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Broken Hill Operations Pty Ltd (BHOP)

Rasp Mine Extension

Risk Analysis – Surface / Environmental Aspects

Report Title:	BHOP Rasp Mine Extension Risk Analysis – Surface / Environmental Aspects
Client:	Visko Sulicich – Chief Operating Officer
Submitted By:	Peter Reardon – Director SP Solutions
Job:	J4508
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DOCUMENT DISTRIBUTION AND CONTROL

Document No.	D6674
Title	Broken Hill Operations (BHOP) – Rasp Mine Extension Risk Analysis Report
General Description	A summary of the review of controls and risks related to mine extension related hazards at the Rasp Mine. The primary focus is on the potential effects to the surface from the underground mining activities. Underground hazards and interactions with other underground workings or mines are assessed and controlled through the existing Mine Safety Management Plan.
Key Supporting Documentation	AS/NZS ISO 31000 Risk Management Pacific Environment – 9328 CBH Rasp Vent Shaft #6 AQA L0 R1 Prism Mining – Blast Vibration Review at Zinc Lodes, Rasp Mine Ground Control Engineering – G0057_AA_RE01_V03_RASP_ZINC_LODES DRAFT FINAL WITH APPENDICES, 16th October 2014 EMM – Approval Variation Noise Assessment – Zinc Lodes Barnson - Extension to Rasp Mine ay Broken Hill – Zinc Lode Affects to Road Reserve Infrastructure, 20 October 2014

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1	20/10/14	First issue	P. Reardon	R. Harrison
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No	User	Position
1	Visko Sulicich	Chief Operating Officer (COO)
2	Gwen Wilson	Group Manager Health, Safety, Environment and Community
3	Safe Production Solutions	Records

TABLE OF CONTENTS

List of Tables

List of Figures

1 EXECUTIVE SUMMARY

Broken Hill Operations Pty Ltd (BHOP) is a subsidiary of CBH Resources. BHOP owns and operates the Rasp Mine in Broken Hill. Australia. BHOP engaged SP Solutions to facilitate a risk analysis on Rasp Mine Extension as part of the Mine Safety Management Plan and the Application process for the extension. The approach taken was to identify typical causes and the related controls for those hazards that posed a threat to surface infrastructure, activities, environmental and the community.

The scope for the study was:

"To conduct a risk analysis of the mine extension to identify threats/hazards during the life cycle of the project that may impact on the surface (primarily environmental and community risks); clarify the risk potential and identify preventative controls, reactive controls and recommendations for consideration."

The Threat Analysis (Mind Maps) are included in Appendix 9.2, and the resulting Risk Treatment Plan is in Appendix 9.3.

Key Findings

A total of 5 key specific threats (with multiple sub-causes) were identified and have been included in the Analysis. Preventative and reactive or mitigation controls were allocated and an additional 24 recommendations were identified by the team for review by BHOP (refer to the Consolidated Action Plan on the next page).

Vibration transmission to the surface will be the primary concern but more data will be collected as access development gets closer to the area to verify effectiveness of controlling blasts. Blast size can therefore be controlled and increased incrementally to meet defined criteria. The critical control is that significantly smaller excavations will be created with significantly smaller blasts as compared with current mining activities.

Critical Controls for a range of threats identified at this stage of the process include:

Rasp Mine Extension – Critical Controls		
Structural Modelling to ensure constraints are known for drill/blast designs and vibration analysis	60m Crown Pillar between surface infrastructure and the upper mining horizon	Geotechnical assessment to ensure safe and stable excavations underground
Conservative stope design dimensions	Immediate filling after extraction	Mine planning and scheduling (operational control)
Ground control design	Geotechnical monitoring – verify performance of the excavations	Ground Control Management Plan
Blasting assessment, vibration and overpressure analysis	Drill and blast designs – limited in size hence potential vibration effects	Drilling implementation – to ensure accurate drilling of blast holes
Preparation, charging and blast control – various procedures to control the blasting	Mine sequencing/scheduling – to ensure excavations are created and filled on time	Survey control – of drill/blast holes and mining excavations to ensure separation distances are maintained
Blasting Management Plan	Heritage management	TARP – Trigger and Action Response Plan (in case there are potential indicators of overpressure, vibration or other effects on the surface

Critical documentation included the Ground Control Management Plan, Blasting Management Plan, and Emergency Response Management Plan.

Way Forward

The following table summarises the additional controls / actions from the team session. These will be reviewed by the site management team and included into the system with accountabilities (By Whom) and timing (By When) where suitable.

Table 1 : Consolidated Recommendations for Consideration

#	Threat/Hazard	Aspect	Information on Aspect	Additional Controls / Actions
1	Key Assumptions	The current Mine Safety Management Plan (or similar) is effective for ongoing management of risks associated with mining activities underground (including the mining methods and all associated tasks such as drilling, blasting, equipment operation etc.) including interactions with Perilya activities.	Specific operational risk assessments are conducted on any new activity or interaction	Conduct interaction risk assessment for mining in close proximity to Perilya as part of the safety management system.
2	Ground Failure / Subsidence affecting surface	Data collection	Data collection and detailed characterisation of ground conditions in the hanging wall and crown of the ore lens using existing drill core from 22 holes. Collect data through a staged approach to opening the area (1) development (2) cut and fill (3) bench stope.	Conduct ongoing testing of representative samples of the rock mass to characterise the engineering properties - particularly after initial development. Also includes validation of drill hole orientation
3	Ground Failure / Subsidence affecting surface	Structural Model	Initial review indicates there are no significant structures, shear zones and dolerite.	Develop structural model and refine as obtain more data

#	Threat/Hazard	Aspect	Information on Aspect	Additional Controls / Actions
4	Ground Failure / Subsidence affecting surface	Structural Model	Initial review indicates there are no significant structures, shear zones and dolerite.	Collect and interpret structural defect data and geotechnical data is necessary as mining progresses in the zinc lodes. This will allow validation of design parameters and timely input to the mine design process
5	Ground Failure / Subsidence affecting surface	60m Crown Pillar between surface infrastructure and the upper mining horizon	Initial analysis has been focussed on ensuring that the stopes are stable so that the crown pillar is not compromised – there must be no appreciable subsidence on the surface in order to protect surface assets	Formalise the analysis regarding the 60m pillar stability – COMPLETE. This has been completed and is provided in G0057_AA_RE01_V03_RASP_ZINC_LODES_DRAFT_FINAL_WITH_APPENDICES, 16th October 2014
6	Ground Failure / Subsidence affecting surface	Geotechnical assessment	The significant shear zones identified from the geotechnical core logging are not located in the hanging wall or crown of the bench stopes and are not expected to have an impact on the stability of the stopes or development access drives. Escalation Factor : distribution of the available geotechnical data throughout the zinc lode ore body is insufficient to discount the potential risk that development or stoping could intersect structures with sufficient continuity to influence the stope stability during production.	Increase the size and quality of the geotechnical database for the Zinc Lodes by collecting geotechnical information from future resource drilling programs
7	Ground Failure / Subsidence affecting surface	Immediate filling after extraction	Escalation Factor: not enough fill. Escalation Factor: fill infrastructure not in place to place fill. Combination of waste and hydraulic fill using existing fill and filling infrastructure extended as required (including tight filling the final 5m top access drive immediately beneath the road at decommissioning)	Ensure surface to underground backfill holes are included in the Mine Operations Plan (MOP) and Application
8	Ground Failure / Subsidence affecting surface	Geotechnical monitoring	Ongoing monitoring and back analysis of the performance of stope spans is carried out. Stope performance data is recorded and applied to stope and mine design.	Develop a comprehensive program to monitor stope stability and potential surface subsidence (implemented before and during the extraction of the zinc lodes)

#	Threat/Hazard	Aspect	Information on Aspect	Additional Controls / Actions
9	Ground Failure / Subsidence affecting surface	Ground Control Management Plan (GCMP)	There is an existing Ground Control Management Plan for the organisation so this needs to be updated to include the safeguards identified in this review and associated studies (eg) geotechnical assessment and modelling	Update the ground control management plan (GCMP) for the Zinc Lodes ore body. COMPLETE - This has been completed and is provided in the Appendices of G0057_AA_RE01_V03_RASP_ZINC_LODES_DRAFT_FINAL_WITH_APPENDICES, 16th October 2014
10	Ground Failure / Subsidence affecting surface	Trigger and Action Response Plan (TARP)	Trigger and Action Response Plan – is included in the GCMP but will need updating	Update the TARP to include the Zinc lode
11	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Vibration monitors are used to provide data from blasting and other potential sources (e.g.) activities on or near the points of interest such as the road, nearby buildings and Perilya activities etc.	Finalise the location of the vibration monitors (taking into account the nearest points of interest and associated limits that may be different for those points of interest, and the relative distances).
12	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Vibration monitors are used to provide data from blasting and other potential sources (e.g.) activities on or near the points of interest such as the road, nearby buildings and Perilya activities etc. Liaison with the road asset owner will be required to confirm blast levels that would not pose a threat to this structure. This level, based on engineering studies, will then be negotiated with the owner.	Formalise the limit for the road to protect the asset
13	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Vibration monitors are used to provide data from blasting and other potential sources (e.g.) activities on or near the points of interest such as the road, nearby buildings and Perilya activities etc. It is important to get baseline prior to blasting to ensure extraneous activities (eg) traffic, are taken into account	Validate the road vibration monitor to account for traffic effects (as a baseline)

#	Threat/Hazard	Aspect	Information on Aspect	Additional Controls / Actions
14	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Vibration monitors are used to provide data from blasting and other potential sources (e.g.) activities on or near the points of interest such as the road, nearby buildings and Perilya activities etc. There is an ongoing process of vibration analysis that can be updated as part of this vibration analysis	Finalise the 12 month rolling vibration data analysis
15	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Escalation factor: Do not set up the monitors properly and external interference	Establish the standard, procedure and training for the location, establishing, installing and taking results for monitor stations and roving monitoring units (including location and protection to prevent interference)
16	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Suitably competent personnel collect and review the data (internal and external)	Formalise the review/audit process for the vibration analysis and blast management plan
17	Blasting affecting surface (Vibrations and Overpressure)	Blasting assessment, vibration and overpressure analysis	Suitably competent personnel collect and review the data (internal and external)	Conduct additional training for key personnel (including assessment of vibration results, waveform etc.)
18	Blasting affecting surface (Vibrations and Overpressure)	Drilling implementation	Drilling equipment and drill consumables matched to achieving targeted limits – drilling accuracy can have significant impact on blast control (hence vibration)	Review the drilling equipment and drill consumables combination to optimise the control of drill hole accuracy
19	Blasting affecting surface (Vibrations and Overpressure)	Mine sequencing / scheduling	Firing takes into account points of interest with regards to vibration effects and potential impacts (Note: broken ground created between shots and the point of interest may have dampening effects)	Consider shrouding effects from filled stopes, voids and workings that assist to shield vibration transmission (Note : consider orientation of shear zones and how this can affect vibration transmission since can be variable)
20	Blasting affecting surface (Vibrations and Overpressure)	Survey control	Approved and accurate survey plans - Escalation Factor : Mis-match between grids used by Perilya and BHOP	Confirm the joining of the survey grids between BHOP and Perilya leases

#	Threat/Hazard	Aspect	Information on Aspect	Additional Controls / Actions
21	Blasting affecting surface (Vibrations and Overpressure)	Blast Management Plan	Formalise the approach taken to control blasting	Finalise the Blast Management Plan
22	Blasting affecting surface (Vibrations and Overpressure)	Blast Management Plan	Personnel feeling vibration on the surface during blasting. The limit could be set for the road at 100mm/s to manage impact on the road corridor assets however vibrations could still be felt on the surface.	Establish agreed PPV at which point pedestrian and vehicle traffic may be warned and/or temporarily stopped during blasts that exceed those limits - develop procedure to be applied at the time as required.
23	Amenity - Light, Air Quality / Odour, amenity and public interaction	Shaft 5 is fenced	There is already fencing around Shaft 5 but this will need to be improved/repaired as required	Review and upgrade the hole cover, fencing and signage for shaft 5
24	Impacts on local council Heritage	Heritage management	The main heritage items are locally vested (Council) and on the BHOP leases – no known Nationally listed items	Review nearby heritage items

2 INTRODUCTION

2.1 Objectives and Deliverables

The objectives of the team based risk analysis were as follows:

1. Identify, analyse, and assess the general risks associated with mine extension;
2. Identify current controls; and
3. Recommend additional controls where deficiencies or concerns are identified.

