the total face area of such features within the South Bates Extension Area).
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.
Central Hunter Valley Eucalypt Forest and Woodland Ecological Community	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.

Feature	Subsidence Impact Performance Measure
Other species, populations or communities listed under the *Biodiversity Conservation Act 2016* or the *Environment Protection and Biodiversity Conservation Act 1999*	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.



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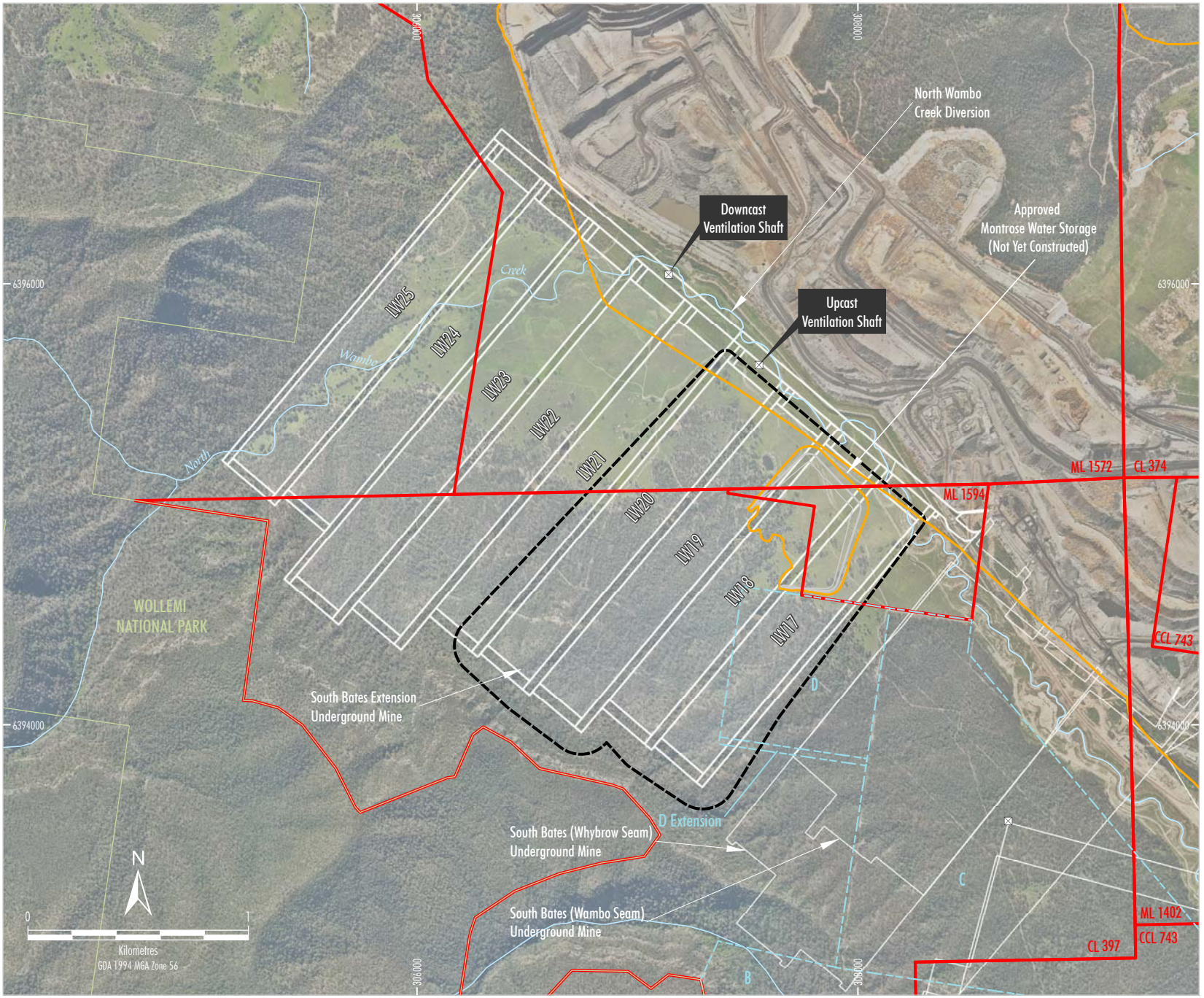
WAMBO COAL MINE

Wambo Coal Mine
Collective General Arrangement

Figure 1

WAM-09-15_SBX_EP_MP_SRA_201A



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Aerial Photograph of Longwalls 17 to 20

Figure 2

The Extraction Plan review process involved the following key steps:

1. Earlier studies from 2014 to 2016;
2. Latest extraction plan approved for Longwalls 11 to 16 approved in October 2017; and
3. Prepare Extraction Plan for Longwalls 17 to 20 for lodgement in the second quarter of calendar year 2018.