2.2 Client

The client for the risk assessment is Visko Sulicich – COO, Broken Hill Operations.
The coordinator is Gwen Wilson – Group Manager of Safety, Health, Environment and Community, BHOP.

2.3 Scope

The scope was to:

> ***"To conduct a risk analysis of the mine extension to identify threats/hazards during the life cycle of the project that may impact the surface (primarily environmental and community risks); clarify the risk potential and identify preventative controls, reactive controls and recommendations for consideration."***

The scope included:

1. Life cycle of the project – 3 years;
2. Linkages to current mine where applicable – concurrent activities that may impact on the project; and
3. Zinc Lode.

The scope did not include:

1. Current operation; and
2. Satellite targets – block 8 (already in current approval).

The diagram on the following page was used to clarify the scope with the team.

2.4 Team Mandate

Provide input into the process and challenge the adequacy of the controls (eg) procedures, training, equipment etc. The key focus is on hazards (underlying threats/causes) and the controls. Recommendations to be provided for the client to consider as part of the overall risk management program.

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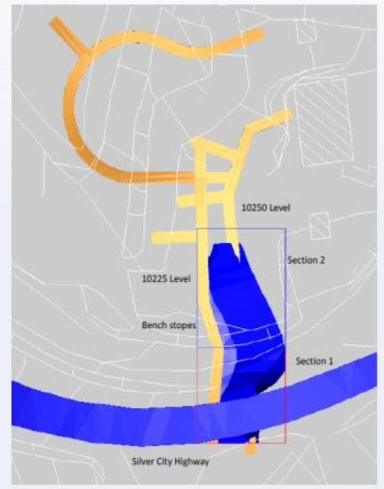
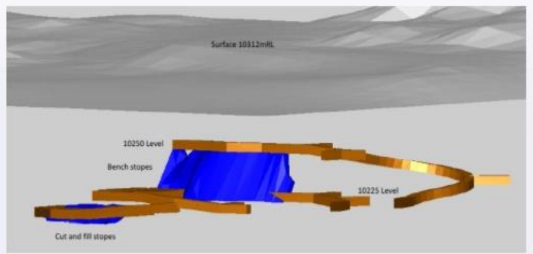
Figure 1 : Scope and Overview

CBH Rasp Mine Extension - Surface Interaction Review

- **Client**
  - COO
    - Visco Sulicich
- **Scope**
  - Scoping Statement
    - To conduct a risk analysis of the mine extension to identify threats/hazards during the life cycle of the project; clarify the risk potential and identify preventative controls, reactive controls and recommendations for consideration
  - Scope includes
    - Life cycle of the project
      - 3 years
    - Linkages to current mine where applicable
      - Concurrent activities that may impact on the project
    - Zinc lode
  - Scope does not include
    - Current operation
    - Satellite targets - block 8
      - Already in current approval
- **Mandate**
  - To conduct the review and provide recommendations for consideration
- **Context**
  - The Rasp mine is intending to extend under the South Road
  - Application is required to be submitted
  - Risk review is a key part of the application process
- **Key Assumptions**
  - Conservation Management Plan will be completed (post closure use or tourism etc)
  - The Ground Control Management Plan will be updated to suit the changes implemented for the mine extension / zinc lode
  - The Blast Management Plan will be developed to suit the changes implemented for the mine extension / zinc lode
  - The current Mine Safety Management Plan (or similar) is effective for ongoing management of risks associated with mining activities underground (including the mining methods and all associated tasks such as drilling, blasting, equipment operation etc.) including interactions with Perilya activities.
    - *AC - Conduct interaction risk assessment for mining in close proximity to Perilya as part of the safety management system.*
- **Key Mine Phases**
  - Access Development
  - Stope Development
    - Cut and Fill
    - Bench stopes
  - Stope drill and blast
    - Cut and Fill
    - Bench stopes
  - Production load and haul
  - Filling
  - Services
  - Maintenance
  - Decommissioning



- **Brainstorm of issues and areas to consider**
- **Key Threats and Controls**
  - Ground Failure / Subsidence affecting surface
  - Blasting affecting surface (Vibrations and Overpressure)
  - Noise
  - Amenity - Light, Air Quality / Odour, amenity and public interaction
  - Impacts on local council Heritage



= Linked Tree (More Information)

2.5 External Facilitation

The team was facilitated through the process by ***SP Solutions*** – a company specialising in project risk management processes.

2.6 The Team

The team met on 9th October 2014 on-site at Broken Hill Operations (BHOP). A team based approach was utilised in order to have an appropriate mix of skills and experience to identify the potential loss scenarios/issues and the controls to be applied. Details of the team members and their relevant qualifications and experience are included in the following table.

Table 2 : Team Members

Name	Organisation / Role	Experience
Rob Williamson	BHOP / GM Rasp Mine	16 years. Bachelor of Engineering. First Class Mine Manager Certificate
Costa Papadopoulos	BHOP / HSE Manager Rasp Mine	25 years
Callum Ker	I.A.R. / Senior Mining Engineer	10 years. Bachelor of Engineering. Bachelor of Science (Geo)
Mike Humphreys	Prism Mining Pty Ltd	25 years. BSc. PHD of Mining Engineering
Gwen Wilson	BHOP / SHEC Group Manager	30 years. BCom. Occupational Grad Dip Hazard Management
Visko Sulicich	BHOP / COO	35 years. BE Mining. Mine Manager Certificate
Brett Anderson	BHOP / Mining Manager	25 years. BE Mining. Mine Manager Certificate
Leanne Waddell	BHOP / Technical Services Superintendent	17 years. Grad Dip of Mining
Patrick Evers	BHOP / Mining Superintendent	38 years
Cameron Tucker	GCE / Geotechnical Engineer	14 years
Richard Noonan	Barnson / Civil Engineer	22 years. BE, MIE Aust CP Eng
Peter Reardon	SP Solutions / Director Facilitator	BE Min Eng (Hon). Grad Dip Business Management. Registered First Class Mine Manager (Underground Metal). Over 25 years of experience in mining and construction incl. Mine Manager then 15 years as Principal of SPS conducting risk work throughout the minerals industry in Australia and overseas

3 ESTABLISH THE CONTEXT

3.1 Strategic and Organisational Context

CBH Resources Limited is a significant producer of silver, lead and zinc in Australia. CBH owns Broken Hill Operations Pty. Ltd. (BHOP) which operates the Rasp Mine in Broken Hill. The Rasp mine was officially opened on 25 July 2012 and commercial rates of production are now being achieved. Annual production is planned to average 34,000 tonnes of zinc metal in concentrate, 28,000 tonnes of lead metal in concentrate, and 1.1 million ounces of silver in the lead concentrate. Rasp Mine employs 160 people and will have a mine life in excess of 15 years.

More information please refer to http://www.cbhresources.com.au/operations/rasp-mine/

Figure 2 : Location Map

The Rasp mine is following mineralisation towards the south and a new application is required to cover the program of work. The Zinc Lodes are typically higher in grade and it is intended that the ore will be blended with other ore sources so as to ensure the mine remains economically viable.

The following figures provide an overview to provide context for the risk analysis.