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 17 to 20 inclusive in the Whybrow Seam only;
- All commitments made in approval documentation (e.g. the *Wambo Development Project Environmental Impact Statement* and *South Bates Extension Modification Environmental Assessment*) or controls currently allocated to a work stream were taken to be “planned controls”; and
- Risk ranking was undertaken on the basis of consequences being in excess of approved levels and in consideration of remediation.

5 METHOD

5.1 *Key Steps*

The key steps in the risk assessment process were:

1. Background analysis on the subsidence issues and experiences of underground mining at the Wambo Coal 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 subject matter experts on the project and the status of detailed studies;
    c. review of earlier relevant Risk Assessment studies (for Longwalls 11 to 16 and the North Wambo Underground Mine);
    d. modified HAZOP - reviewing an aerial photo view of the mine to identify potential surface features which could contribute to/be affected by subsidence;
    e. cross mapping to the applicable 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 in Appendix B of EDG17 to confirm all items have been addressed;
    f. prioritisation (of identified items) – through a voting system conducted by the team;
    g. risk ranking of the outcomes shown in the confirmed risk and control chart;
    h. identification of planned (existing) and additional controls to mitigate risk levels to a tolerable state; and
    i. 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; and
5. Finalise the report and issue as a controlled copy for ongoing use.

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[2].

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

[2] It is noted that although this Guideline no longer applies, however, it still provides a list of features that aid in hazard identification.

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 5. 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 private points allocation system whereby team members were assigned a number of points 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.)[3].

[3] 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.

A number of points (60) were issued to the team members as notes which they could allocate against the various individual points.

The results of this output are shown in Table 4, ordered by descending points 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 the Appendices.

Table 4: Priority Issues

Ref	Process/Issue/Activity	Priority	Aspect Type
SB012/ SB044	Unintended subsidence impacts resulting in rock instability of the Wollemi National Park escarpment and associated environmental consequences.	65	Land
SB071	Unanticipated subsidence remediation and/or rework of remediation required due to subsidence controls and/remediation implemented not meeting regulator expectations	50	Business
SB011	North Wambo Creek Diversion damaged by subsidence resulting in reduced flow affecting downstream water quality.	30	Surface Water
SB013A	Exceedance of subsidence impact performance measure for the low level cliffs above longwalls.	30	Land
SB016	Subsidence impacts on the RWEP (Remnant Woodland Enhancement Program) areas and potential United Wambo Joint Venture Offset areas reducing biodiversity values.	30	Flora/Fauna
SB068	Potential impacts on rock shelters (three sites located directly above and one outside the extent of the longwalls).	30	Archaeological
SB008	Failure of the monitoring program to detect and respond to an impact on the groundwater system.	25	Groundwater
SB051	Impacts on access for firefighting or fire management purposes over Longwalls 17 to 20.	25	Public Safety
SB045	Induced leakage from North Wambo Creek Diversion due to subsidence resulting in adverse impact on environmental flow.	20	Surface Water
SB064	Ingress of oxygen into mine workings as a result of subsidence cracking and subsequent spontaneous combustion events.	20	Business
SB015	Subsidence impacts resulting in significant cracking and downslope movement of steep slopes and associated environmental consequences.	10	Land
SB046	Creation of subsidence repairs, monitoring or other tracks affects the conservation values of the RWEP (Remnant Woodland Enhancement Program) areas and potential United Wambo Joint Venture Offset areas.	10	Flora/Fauna
SB053	Subsidence impact on proposed Montrose Dam.	10	Infrastructure
SB056	Subsidence impacts to WCPL buried power lines and communication cables.	10	Infrastructure
SB003	Reduced base flow to North Wambo Creek / diversion resulting from a lowering of the water table associated with the extraction of Longwalls 17 to 20.	5	Surface Water
SB004	Environmental consequences associated with water flow and quality changes in unnamed minor drainage lines resulting from subsidence impacts associated with the extraction of Longwalls 17 to 20.	5	Surface Water
SB010	North Wambo Creek Diversion damaged by subsidence (surface cracking along diversion directly above Longwall 17) resulting in inflow to workings and delay to operations.	5	Infrastructure
SB013	Subsidence impacts resulting in instability or rock fall of intermediate cliff lines resulting in environmental consequence (i.e. lower level cliff lines and spur).	5	Land
SB017	Subsidence impacts to unsealed gravel access roads or fire trails.	5	Infrastructure
SB019	Mine subsidence impacts resulting in impacts on vegetation along the North Wambo Creek Diversion.	5	Flora/Fauna
SB021	Subsidence impacts and surface disturbance due to extraction of Longwalls 17 to 20 resulting in long-term loss of native vegetation.	5	Flora/Fauna