Figure 3 : Summary of Mineralised Zones

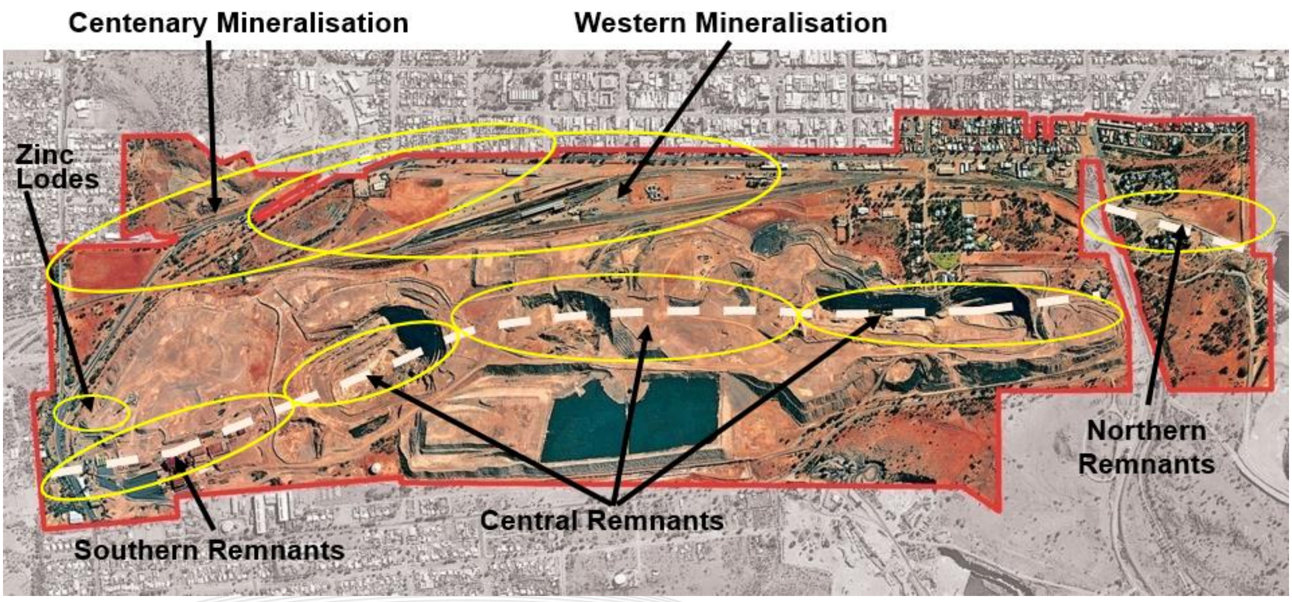


Figure 4 : Area of Interest

Figure 5 : Underground Workings relative to Surface Infrastructure

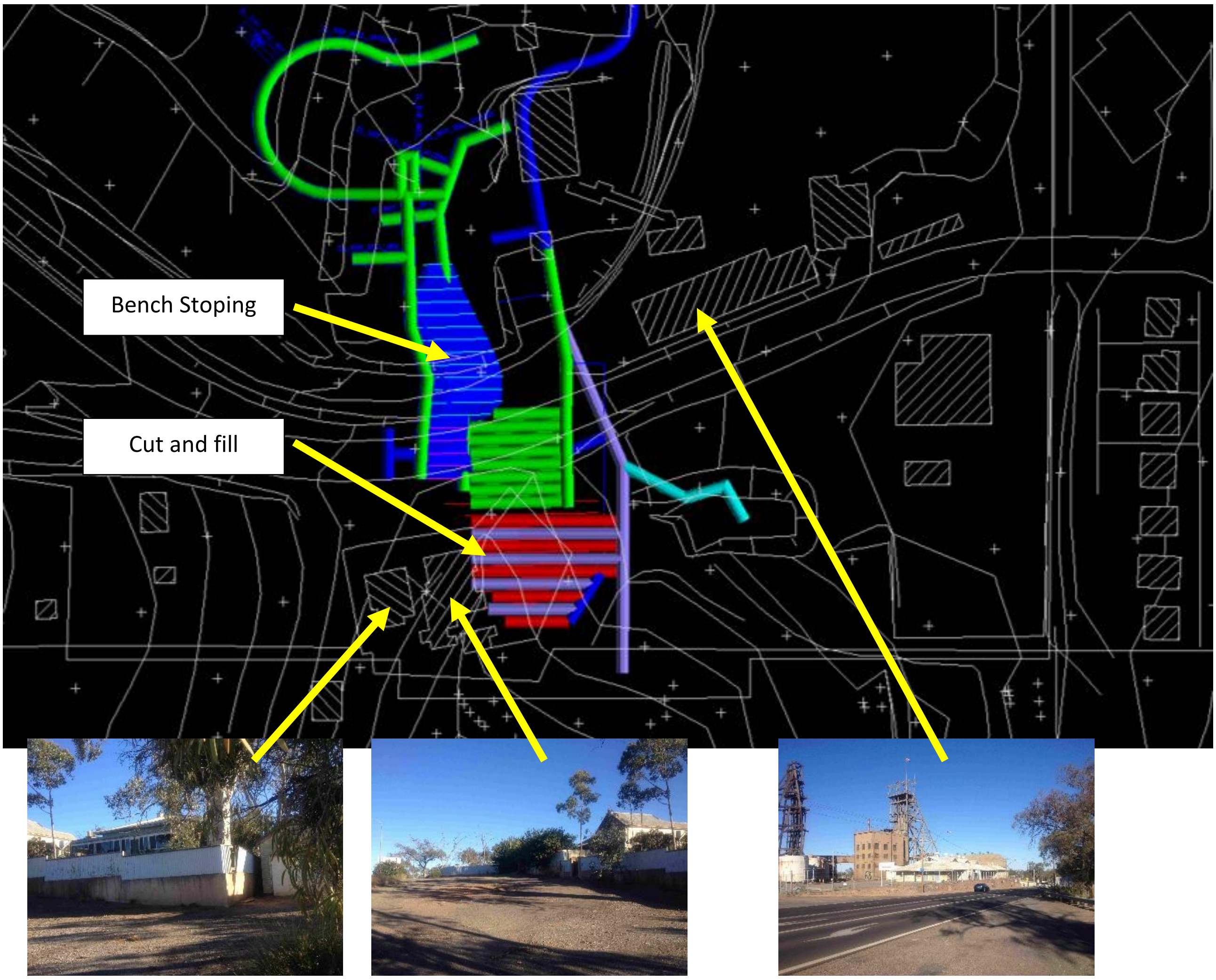


Figure 6 : Schematic Plan View – Bench Stoping Area

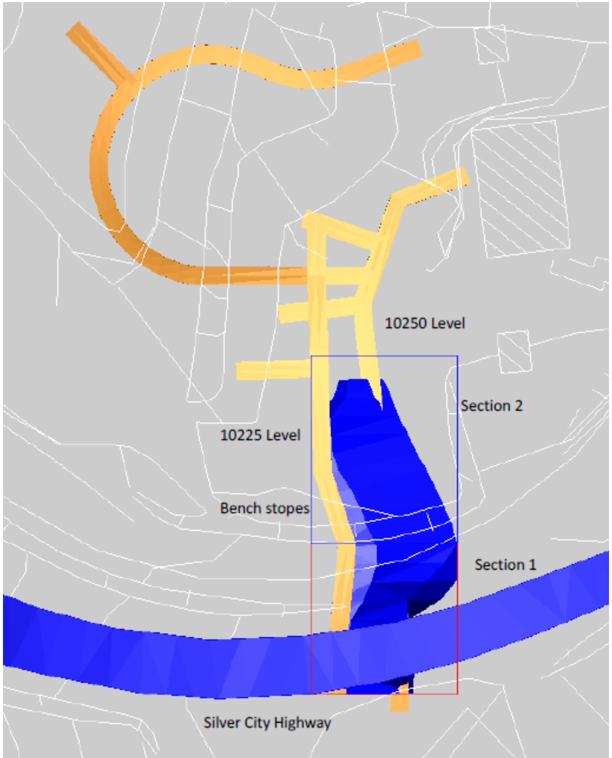
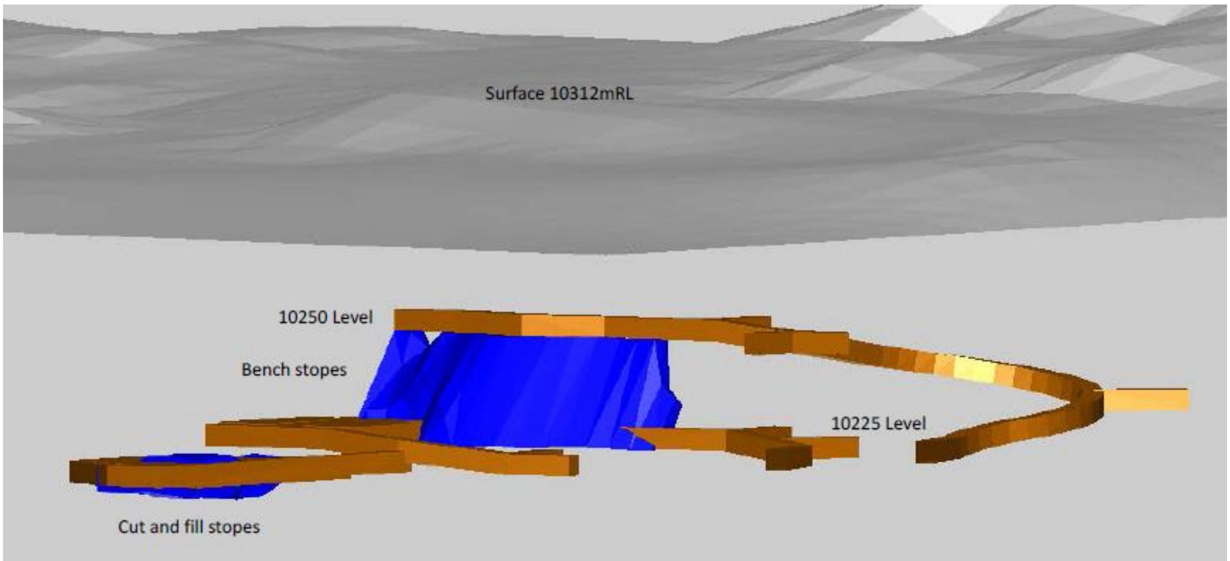


Figure 7 : Schematic Section View



It should be noted that the plan view does not reflect the true width of mining underneath the area in question. The intent is to control the top of the nearest excavation to approximately 5m in width – this is the width of the initial access development drive only. That is, the closest excavation is restricted to 5m wide and 60m below the surface. Mining in this closest proximity would not last for a long period of time and this will be determined in the final production / mining schedules. The cut and fill stopes are deeper (hence further from surface infrastructure) than the bench stopes. The bench stopes may include an intermediate drill horizon to further control blast size and excavation stability but this can be assessed based on performance at the time.

3.2 Risk Management Context

The mine extension risk review is part of the BHOP Mine Safety Management System. The focus of this review is on the hazards and controls. The review process was:

1. based on the framework detailed in ISO 31000:2009 Principles and Generic Guidelines on Risk Management; and
2. aligned to meet BHOP and CBH requirements for risk management.

The Rasp mine is intending to extend under the South Road. The Application will be submitted soon and the risk review is a key part of the application process.

3.3 Legal Context

The primary focus of this review is on environmental and community risks. The document that supports the modification application is the Environment Assessment and this risk report will form part of this document. The relevant legislation is the *Protection of the Environment Operations Act 1997* and regulations.

Outputs of this review may also be used for any health and safety risk assessments that BHOP may conduct on the mine extension (eg) interaction with Perilya activities, ground instability and inrush risk reviews. These are typically required under the following legislation in NSW:

- Mine Health and Safety Act 2004
- Mine Health and Safety Regulation 2007
- Work Health and Safety Act 2011
- Work Health and Safety Regulation 2011

The NSW Work Health and Safety (WHS) Act requires all persons conducting a business or undertaking (including the mine holder and the mine operator) to ensure, so far as is reasonably practicable, that workers and other persons are not put at risk from work carried out as part of the business or undertaking. This involves eliminating or minimising risks to health and safety so far as is reasonably practicable.

3.4 Key Assumptions

The identification of key assumptions is a critical part of the risk assessment process – they form the basis for many engineering / project decisions and it is important that these are validated and reviewed as part of the risk management process.

Assumptions made were:

1. The Conservation Management Plan will be completed (post closure use or tourism etc.);
2. The Ground Control Management Plan will be updated to suit the changes implemented for the mine extension / zinc lodes;
3. The Blast Management Plan will be developed to suit the changes implemented for the mine extension / zinc lodes; and
4. The current Mine Safety Management Plan (MSMP or similar) is effective for ongoing management of risks associated with mining activities underground (including the mining methods and all associated tasks such as drilling, blasting, equipment operation etc.) including interactions with Perilya activities. An operational and interaction risk assessment will be conducted as part of the MSMP.

3.5 Referred Issues

There were no referred issues.

4 Identify Risks

4.1 Overview

The key steps of the overall process included the following:

1. Data collection and analysis;
2. Conduct team based risk review;
3. Complete the Risk Treatment Plan (hazards, Preventative and Mitigating Controls, recommendations for improvement); and
4. Write report for review and distribution.

The team based risk analysis (this report) is only part of a comprehensive, ongoing process.

4.2 Brainstorming

This process involved encouraging all of the team members to note down their issues related to mine extensions at BHOP Rasp. The issues identified included:

- Causes / threats;
- Escalators (causes which impact on controls);
- Controls – either existing or potential improvements;
- Incidents / Outcomes (end result of incidents), and
- General background information.

The brainstorming list was then reviewed so as to ensure that all aspects and issues had been included. If not, the item was included into the Risk Treatment Plan. This ensured a range of techniques were utilised to build the risk model. The diagrams from the brainstorming at the start of the team session are included in Appendix 9.1. These lists may also be used for site engineers and technical personnel to take into consideration when developing applicable procedures and management plans to manage the specific causes/hazards.

4.3 Threat Analysis

A threat analysis was then conducted by the team. A series of diagrams were developed as a primary input into developing the Risk Treatment Plan.