8 ASSESS RISK

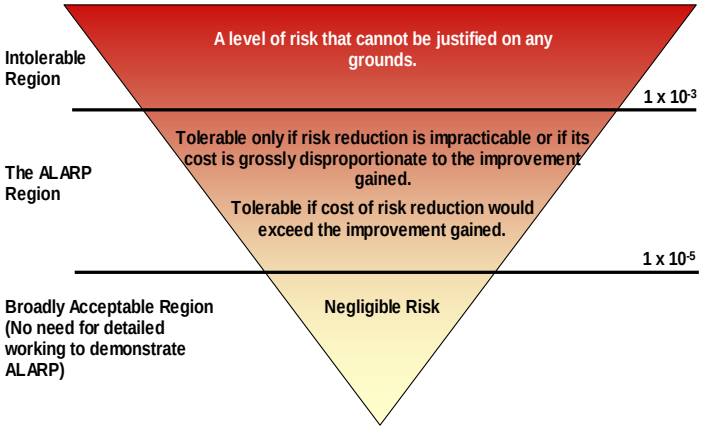
8.1 *Risk Acceptability and Risk Criteria*

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 (Appendices).

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 3**. A risk may be tolerable in the ALARP zone if the cost of removing the risk is disproportionate to the benefits gained.

Figure 3: 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 given in the Appendices shows the risk ranking results. The teams took into account cumulative impacts throughout all loss scenarios.

Figure 4: Risk Assessment Matrix

			Consequence					
Likelihood	*Likelihood description*	*Probability*	Low (1)	Minor (2)	Moderate (5)	Significant (10)	Major (25)	Catastrophic (50)
5 - Very Likely	Likely to occur repeatedly – Expected in the work team	10% - 100%	5	10	25	50	125	250
4 - Likely	Probably will occur several times - Expected at this location	1% - 10%	4	8	20	40	100	200
3 - Possible	Could occur intermittently - Expected within Peabody	0.1% - 1%	3	6	15	30	75	150
2 - Unlikely	Could occur but hardly ever - Expected within the mining industry	0.01% - 0.1%	2	4	10	20	50	100
1 - Rare	Improbable or unrealistic - Not expected in the mining industry but seen in other industries	< 0.01%	1	2	5	10	25	50