These were focused on:

1. Causes / Hazards;
2. Preventative Controls;
3. Reactive or Mitigation Controls; and
4. Recommendations (Actions) to improve the effectiveness of current controls or fill significant gaps.

The team session diagrams for the Threat Analysis is included in Appendix 9.2.

5 ANALYSE RISKS

5.1 Threat Analysis

The Threat Analysis (Appendix 9.2) included information which allowed the development of the Risk Treatment Plan (Appendix 9.3).

5.2 Level of Risk – Risk Ranking

All issues identified by the team were risk ranked on the basis of current controls (residual risk). To calculate the likelihood of the consequence above occurring, refer to the following table:

Figure 8 : Likelihood and Definition

Likelihood	Definition
Almost Certain	Is expected to occur almost every time the task is completed. Occurs once per week.
Likely	Is likely to occur on a regular basis. Occurs once a month.
Possible	Would expect this to occur every now and then. Occurs once a year.
Unlikely	Would not expect this to occur too often. Once every five years.
Rare	Not likely to occur unless under exceptional circumstances.

Combination of Likelihood and Consequence determines level of Risk, see the following table:

Figure 9 : Risk Likelihood and Consequence Matrix

Likelihood	Consequence				
	Minor	Moderate	Significant	Major	Catastrophic
Almost Certain	11	16	20	23	25
Likely	7	12	17	21	24
Possible	4	8	13	18	22
Unlikely	2	5	9	14	19
Rare	1	3	6	10	15
(Tick Low, Medium or High)	1 - 5 Low Risk		6 - 17 Medium Risk		18 - 25 High Risk

This Risk Ranking Matrix shall be used for all Risk Assessments and Incident Severity rating. To calculate the consequence, refer to the following table:

Figure 10 : Risk Ranking Matrix

	Safety	Environment	Community/Reputation	Operations
Catastrophic	• Fatality. • Permanent disability. • Serious injury, loss of limb. • Prosecution or litigation.	• Fatality of a person. • Devastation to large area of land. • Severely health effects or death or severe impact to protected flora and fauna or their habitat. • Prosecution or litigation.	• Community complaint impacts State/National level. • Destruction of cultural items of significance. • Complaint causes cessation of operations > 1 week.	• Downtime of critical equipment > 1 week. • Potential loss/ property damage > $200,000.
Major	• Lost time injury. • Disabling injury > 4 days. • Serious breach of safety regulations (breach of Golden Rules).	• Recorded health effect to people. • Impact on protected fauna, flora. • Emission/discharge exceeding legal guideline and requires government reporting. • Loss of containment of substance (on site) >200L.	• Community complaint impacts State level. • Permanent damage to cultural items of significance. • Prosecution/Litigation. • Complaint causes cessation of operations < 1 week.	• Downtime of critical equipment > 1 shift < 1 week. • Potential loss/ property damage > $50,000 < $200,000.
Significant	• Requires government reporting. • Medical treatment eg stitches, etc.	• Any loss of containment off site to private or State property, road, waterway, etc. • Loss of containment of substance (on site) 50 – 200L. • Requires government reporting.	• Community complaint impacts Council level. • Damage to items of significance. • Community relations affects ability to obtain environmental licence/approval.	• Production loss > 4 hours < 12 hours. • Potential loss/ property damage > $10,000 < $50,000. • Theft on site requires police involvement.
Moderate	• First aid treatment.	• Loss of containment of substance (on site) 20 – 50L. • Non-compliance with internal environmental target. • Concern by local community re environmental matter.	• Local complaint resolved and has future impact. • Minor infringement of cultural heritage.	• Production loss > 1 hour < 4 hours. • Potential loss/ property damage > $2,000 < $10,000.
Minor	• Reported injury, no first aid required.	• Loss of containment of substance (on site) <20L.	• Local complaint resolved.	• Production loss < 1 hour. • Potential loss/ property damage < $2,000. • Theft on site no police involvement.

5.3 Risk Acceptability and Risk Criteria

The risk criteria utilised is to reduce the level of risk to As Low As Reasonably Practicable (ALARP).

5.4 Risk Priority

All mine extension risk elements were qualitatively risk ranked using the client Risk Assessment Matrix. This is included in the Risk Treatment Plan (Appendix 9.3).

6 TREAT RISKS

The Threat Analysis (Appendix 9.2) included a summary of the controls for the threats.

Refer to risk treatment plan / risk register in Appendix 9.3.

Additional risk treatment information is provided in the Appendices (Appendix 9.5).

7 MONITOR AND REVIEW

7.1 Nominated Coordinator

The nominated coordinator is Gwen Wilson – Group Manager of Safety, Health, Environment and Community BHOP. The coordinator should encourage all parties who attended the 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 review on any decisions which may be different from team expectations / recommendations; and
3. Monitor the completion of the sustaining actions to confirm there is close out of each action.

7.2 Implementation Review Plan

It is critical that the risk controls and actions are appropriately managed. The expectation of the team was that:

1. Appropriate personnel and resources are allocated for implementation of recommended actions within the specified date for completion;
2. Assumptions are validated; and
3. Action items would be appropriately refined, resourced and implemented.

The client 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 desk top review to assess if the risk of the underlying hazard remains tolerable is required.

7.3 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 of the project.

Consultation and involvement were achieved with line personnel during the process, and the final outputs of this study should be shared more broadly with other personnel as required.

7.4 Concluding Remarks

A significant goal of the process was to identify the required controls to prevent a mine extension related incident from occurring and then to reduce the consequences if one occurs. The model will be used to guide the continual improvement of related management plans and procedures etc. on site.

SP Solutions would like to thank all personnel who contributed to the team session.

8 REFERENCES

- **Australian/New Zealand Standard –** AS/NZS/ISO 31000:2009 Risk Management
- **Pacific Environment –** Proposed upcast ventilation Shaft #6 – Air Quality aspects
- **Prism Mining –** Blast Vibration Review at Zinc Lodes, Rasp Mine
- **BHOP –** Blasting Parameters Calculation Sheet
- **Ground Control Engineering –** Draft Geotechnical Assessment – Zinc Lodes
- **EMM –** Approval Variation Noise Assessment – Zinc Lodes
- **NSW RMS –** Documentation Preparation for Application of Extension to Rasp Mine by BHOP
- **Barnson** – Extension to Rasp Mine ay Broken Hill – Zinc Lode Affects to Road Reserve Infrastructure, 20 October 2014.

8.1 Definitions and Abbreviations

TERM	EXPLANATION
ALARP	"As Low As Reasonably Practicable". The level of risk between tolerable and intolerable levels that can be achieved without expenditure of a disproportionate cost in relation to the benefit gained.
BHOP	Broken Hill Operations Pty Ltd.
DTI	Department of Trade and Investment (formerly Department of Industry and Investment)
Escalation Factor	The term "escalator" is applied in risk engineering to any factor (human error, equipment issue or aspect of the controlled work environment) which causes a preventative or mitigating control to fail or be significantly weakened. It is effectively the "failure mode of a control"
FFP	Fit For Purpose
GCMP	Ground Control Management Plan
Hazard	A thing or a situation with potential to cause loss including injury or illness to a person.
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.
Job Safety Analysis (JSA / JHA)	Systematic breakdown of a job into steps in order to identify hazards associated with each step and the selection of appropriate controls to manage the identified hazards.
Level of risk	Term applied to a ranking using the company's risk ranking matrix
Likelihood	Used as a qualitative description of probability and frequency
LTA	Less Than Adequate
MSMP	Mine Safety Management Plan
Personnel	Includes all people working in and around the site (e.g.) all contractors, sub-contractors, visitors, consultants, project managers etc.
PPV	Peak Particle Velocity – measurement for vibration in mm/s
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.
RMS	Roads and Maritime Services
TARP	Trigger and Action Response Plan

9 APPENDICES

9.1 Affinity Diagrams – Brainstorming

AC = Additional Control (Recommendation)