			Consequence descriptions					
	Consequence Category		Low	Minor	Moderate	Significant	Major	Catastrophic
	Harm to People	P	Near miss, near hit, no medical treatment, report only (RO)	Slightly injured, first aid treatment (FAI)	Medical treatment (MTI), disabling reversible impairment, restricted work (RWI) or lost time (LTI)	Serious bodily injury or disabling irreversible impairment, permanent partial disability (PPD)	Single fatality incident. Total and permanent disability (TPD). Major irreversible health effects	Multiple fatality incident. Major injury / disease among multiple employees
	Environmental	E	Negligible or reversible environmental impact Nil to minor remediation (typically a shift) No breach of regulations or requirement to report to regulators	Minor reversible environmental impact, minor remediation (typically < 5 days) Non-compliances and breaches of regulation that may result in a citation (NOV) May require reporting to the regulators	Incident resulting in moderate reversible onsite and/or off-site impact causing short term effect. Moderate remediation required (typically a month) Non-compliances and breaches of regulation that may result in prosecution or citation or punitive fine. Requirement or obligation to report to the regulators	Incident resulting in significant onsite or off-site environmental impact causing medium to long term environmental harm Significant remediation required (typically less than 12 months) Significant legal issues, non-compliances and breaches of regulation that results in a prosecution or citation or fine Moderate litigation issues involving many weeks of senior management time	A major incident resulting in regional environmental impact causing long term environmental harm Major long term remediation required (greater than 12 months) Major litigation or prosecution resulting in long term interruption to operations or loss of licence at a site	Incident resulting in catastrophic widespread regional environmental harm causing disastrous effect Major long term remediation required (over multiple years) Major litigation or prosecution , Loss of License to operate at Multiple sites
	Finance (higher of cost or NPV)	F	<$10,000	$10,000 - $100,000	$100,000 - $1 mil	$1 mil - $20 mil	$ 20 mil-$100 mil	>$100 mil
	Impact on reputation	R	Minor impact, no public concern; Market cap impact < $20 M (< $0.07 per share)	Local media or public concern; Market cap impact $20 M - $30 M ($0.07 - $0.12 per share)	Regional media or public concern. Local criticism; Market cap impact $30 M - $100 M ($0.12 - $0.40 per share)	National adverse media or public criticism; Market cap impact $100 M - $250 M ($0.40 - $1.00 per share)	International adverse media or public criticism. International public concern; Market cap impact $250 M - $500 M ($1.00 - $1.85 per share)	Significant international public or media criticism or condemnation; Market cap impact > $500 M (> $1.85 per share)
	Law / Compliance / regulatory	C	Minor, one-off violations of law, regulation, permit or policy; minimal fines, penalties or costs	Recurring or systemic minor violations of law, regulation, permit or policy	Violations of law, regulation, permit or policy with moderate fines or penalties, Moderate Litigation, MSHA imminent danger order or similar	Significant violation of law or permit with material fines, penalties or costs. Serious dispute with strategic customer. Major Litigation	Material Litigation. Serious investigation by SEC, DOJ or foreign equivalent. Code of Conduct violations	Criminal investigation or proceedings involving officers or directors. Litigation with allegations of executive fraud or misappropriation
	Strategic risk	SR	Event does not have a meaningful impact to Strategic Outlook	Event does not have meaningful impact to Strategic Outlook, but may require further monitoring	Event may have a material impact on near-term outlook for a region or mine	Event has a material impact on strategic outlook for a region or basin that may require a change to operations to mitigate risk	Event causes mines in a region or basin to cease current operations	Event or threat such that BTU would cease to exist as an ongoing concern in coal operations

Risk Score	Notification	Level	Action (H&S)
<11	Crew / team	Same level	Develop a plan (formal or informal) with crew or continue with and established plan (SOP etc.) that ensures the task can be completed safely. Team should remain aware for changing conditions.
11 to 30	Supervisor	.+1	Develop a formal safe action plan with supervisor and others within the crew (SOP) that identifies all known hazards and details what controls need to be in place and how the task should be performed to ensure it can be completed safely.
31 to 50	Area manager or site GM	.+2	Conduct a formalized risk review of existing work process and controls. Explore additional control options that eliminate, substitute or reduce the risk. Monitor controls for effectiveness during the task.
51 - 100	BU Mgt	.+3	Controls should be reviewed to ensure risk is as low as reasonably practicable (ALARP), critical controls must be identified and monitored for effectiveness. If risk is not at ALARP, additional controls must be identified and a plan developed for implementation.
101 to 199	ELT	.+4	Controls should be added / improved and an additional risk assessment completed for activity to proceed.
200 or greater	CEO	.+5	Controls should be added / improved and an additional risk assessment completed for activity to proceed.

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.

A 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 analysed and recommendations for amendments or additions made where these existing controls were deemed unacceptable or inadequate.

Further, the prospective reliability of the controls identified was 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 given in the Appendices shows the risk evaluation results.

10 MONITOR AND REVIEW

10.1 *Nominated Coordinator*

The nominated coordinator is the WCPL Environment and Community Manager. 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 Hinks and Peter Jaeger who arranged the sessions and resources provided – and other team members who contributed to the risk assessment.

11 REFERENCES

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

Mine Subsidence Engineering Consultants (2016) Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan for WYLW11 to WYLW13 in the Whybrow Seam and WMLW14 to WMLW16 in the Wambo Seam.

Mine Subsidence Engineering Consultants (unpublished) Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan for WYLW17 to WYLW20

Operational Risk Mentoring (2015) South Bates (Whybrow Seam) Underground Mine – Longwalls 11 to 13 Subsidence Risk Assessment Report.