Figure 11 : Affinity Diagrams – Brainstorming 1

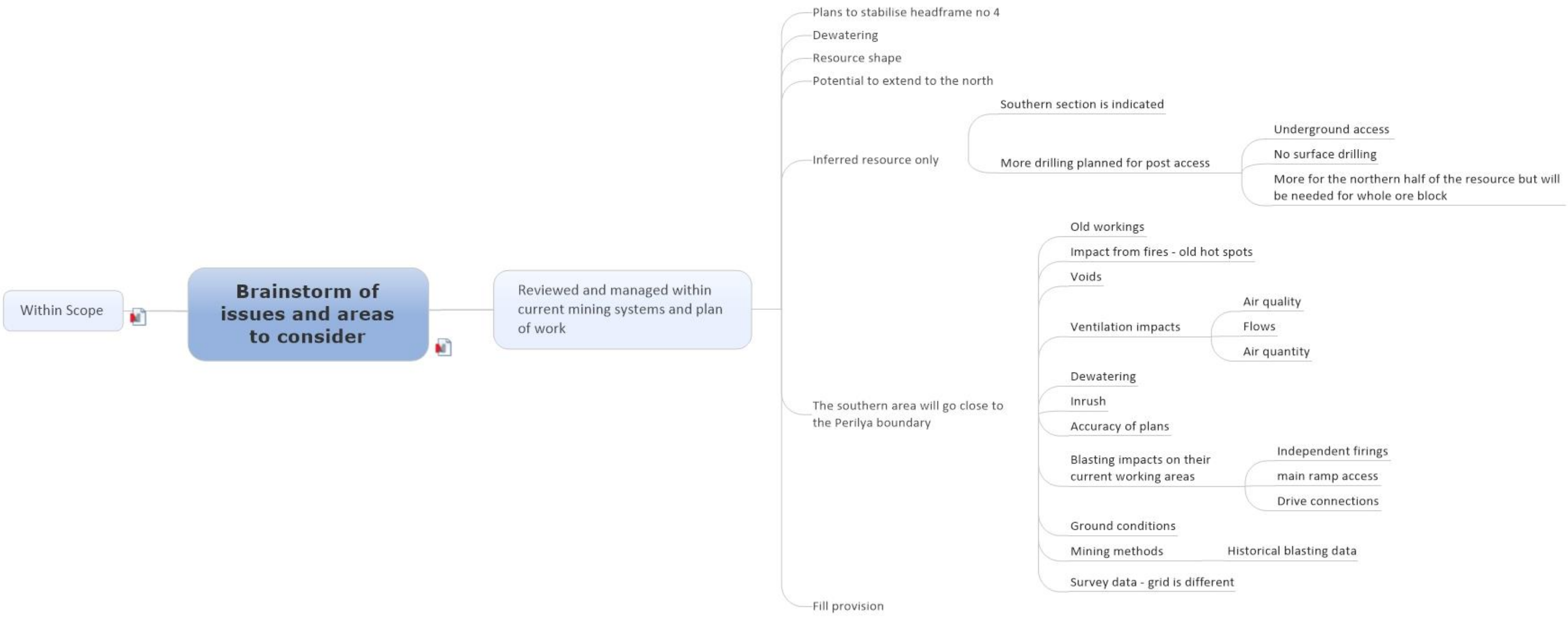
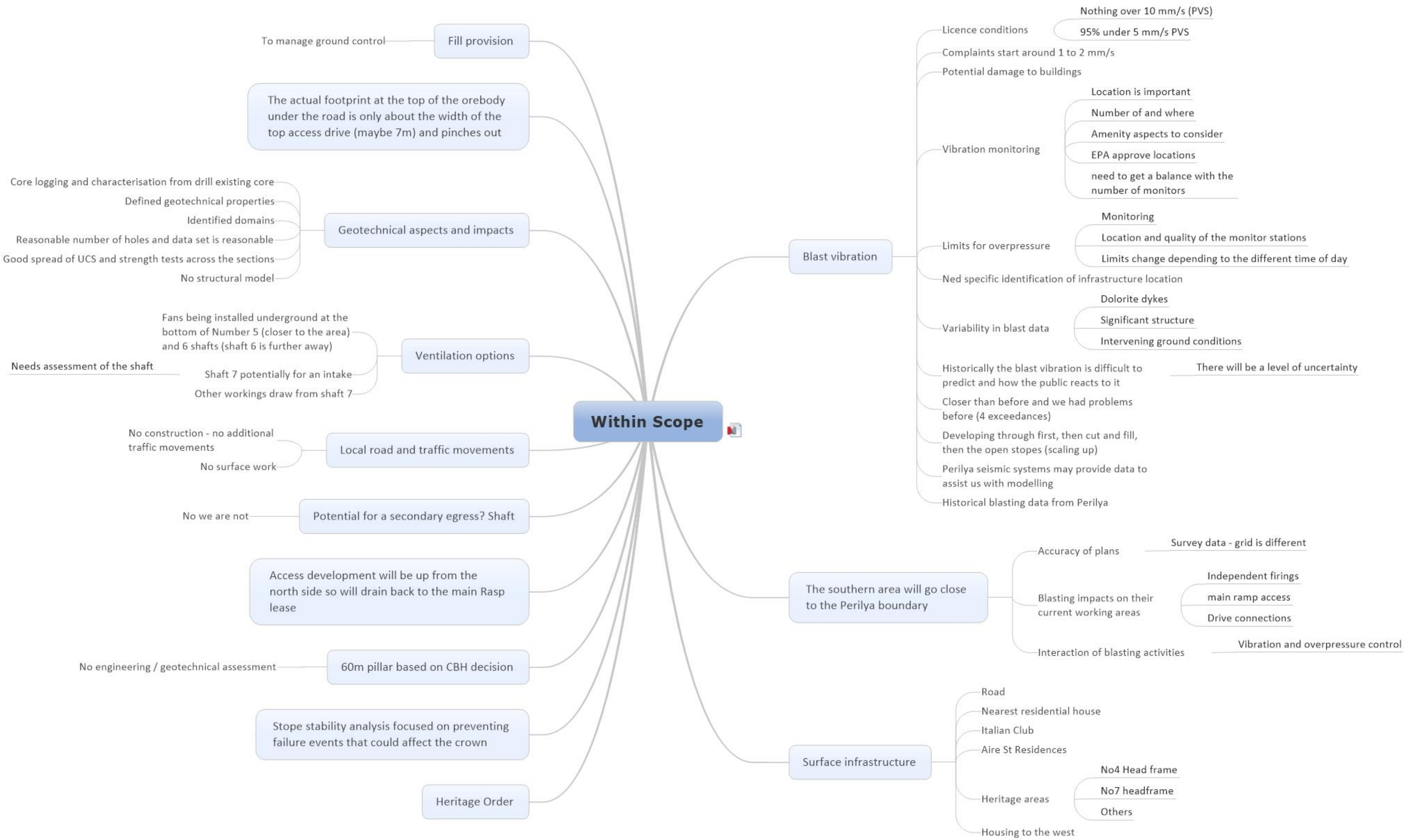


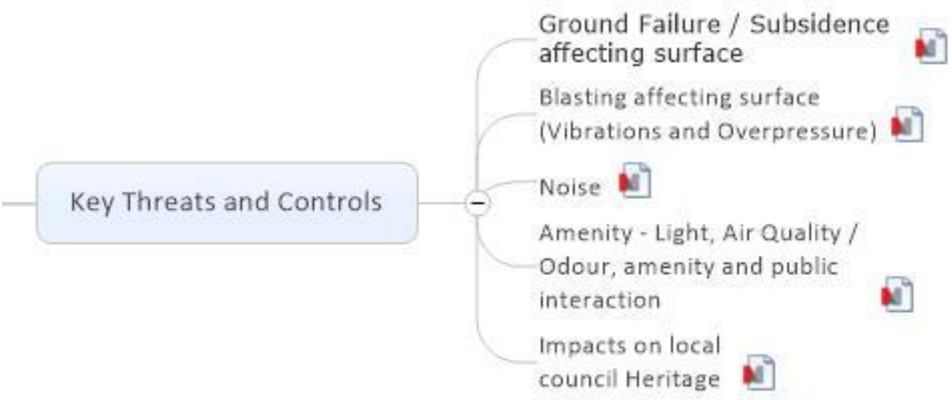
Figure 12 : Affinity Diagrams – Brainstorming 2



9.2 Team Session – Threat Analysis (Causes, Controls, Recommendations)

There were 5 primary threats to surface infrastructure and the environment/community from underground activities identified by the team for further analysis. There are no surface construction activities or increase in traffic that could impact the area.

Figure 13 : Key Threats



Each group was analysed for sub-causes, preventative and reactive controls. The team discussed the suitability and effectiveness of the controls and identified additional controls – denoted by AC – Additional Control = Recommendation.

Figure 14 : Threat – Ground Failure / Subsidence Affecting Surface

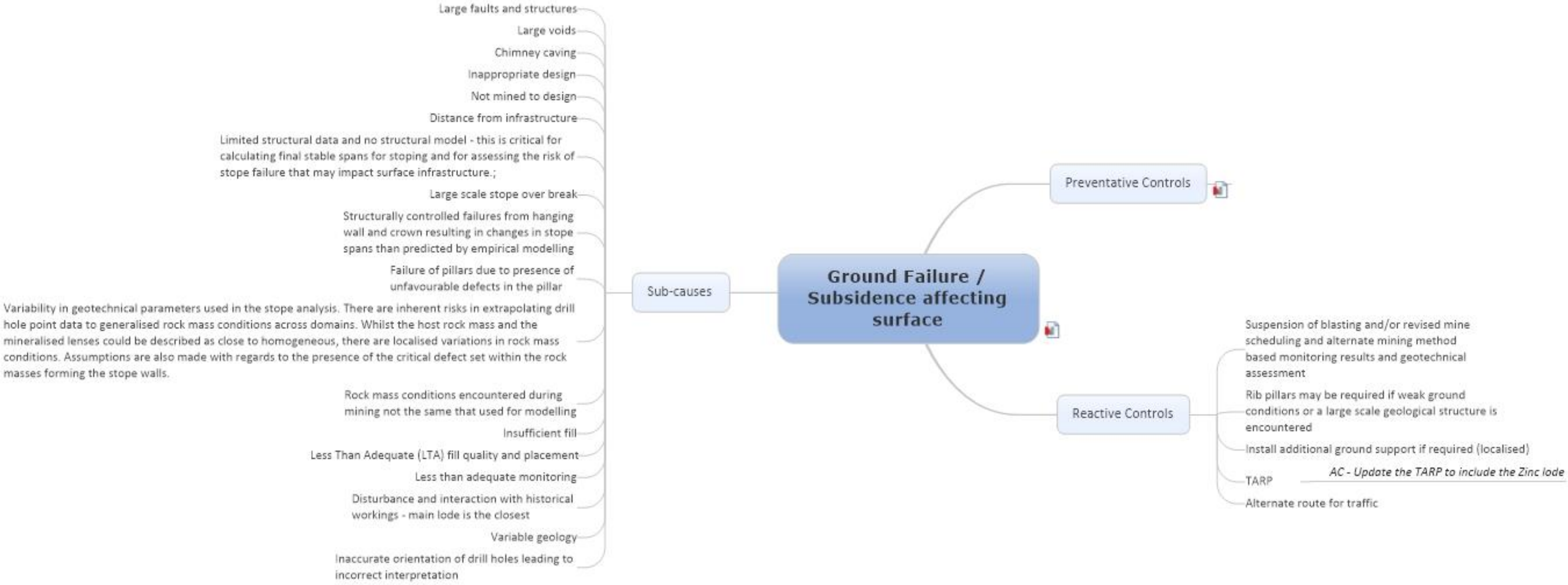


Figure 15 : Ground Failure / Subsidence Affecting Surface – Preventative Controls