Operational Risk Mentoring (2016) South Bates Underground Mine – Longwalls 11 to 16 Subsidence Risk Assessment Report.

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

Wambo Coal Pty Limited (2015) South Bates (Wambo Seam) Underground Mine Modification Environmental Assessment.

Wambo Coal Pty Limited (2017a) South Bates Extension Modification Environmental Assessment.

Wambo Coal Pty Limited (2017b) South Bates Underground Mine Extraction Plan Longwalls 11 to 16.

12 APPENDICES

12.1 *Risk Treatment Plan*

The following Risk Treatment Plan was developed by the team during the session on 1st February 2018.

The table is ordered by aspect type and priority.

Table 5: Risk Treatment Plan

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB012/ SB044	Unintended subsidence impacts resulting in rock instability of the Wollemi National Park escarpment and associated environmental consequences.	65	Land	Implementation of Extraction Plan, Land Management Plan and Public Safety Management Plan. Identification of cliff lines that are associated with the Wollemi National Park with appropriate mine design offsets applied. *Ranking basis - Considered the implications of a serious non-compliance should the event occur. All the subsidence models and site experience suggest that this event is improbable and not expected to occur - but the consequence would be significant for both legal and reputation.*	C/R	1	10	10	Review monitoring for Wollemi National Park escarpment, and augment if required.	Environment and Community Team
SB071	Unanticipated subsidence remediation and/or rework of remediation required due to subsidence controls and/remediation implemented not meeting regulator expectations	50	Business	Mining Operations Plan and Extraction Plan process, third party inspection of previously subsidence areas and development of a register of works. *Ranking basis - Based on the potential for changing regulatory requirements / expectations and / or organisational changes on site, and the potential for access challenges to complete remediation.*	C	3	5	15	Consult with government to get agreement on methodology and approach. Incorporate outcomes of government consultation into business planning processes.	Environment and Community Team

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB011	North Wambo Creek Diversion damaged by subsidence resulting in reduced flow affecting downstream water quality.	30	Surface Water	Implementation of Extraction Plan and Water Management Plan, including bed and bank stability monitoring and remediation. *Ranking basis - Based on only a small section of the diversion experiencing further subsidence and the experience with earlier longwalls which showed no ingress of water into the underground.*	E	2	5	10	-	-
SB013A	Exceedance of subsidence impact performance measure for the low level cliffs above longwalls.	30	Land	Implementation of Extraction Plan, Land Management Plan and Public Safety Management Plan. Monitoring program against performance criteria (before and after subsidence). Contingency plan. *Ranking basis - Based on subsidence models, which indicate impacts are unlikely as the cliffs are small and conglomerate rock. Consequences are related to legal compliance.*	C	2	5	10	-	-
SB016	Subsidence impacts on the RWEP (Remnant Woodland Enhancement Program) areas and potential United Wambo Joint Venture Offset areas reducing biodiversity values.	30	Flora/Fauna	Implementation of the Extraction Plan, Biodiversity Management Plan, bed and bank stability monitoring, flora and fauna monitoring program, visual inspections and remediation.	E	3	2	6	-	-
SB068	Potential impacts on rock shelters (three sites located directly above and one outside the extent of the longwalls).	30	Archaeological	Recording of site prior to subsidence. Monitoring of two of the sites. New Aboriginal Heritage Impact Permit will be in place for the Application Area. Implementation of the Heritage Management Plan. *Ranking basis - Based on subsidence models, which indicate less than 10% probability for the four areas (so possible).*	E	3	2	6	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB008	Failure of the monitoring program to detect and respond to an impact on the groundwater system.	25	Groundwater	Documentation and execution of the Water Management Plan (including the Surface Water Monitoring Program, Groundwater Monitoring Program, Surface and Groundwater Response Plan and North Wambo Creek Subsidence Response Strategy). Assessment of impacts during development of the Extraction Plan. Clear allocation of roles and responsibilities in the management plans.	E	2	5	10	Update groundwater program and Equis system as part of the Extraction Plan.	Environment and Community Team
SB051	Impacts on access for firefighting or fire management purposes over Longwalls 17 to 20.	25	Public Safety	Implementation of the Public Safety Management Plan. Subsidence monitoring and remediation. Implementation of the Bush Fire Management Plan (which includes weekly inspections of fire trails).	P	1	2	2	-	-
SB045	Induced leakage from North Wambo Creek Diversion due to subsidence resulting in adverse impact on environmental flow.	20	Surface Water	Implementation of Water Management Plan and subsidence remediation. Noted to be a lower likelihood than in previous risk assessments due to the distance to the diversion (as the diversion is generally outside the mining area). *Ranking basis - Potential for some impact on a small section of the North Wambo Creek Diversion and consequence related to a leakage from the creek and inflows into the mine which may lead to a loss of environmental flows. Impact on licensing is likely to lead to a moderate impact through either fines or the requirement to purchase additional licenses also in the moderate range.*	L/F	2	5	10	-	-
SB064	Ingress of oxygen into mine workings as a result of subsidence cracking and subsequent spontaneous combustion events.	20	Business	Implementation of Ventilation and Gas Management Plan, Mines Inspection System and Spontaneous Combustion Management Plan. Subsidence modelling and monitoring.	SR	2	10	20	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB015	Subsidence impacts resulting in significant cracking and downslope movement of steep slopes and associated environmental consequences.	10	Land	Implementation of Extraction Plan, Land Management Plan and Public Safety Management Plan.	E	3	5	15	-	-
SB046	Creation of subsidence repairs, monitoring or other tracks affects the conservation values of the RWEP (Remnant Woodland Enhancement Program) areas and potential United Wambo Joint Venture Offset areas.	10	Flora/Fauna	Adherence to Surface Disturbance Permit as per Biodiversity Management Plan. Consultation with regulator. Remediation database. *Ranking basis - Based on costs associated with acquiring additional biodiversity offsets.*	F	2	5	10	-	-
SB053	Subsidence impact on proposed Montrose Dam.	10	Infrastructure	Dam not yet constructed - requirement for detailed design prior to construction and within mining sequence. *Ranking basis - Based on impacts on the potential to construct the dam in that location and a subsequent increase in cost of construction.*	F	2	5	10	-	-
SB056	Subsidence impacts to WCPL buried power lines and communication cables.	10	Infrastructure	Implementation of Extraction Plan and Built Features Management Plan. *Ranking basis - Based on no current infrastructure being located in the area.*	F	1	2	2	-	-
SB003	Reduced base flow to North Wambo Creek / diversion resulting from a lowering of the water table associated with the extraction of Longwalls 17 to 20.	5	Surface Water	Implementation of Extraction Plan and Water Management Plan, including monitoring and remediation.	E	2	5	10	-	-
SB004	Environmental consequences associated with water flow and quality changes in unnamed minor drainage lines resulting from subsidence impacts associated with the extraction of Longwalls 17 to 20.	5	Surface Water	Implementation of Extraction Plan and Water Management Plan, including monitoring and remediation.	E	2	5	10	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB010	North Wambo Creek Diversion damaged by subsidence (surface cracking along diversion directly above Longwall 17) resulting in inflow to workings and delay to operations.	5	Infrastructure	Adequate design of North Wambo Creek Diversion. Implementation of the Extraction Plan. Implementation of a TARP for crack remediation. Installation of adequate mine dewatering capacity.	SR	1	5	5	Revise relevant assessment for Clause 33 notification process for Longwalls 17 to 20.	Technical Services Manager
SB013	Subsidence impacts resulting in instability or rock fall of intermediate cliff lines resulting in environmental consequence	5	Land	Implementation of Extraction Plan, Land Management Plan and Public Safety Management Plan. *Ranking basis - Based on subsidence models, which indicate subsidence would be approximately 30 mm so likelihood is rare.*	E	1	2	2	-	-
SB017	Subsidence impacts to unsealed gravel access roads or fire trails.	5	Infrastructure	Implementation of Extraction Plan and Built Features Management Plan, including monitoring and remediation.	F	3	2	6	-	-
SB019	Mine subsidence impacts resulting in impacts on vegetation along the North Wambo Creek Diversion.	5	Flora/Fauna	Implementation of the Extraction Plan, Biodiversity Management Plan, bed and bank stability monitoring, flora and fauna monitoring program, visual inspections and remediation. IDSC annual monitoring program.	E	2	2	4	-	-
SB021	Subsidence impacts and surface disturbance due to extraction of Longwalls 17 to 20 resulting in long-term loss of native vegetation.	5	Flora/Fauna	Implementation of the Extraction Plan, Biodiversity Management Plan, bed and bank stability monitoring, flora and fauna monitoring program, visual inspections and remediation.	E	1	2	2	-	-
SB007	A change in land surface slope and preferential pathways for rainfall infiltration resulting from fracturing to the land surface caused by the extraction of Longwalls 17 to 20.		Surface Water	Implementation of Extraction Plan and Water Management Plan, including bed and bank stability monitoring and remediation. Implementation of hard engineering management structures (rock chutes). Annual IDAS monitoring.	E	2	5	10	-	-
SB009	Structural damage to wells and bores close to the mine footprint, in particular monitoring bores and other gas drainage infrastructure.		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan.	F	2	5	10	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB014	Subsidence impacts resulting in instability of rock pagodas or other rock features and associated environmental consequences.		Land	Implementation of Extraction Plan, Land Management Plan and Public Safety Management Plan. (Note: no pagodas known in the study area).	E	1	5	5	-	-
SB020	Subsidence impacts and surface disturbance due to the extraction of Longwalls 17 to 20 resulting in loss of habitat for threatened species.		Flora/Fauna	Implementation of the Extraction Plan, Biodiversity Management Plan, bed and bank stability monitoring, flora and fauna monitoring program, visual inspections and remediation.	E	1	5	5	-	-
SB022	Mine subsidence impacts to fences on WCPL owned land.		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan, including monitoring and remediation.	F	3	2	6	-	-
SB023	Mine subsidence impacts to WCPL mine dewatering pipeline.		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan, including monitoring and remediation.	SR	2	2	4	-	-
SB024	Mine subsidence impacts to other water management infrastructure (pipelines, roads and pumps).		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan, including monitoring and remediation.	SR	2	2	4	-	-
SB025	Exploration activities affected by subsidence.		Infrastructure	Ground Disturbance Permit and Surface Disturbance Permit processes.	SR	1	2	2	-	-
SB026/ SB038	High wall or end wall instability or collapse of the Montrose West pit due to insufficient protection from subsidence impacts.		Infrastructure	Implementation of Built Features Management Plan, Slope Stability Management Plan, high wall inspection program. Execution of geotechnical assessment processes.	SR	1	1	1	Technical Services to undertake appropriate geotechnical studies into the potential impact of subsidence on pit walls and mine landforms.	Technical Services Manager
SB027	Subsidence impacts to active services lines over LWs 17 to 20 resulting in delays in production.		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan.	SR	2	2	4	-	-
SB028	Mine subsidence impacts on known items/open sites of Aboriginal heritage.		Archaeological	Implementation of Heritage Management Plan. New Aboriginal Heritage Impact Permit will be in place for the Application Area. Due diligence process for surface disturbance (Surface Disturbance Permit process).	E	2	2	4	New AHIP Consent to be granted.	Environment and Community Team