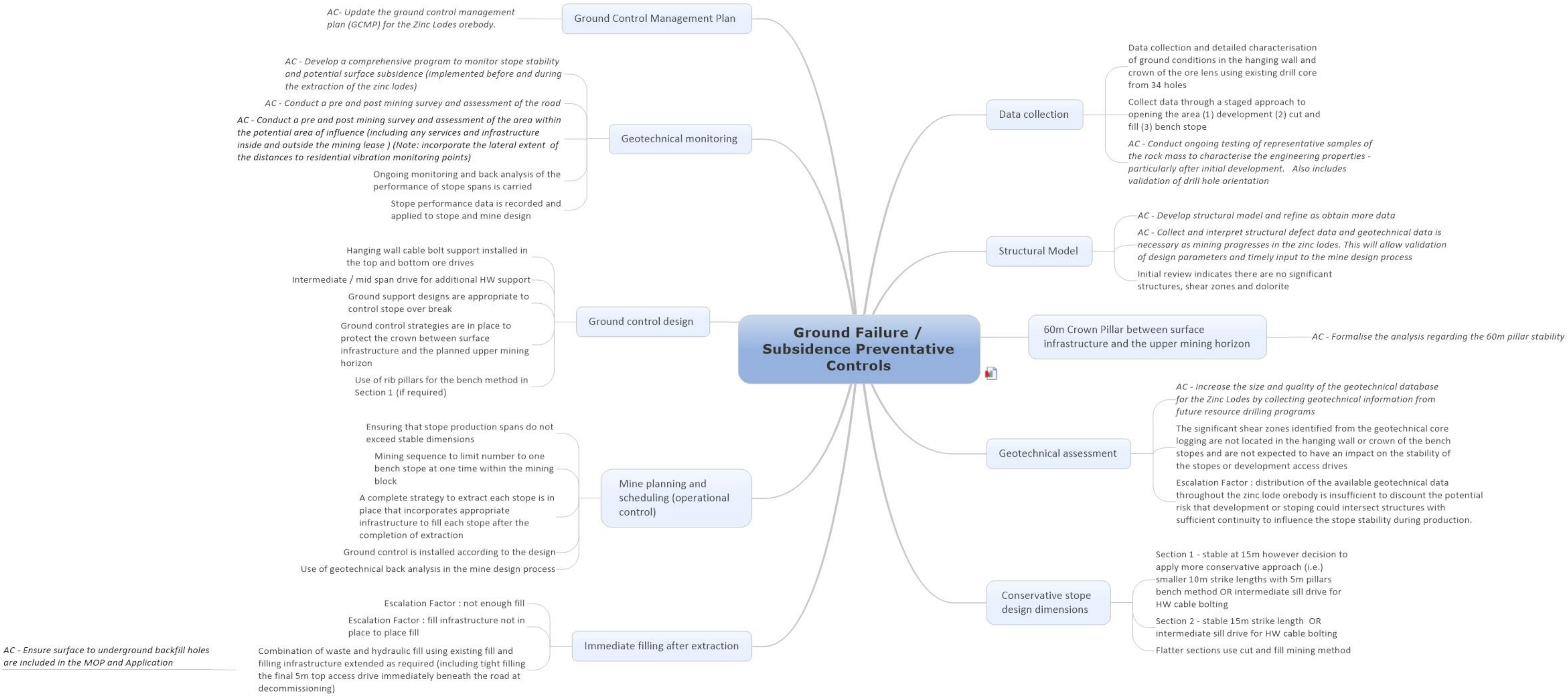


Figure 16 : Threat – Blasting Affecting Surface

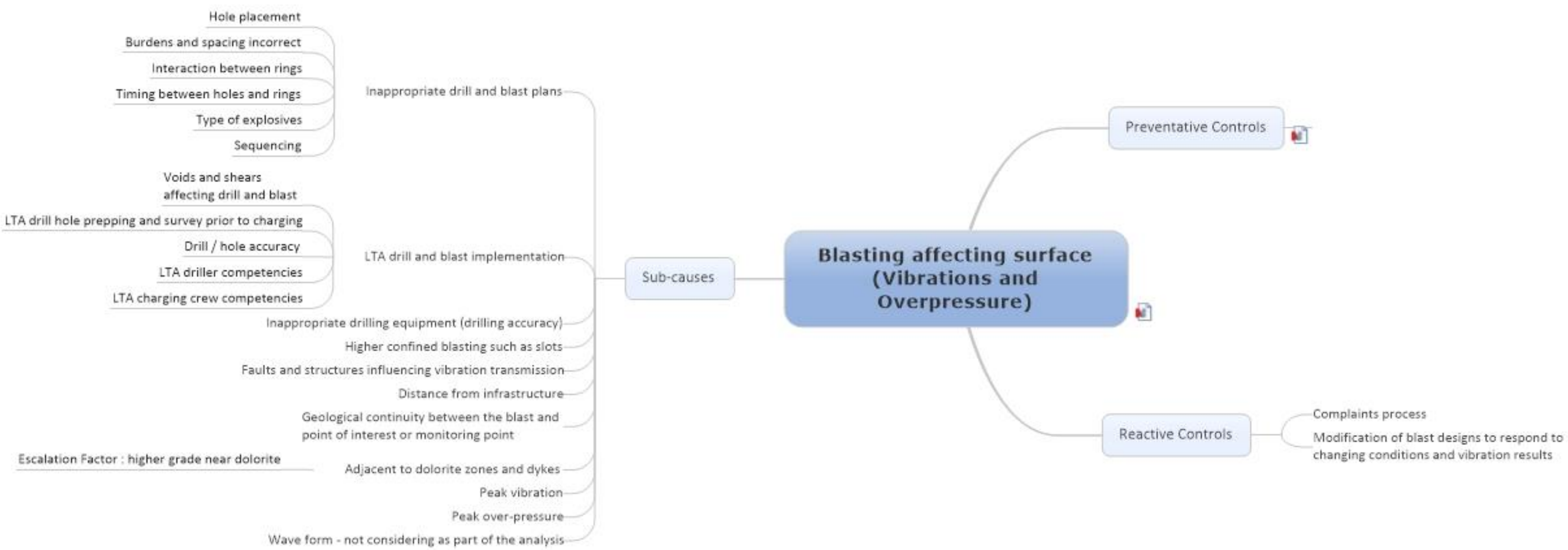


Figure 17 : Blasting Affecting Surface - Preventative Controls

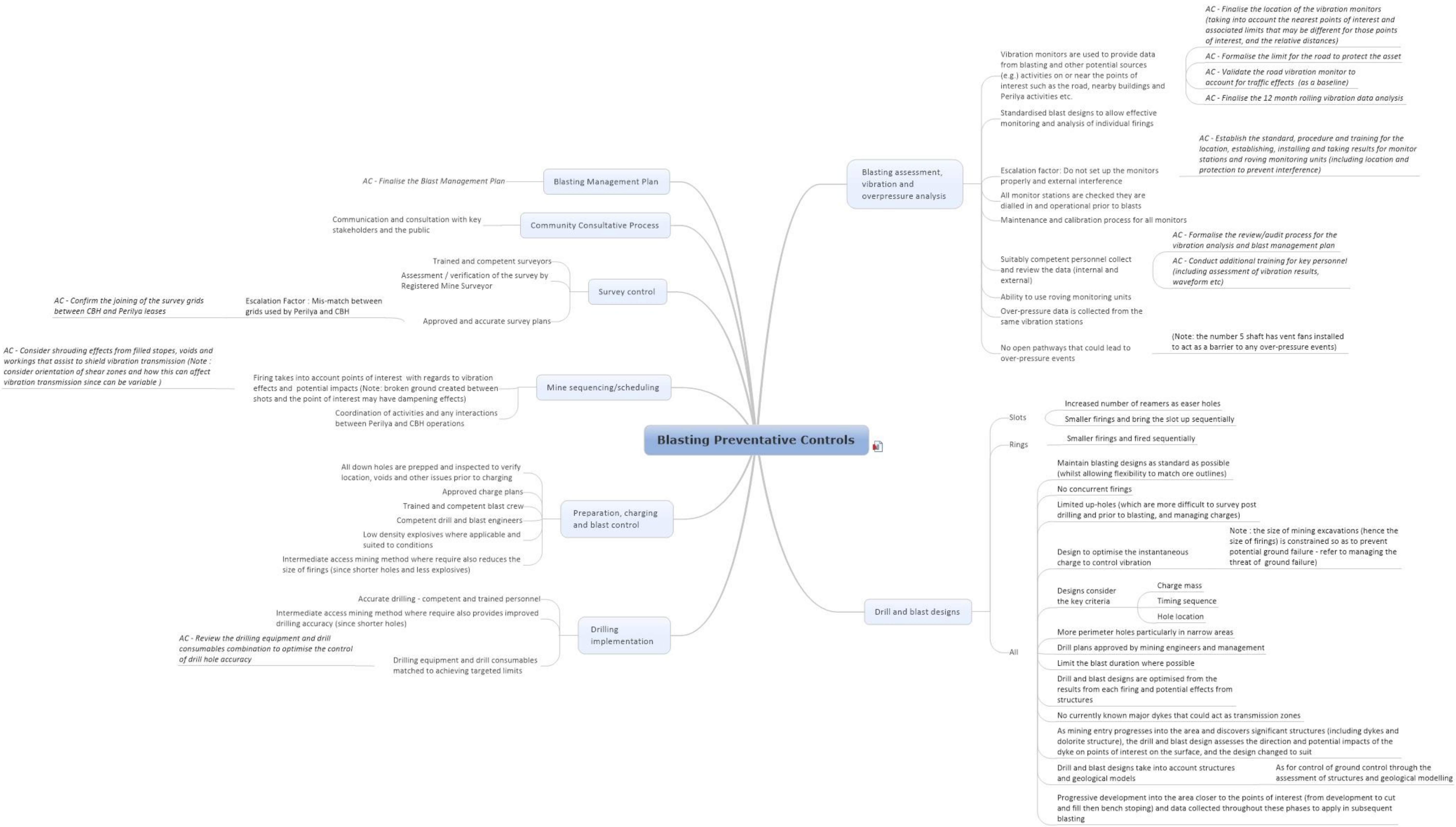


Figure 18 : Threat – Noise

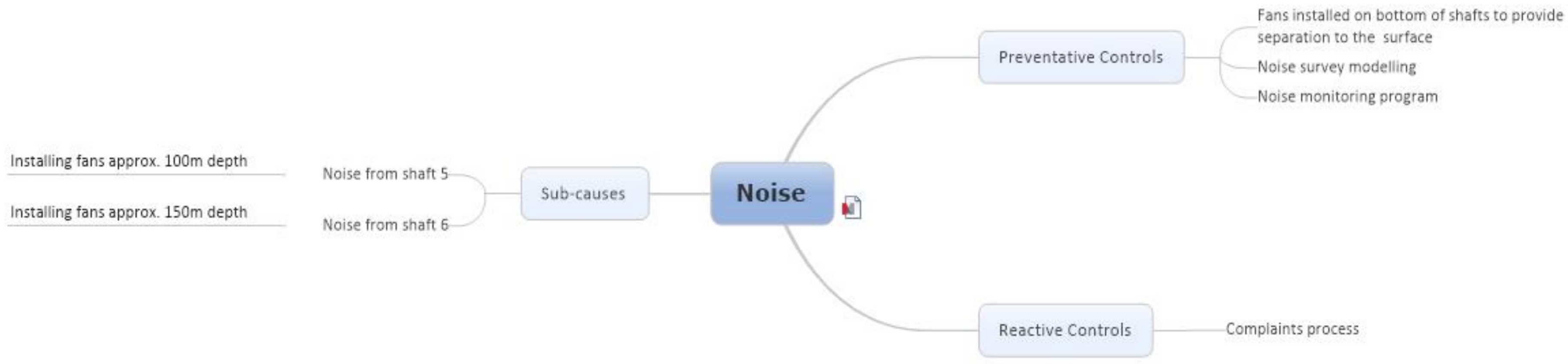


Figure 19 : Threat – Amenity – Light, Air Quality

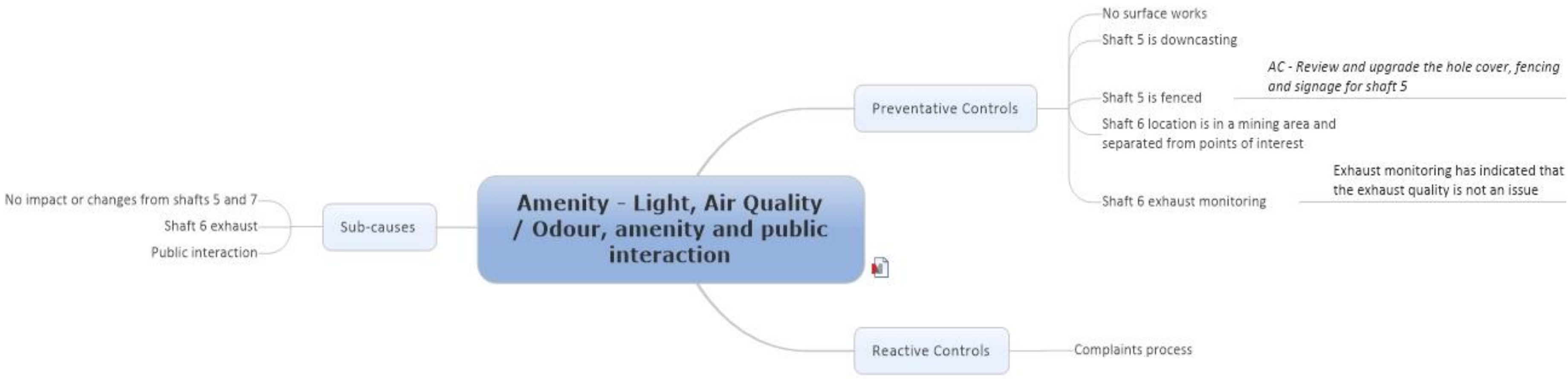
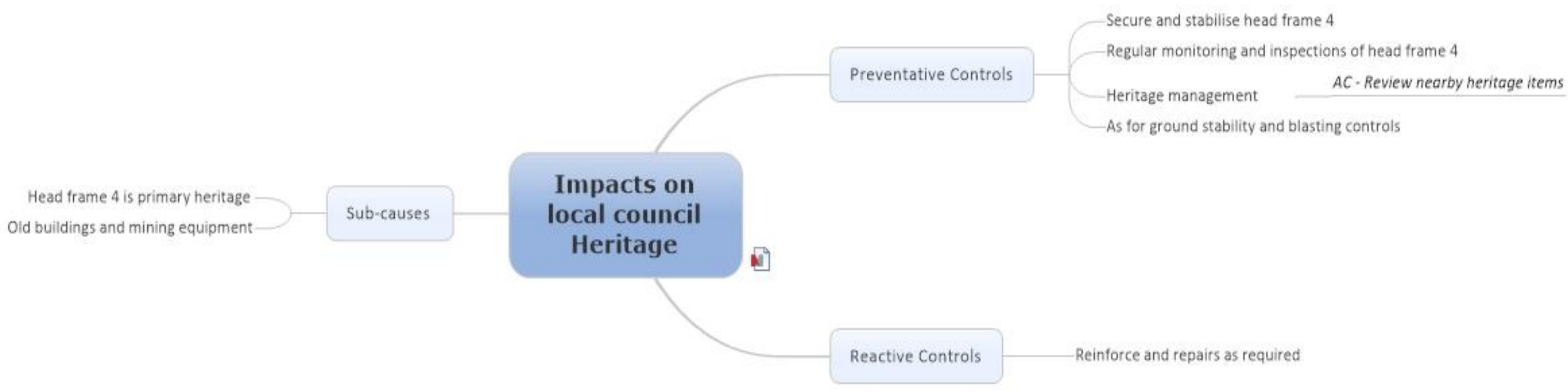