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB029	Mine subsidence impacts on items of unknown Aboriginal heritage.		Archaeological	Implementation of Heritage Management Plan. New Aboriginal Heritage Impact Permit will be in place for the Application Area. Due diligence process for surface disturbance (Surface Disturbance Permit process).	E	2	2	4	-	-
SB034	Impact on statutory inspections and service provision to open cut (e.g. low voltage and high voltage maintenance activities, access for other operational activities etc.).		Infrastructure	Implementation of Extraction Plan, Built Features Management Plan, Slope Stability Management Plan and high wall inspection program.	SR	1	2	2	-	-
SB035	Increased ponding along North Wambo Creek Diversion as a result of subsidence.		Surface Water	Implementation of Extraction Plan and Water Management Plan, including bed and bank stability monitoring and remediation.	E	2	5	10	-	-
SB037	Impact on stability/serviceability of levee bank between North Wambo Creek and the open cut void leading to water flows into the Bates South pit.		Surface Water	Subsidence modelling and assessment prior to extraction. Subsidence monitoring and remediation.	E	1	5	5	-	-
SB042	Subsidence impacts on access tracks restrict access for monitoring/remediation.		Infrastructure	Implementation of Extraction Plan and Built Features Management Plan, including monitoring and remediation.	C	3	5	15	-	-
SB050	Boundary faults and Redmanvale fault result in differences between modelled and observed groundwater drawdown (possibly conservative at a distance, but inaccurate locally).		Groundwater	Documentation and execution of the Water Management Plan (including the Surface Water Management Plan, Groundwater Management Plan and Surface and Groundwater Response Plan). Assessment of impacts during development of the Extraction Plan.	E	2	5	10	Review potential influence of geological features on groundwater predictions.	Environment and Community Team
SB052	Impacts on public access to areas subject to subsidence.		Public Safety	Restricted Access for Public. Implementation of Public Safety Management Plan. Subsidence monitoring and remediation.	P	2	5	10	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB054	A change in flood regimes or extent of potential inundation due to subsidence resulting from the extraction of Longwalls 17 to 20.		Surface Water	Implementation of Extraction Plan and Water Management Plan, including monitoring and remediation. Implementation of hard engineering management structures (rock chutes).	E	3	2	6	-	-
SB057	Subsidence impacts resulting in injury to livestock.		Land	Implementation of Public Safety Management Plan (particularly notification and fencing requirements or termination/suspension of lease).	P	1	2	2	-	-
SB058	Injury to animals or riders engaged in horse riding activities over Longwalls 17 to 20.		Public Safety	Restricted Access for Public. Implementation of Public Safety Management Plan. Subsidence monitoring and remediation.	P	2	5	10	-	-
SB059	Mine subsidence impacts resulting in damage to rehabilitated areas (including North Wambo Creek Diversion).		Flora/Fauna	Implementation of the Extraction Plan, Biodiversity Management Plan, bed and bank stability monitoring, flora and fauna monitoring program, visual inspections and remediation.	E	3	5	15	-	-
SB060	Operational impact associated with mining in proximity to adjacent previous workings in the Wambo Seam.		Business	Previous workings (including angle of draw) outside expected subsidence zones. Clause 33 notification process (for second workings).	SR	2	5	10	-	-
SB061	Operational impact associated with mining in proximity to adjacent previous workings in the Whybrow Seam.		Business	Previous workings (including angle of draw) outside expected subsidence zones. Clause 33 notification process (for second workings).	SR	2	5	10	-	-
SB065	Potential impact on the Whynot Homestead (located outside the mining area).		Archaeological	Archival recording and submission to Singleton Council, DPE, other relevant regulators and stakeholders in accordance with consent conditions.	E	1	1	1	-	-
SB066	Redmanvale Fault results in localised or increased subsidence inside the Wollemi National Park.		Flora/Fauna	Implementation of the Biodiversity Management Plan and Escarpment Monitoring Plan, visual inspections and remediation. Distance that the longwalls are offset from the fault, escarpment and national park.	C	1	10	10	-	-

Ref	Process/Issue/Activity	Priority	Aspect Type	Planned Controls	Cat	L	C	R	Actions	By Whom
SB069	Potential impacts on scarred tree (located outside the mining area).		Archaeological	Implementation of Heritage Management Plan. New Aboriginal Heritage Impact Permit will be in place for the Application Area. Due diligence process for surface disturbance (Surface Disturbance Permit process).	E	1	2	2	-	-
SB070	Subsidence impacts on farm dams leads to exposure to potential health and safety impacts		Infrastructure	Subsidence monitoring. Inrush Control management plan (potential for dewatering).	P	1	1	1	-	-

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

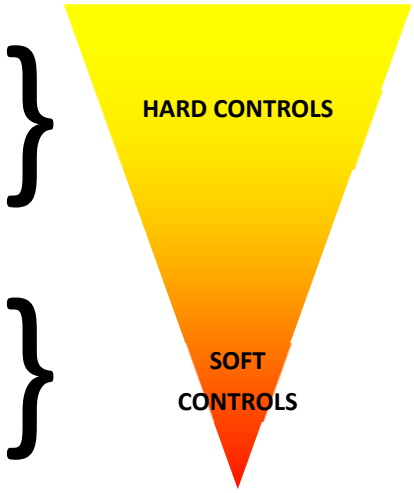
- Physical environment such as the weather, hot/cold, dust, noise;
- Management such as rosters, time of work, communication, shift changes, systems generally;
- Policies;
- Planned inspections; and
- Audits and reviews.

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 *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 due to information reviewed being erroneous or incomplete errors may exist in the document or that the recommendations may not be fully effective in avoiding unwanted risks.

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