Figure 20 : Threat – Impacts on Local Council Heritage



9.3 Risk Treatment Plan / Risk Register

The Risk Treatment Plan is a "living document" and as such, should be added to the client Risk Register. The accountabilities (By Whom) and timing for completion (By When) will be allocated by the client for tracking. The 5 key threats (hazards) have been risk ranked – ground failure/subsidence, vibration/overpressure, noise, amenity and impacts on council heritage.

Table 3 : Risk Treatment Plan

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
1, 2	Ground Failure / Subsidence affecting surface	Large faults and structures; Large voids; Chimney caving; Inappropriate design; Not minded to design; Distance from infrastructure; Limited structural data and no structural model - this is critical for calculating final stable spans for stoping and for assessing the risk of stope failure that may impact surface infrastructure; Large scale stope over break; Structurally controlled failures from hanging wall and crown resulting in changes in stope spans than predicted by empirical modelling; Failure of pillars due to presence of unfavourable defects in the pillar; Variability in geotechnical parameters used in the stope analysis. There are inherent risks in extrapolating drill hole point data to generalised rock mass conditions across domains. Whilst the host rock mass and the mineralised lenses could be described as close to homogeneous, there are localised variations in rock mass conditions. Assumptions are also made with regards to the presence of the critical defect set within the rock masses forming the stope walls; Rock mass conditions encountered during mining not the same that used for modelling; Insufficient fill; LTA fill quality and placement; LTA monitoring; Disturbance and interaction with historical workings - main lode is the closest; Variable geology; Inaccurate orientation of drill holes leading to incorrect interpretation	Data collection	Data collection and detailed characterisation of ground conditions in the hanging wall and crown of the ore lens using existing drill core from 22 holes; Collect data through a staged approach to opening the area (1) development (2) cut and fill (3) bench stope.	Suspension of blasting and/or revised mine scheduling and alternate mining method based monitoring results and geotechnical assessment NOTE : Ranked on the basis of Community. There is elevated "perception risk" even though the technical risk is managed appropriately. Mining activities could be suspended through perceived risk.	Catastrophic	Rare	Medium - 15	Conduct ongoing testing of representative samples of the rock mass to characterise the engineering properties - particularly after initial development. Also includes validation of drill hole orientation

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
3	Ground Failure / Subsidence affecting surface	As above	Structural Model	Initial review indicates there are no significant structures, shear zones and dolerite	Rib pillars may be required if weak ground conditions or a large scale geological structure is encountered				1 Develop structural model and refine as obtain more data; 2 Collect and interpret structural defect data and geotechnical data is necessary as mining progresses in the zinc lodes. This will allow validation of design parameters and timely input to the mine design process
4	Ground Failure / Subsidence affecting surface	As above	60m Crown Pillar between surface infrastructure and the upper mining horizon	In combination with small and stable stopes, this is a significant barrier pillar	Install additional ground support if required (localised)				Formalise the analysis regarding the 60m pillar stability COMPLETE This has been completed and is provided in G0057_AA_RE01_V03_RASP_ZINC_LODES_DRAFT_FINAL_WITH_APPENDICES, 16th October 2014
5	Ground Failure / Subsidence affecting surface	As above	Geotechnical assessment	The significant shear zones identified from the geotechnical core logging are not located in the hanging wall or crown of the bench stopes and are not expected to have an impact on the stability of the stopes or development access drives; Escalation Factor : distribution of the available geotechnical data throughout the zinc lode ore body is insufficient to discount the potential risk that development or stoping could intersect structures with sufficient continuity to influence the stope stability during production.	TARP				1 Increase the size and quality of the geotechnical database for the Zinc Lodes by collecting geotechnical information from future resource drilling programs; 2 (Reactive) Update the TARP to include the Zinc lode
6	Ground Failure / Subsidence affecting surface	As above	Conservative stope design dimensions	Section 1 - stable at 15m however decision to apply more conservative approach (i.e.) smaller 10m strike lengths with 5m pillars[1] bench method **OR** intermediate sill drive for HW cable bolting; Section 2 - stable 15m strike length OR intermediate sill drive for HW cable bolting; Flatter sections use cut and fill mining method.					As for current and recommended controls
7	Ground Failure / Subsidence affecting surface	As above	Immediate filling after extraction	Escalation Factor : not enough fill; Escalation Factor : fill infrastructure not in place to place fill; Combination of waste and hydraulic fill using existing fill and filling infrastructure extended as required (including tight filling the final 5m top access drive immediately beneath the road at decommissioning).					Ensure surface to underground backfill holes are included in the MOP and Application

[1] The geotechnical analysis indicates that 15m span without pillars is stable (G0057_AA_RE01_V03_RASP_ZINC_LODES_DRAFT_FINAL_WITH_APPENDICES, 16th October 2014) so use of pillars (if required) would be very conservative.

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
8	Ground Failure / Subsidence affecting surface	As above	Mine planning and scheduling (operational control)	Ensuring that stope production spans do not exceed stable dimensions; Mining sequence to limit number to one bench stope at one time within the mining block; A complete strategy to extract each stope is in place that incorporates appropriate infrastructure to fill each stope after the completion of extraction; Ground control is installed according to the design; Use of geotechnical back analysis in the mine design process.					As for current and recommended controls
9	Ground Failure / Subsidence affecting surface	As above	Ground control design	Hanging wall cable bolt support installed in the top and bottom ore drives; Intermediate / mid span drive for additional HW support; Ground support designs are appropriate to control stope over break; Ground control strategies are in place to protect the crown between surface infrastructure and the planned upper mining horizon; Use of rib pillars for the bench method in Section 1 (if required).					As for current and recommended controls
10	Ground Failure / Subsidence affecting surface	As above	Geotechnical monitoring	Ongoing monitoring and back analysis of the performance of stope spans is carried; Stope performance data is recorded and applied to stope and mine design.					1 Develop a comprehensive program to monitor stope stability and potential surface subsidence (implemented before and during the extraction of the zinc lodes); 2 Conduct a pre and post mining survey and assessment of the road; 3 Conduct a pre and post mining survey and assessment of the area within the potential area of influence (including any services and infrastructure inside and outside the mining lease) (Note: incorporate the lateral extent of the distances to residential vibration monitoring points)

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
11	Ground Failure / Subsidence affecting surface	As above	Ground Control Management Plan	A consolidation of the "system" to ensure stable excavations and prevention of subsidence	GCMP TARP				Update the ground control management plan (GCMP) for the Zinc Lodes ore body. COMPLETE This has been completed and is provided in G0057_AA_RE01_V03_RASP_ZINC_LODES_DRAFT_FINAL_WITH_APPENDICES, 16th October 2014
12	Blasting affecting surface (Vibrations and Overpressure)	Inappropriate drill and blast plans that include hole placement, burdens and spacing incorrect, interaction between rings; timing between holes and rings, type of explosives and sequencing. LTA drill and blast implementation that involves voids and shears affecting drill and blast; LTA drill hole prepping and survey prior to charging; drill / hole accuracy; LTA driller competencies; LTA charging crew competencies. Inappropriate drilling equipment. Higher confined basting such as slots. Faults and structures influencing vibration transmission. Distance from infrastructure. Geological continuity between the blast and point of interest or monitoring point. Adjacent to dolerite zones and dykes. Peak vibration. Peak over-pressure. Wave form – not considering as part of the analysis.	Blasting assessment, vibration and overpressure analysis	Vibration monitors are used to provide data from blasting and other potential sources (e.g.) activities on or near the points of interest such as the road, nearby buildings and Perilya activities etc. Standardised blast designs to allow effective monitoring and analysis of individual firings. Escalation factor: Do not set up the monitors properly and external interference. All monitor stations are checked they are dialled in and operational prior to blasts. Maintenance and calibration process for all monitors. Suitably competent personnel collect and review the data (internal and external). Ability to use roving monitoring units. Over-pressure data is collected from the same vibration stations. No open pathways that could lead to over-pressure events. (Note: the number 5 shaft has vent fans installed to act as a barrier to any over-pressure events)	Complaints process NOTE : Ranked on the basis of Community. There is elevated "perception risk" even though the technical risk is managed appropriately. Mining activities could be suspended through perceived risk that vibration is a major issue because people can feel and hear the blasts but the blasts are within agreed thresholds	Major	Unlikely	Medium - 14	1 Finalise the location of the vibration monitors (taking into account the nearest points of interest and associated limits that may be different for those points of interest, and the relative distances); 2 Formalise the limit for the road to protect the asset; 3 Validate the road vibration monitor to account for traffic effects (as a baseline); 4 Finalise the 12 month rolling vibration data analysis; 5 Establish the standard, procedure and training for the location, establishing, installing and taking results for monitor stations and roving monitoring units (including location and protection to prevent interference); 6 Formalise the review/audit process for the vibration analysis and blast management plan; 7 Conduct additional training for key personnel (including assessment of vibration results, waveform etc.).

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
13	Blasting affecting surface (Vibrations and Overpressure)	As above	Drill and blast designs	Slots - Increased number of reamers as easer holes; Smaller firings and bring the slot up sequentially. Rings – Smaller firings and fired sequentially. All - Maintain blasting designs as standard as possible (whilst allowing flexibility to match ore outlines). No current firings. Limited up-holes (which are more difficult to survey post drilling and prior to blasting, and managing charges); Design to optimise the instantaneous charge to control vibration (Note: the size of mining excavations (hence the size of firings) is constrained so as to prevent potential ground failure - refer to managing the threat of ground failure)); Designs consider the key criteria (charge mass, timing sequence, hole location); More perimeter holes particularly in narrow areas; Drill plans approved by mining engineers and management; Limit the blast duration where possible; Drill and blast designs are optimised from the results from each firing and potential effects from structures; No currently known major dykes that could act as transmission zones; As mining entry progresses into the area and discovers significant structures (including dykes and dolerite structure), the drill and blast design assesses the direction and potential impacts of the dyke on points of interest on the surface, and the design changed to suit; Drill and blast designs take into account structures and geological models; Progressive development into the area closer to the points of interest (from development to cut and fill then bench stoping) and data collected throughout these phases to apply in subsequent blasting.	Modification of blast designs to respond to changing conditions and vibration results				As for current and recommended controls
14	Blasting affecting surface (Vibrations and Overpressure)	As above	Drilling implementation	Accurate drilling - competent and trained personnel; Intermediate access mining method where require also provides improved drilling accuracy (since shorter holes); Drilling equipment and drill consumables matched to achieving targeted limits.					Review the drilling equipment and drill consumables combination to optimise the control of drill hole accuracy

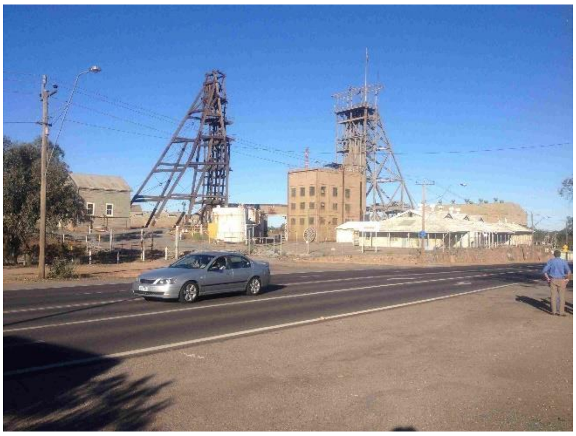
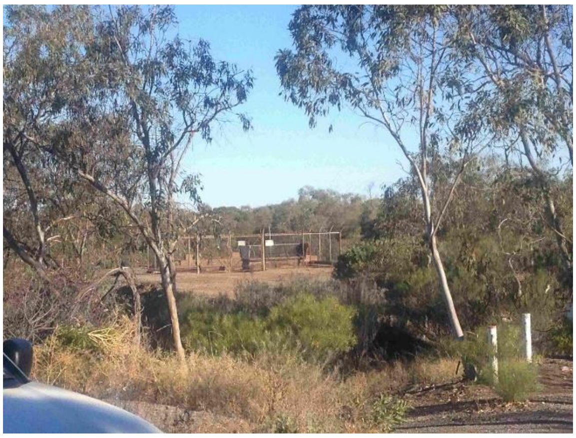
Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
15	Blasting affecting surface (Vibrations and Overpressure)	As above	Preparation, charging and blast control	All down holes are prepped and inspected to verify location, voids and other issues prior to charging; Approved charge plans; Trained and competent blast crew; Competent drill and blast engineers; low density explosives where applicable and suited to conditions; Intermediate access mining method where require also reduces the size of firings (since shorter holes and less explosives).					As for current and recommended controls
16	Blasting affecting surface (Vibrations and Overpressure)	As above	Mine sequencing / scheduling	Firing takes into account points of interest with regards to vibration effects and potential impacts (Note: broken ground created between shots and the point of interest may have dampening effects). Coordination of activities and any interactions between Perilya and BHOP operations.					Consider shrouding effects from filled stopes, voids and workings that assist to shield vibration transmission (Note : consider orientation of shear zones and how this can affect vibration transmission since can be variable)
17	Blasting affecting surface (Vibrations and Overpressure)	As above	Survey control	Trained and competent surveyors; Assessment / verification of the survey by Registered Mine Surveyor; Approved and accurate survey plans. Escalation factor: mis-match between grids used by Perilya and BHOP					Confirm the joining of the survey grids between BHOP and Perilya leases
18	Blasting affecting surface (Vibrations and Overpressure)	As above	Community Consultative Process	Communication and consultation with key stakeholders and the public					As for current and recommended controls
19	Blasting affecting surface (Vibrations and Overpressure)	As above, plus: Personnel feeling vibration on the surface during blasting. The limit could be set for the road at 100mm/s to manage impact on the road corridor assets however vibrations could still be felt on the surface.	Blasting Management Plan	A consolidated document summarising the "system" to ensure blasts are controlled including management of access and interaction with the public and other stakeholders	Community Complaint process				Finalise the Blast Management Plan Establish agreed PPV at which point pedestrian and vehicle traffic may be warned and/or temporarily stopped during blasts that exceed those limits - develop procedure to be applied at the time as required.

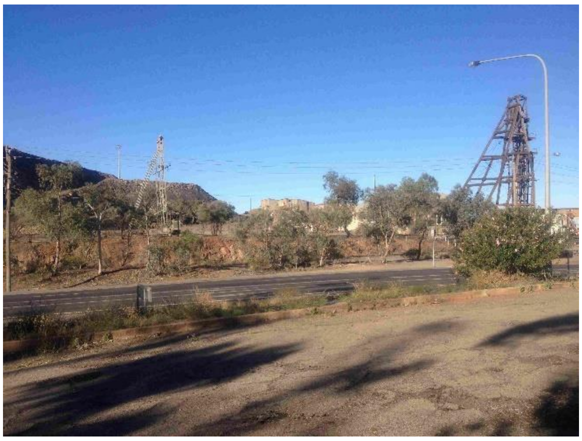
Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
20	Noise	Noise from shaft 5 – Installing fans approx. 100m depth. Noise from underground activities (eg) trucking and loading – the noise could propagate up shaft 5 Noise from shaft 6 – Installing fans approx. 150m depth.	Fans installed on bottom of shafts to provide separation to the surface	Fans installed underground and not on the surface – fans have suppression units if required (based on noise monitoring) The installation of a brick ventilation wall and installation of fans provides a barrier between general underground operations noise from being transferred up the shaft	Complaints process	Moderate	Unlikely	Low - 5	As for current – none additional for noise
21	Noise	Noise from shaft 5 – Installing fans approx. 100m depth. Noise from underground activities (eg) trucking and loading – the noise could propagate up shaft 5 Noise from shaft 6 – Installing fans approx. 150m depth.	Noise survey modelling	Modelling of all noise sources	Refine model based on monitoring results				As for current – none additional for noise
22	Noise	Noise from shaft 5 – Installing fans approx. 100m depth. Noise from underground activities (eg) trucking and loading – the noise could propagate up shaft 5 Noise from shaft 6 – Installing fans approx. 150m depth.	Noise monitoring program	Monitoring to verify noise levels and to provide feedback to fine tune / modify activities and equipment as required	Attenuation of equipment as required				As for current – none additional for noise
23	Amenity - Light, Air Quality / Odour, amenity and public interaction	No impact or changes from shafts 5 and 7; Shaft 6 exhaust; Public interaction.	No surface works	No additional construction or other activities on the surface	Complaints process	Minor	Rare	Low - 1	As for current – none additional for amenity
24	Amenity - Light, Air Quality / Odour, amenity and public interaction	No impact or changes from shafts 5 and 7; Shaft 6 exhaust; Public interaction.	Shaft 5 is down casting	Takes any odour into the mine and away through existing airways					As for current – none additional for amenity
25	Amenity - Light, Air Quality / Odour, amenity and public interaction	No impact or changes from shafts 5 and 7; Shaft 6 exhaust; Public interaction.	Shaft 5 is fenced	To prevent access by the public – existing hazard					Review and upgrade the hole cover, fencing and signage for shaft 5

Ref	Threat	Sub-Causes	Preventative Controls	Information for Controls	Reactive (Mitigation) Controls	C	P	R	Additional Controls / Actions
26	Amenity - Light, Air Quality / Odour, amenity and public interaction	No impact or changes from shafts 5 and 7; Shaft 6 exhaust; Public interaction.	Shaft 6 location is in a mining area and separated from points of interest	Separation and within older mining landscape					As for current – none additional for amenity
27	Amenity - Light, Air Quality / Odour, amenity and public interaction	No impact or changes from shafts 5 and 7; Shaft 6 exhaust; Public interaction.	Shaft 6 exhaust monitoring	Exhaust monitoring has indicated that the exhaust quality is not an issue	Possible use of water suppressant in shaft if required				As for current – none additional for amenity
28	Impacts on local council Heritage	Head Frame 4 is primary heritage; Old buildings and mining equipment.	Secure and stabilise Head Frame 4	The old headframe is being stabilised prior to mining activities	Reinforce and repairs as required	Minor	Rare	Low - 1	As for current – none additional for heritage
29	Impacts on local council Heritage	Head Frame 4 is primary heritage; Old buildings and mining equipment.	Regular monitoring and inspections of Head Frame 4	Ongoing program of work – existing control (regardless of mine extension)					As for current – none additional for heritage
30	Impacts on local council Heritage	Head Frame 4 is primary heritage; Old buildings and mining equipment.	Heritage management	Ongoing program of work – existing control (regardless of mine extension)					Review nearby heritage items
31	Impacts on local council Heritage	Head Frame 4 is primary heritage; Old buildings and mining equipment.	As for ground stability and blasting controls	Ground movement and vibration could influence a structure of this nature but this will be controlled (refer above)					As for current – none additional for heritage

9.4 Photo Study

Figure 21 : Representative Photos of the Area

<table>
<tr><td>
Road – looking towards mining buildings. The road surface has been resealed several times and has been used for a long time. Appears in reasonable condition. Mining area fenced. Some public pedestrians / joggers walk beside the road.</td><td>
Wooden head frame on the left is Head frame 4. This is being reinforced for safety regardless of the mine extension to ensure reasonable steps are taken to preserve for as long as possible (community interest aspect).</td></tr>
<tr><td>
Older disused shaft 5 – fenced and will be turned into a downcast (fresh air intake) for the mine extension</td><td>
Area opposite – two buildings one of which is vacant and another with a resident</td></tr>
</table>

 Cracking and deterioration of old concrete fencing and cracking in the asphalt in front of the buildings is evident	 Front fence of second old building with a resident. Similar deteriorating condition of fencing and access
 View of road – there does appear to be a water / pipeline buried on the far side along the road corridor that needs to be taken into account	 View of road
 View of buildings	 Building with tenant – old building and in poor condition

	
View from tenant residence – looking across the road	Walkway beside road – no under drainage / culverts evident

9.5 Risk Treatment

A Systems Model to Treat Risks

A systems approach to the treatment of risks involves consideration of three aspects:
1. Areas of intervention;
2. Wheel of Safe Production (Nertney Wheel); and
3. Sequence of Barriers.

Areas of intervention

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

- Prevent (P): Aim to reduce the probability of a loss event to as close as possible to zero. This is typically done by designing out the risk, using a different process or providing multiple hard barriers between energy sources and people. Controls can have a preventative nature that acts to avoid the unwanted event from occurring.

- Monitor (M): Aim to put monitoring regimes in place that detect the increased probability of a loss event. Typical examples are fire detection alarm systems, and daily site inspections for strata conditions.

- First Response (R): Aim to install operating systems that react quickly to minimise the consequence of a loss event. Typical examples are pumping systems, and Emergency Response procedures/teams.

- Restore (S): Aim to have access to procedures and resources that restores the system to the condition it was in before a loss event, with the intent of minimising the time the system is impaired and/or to prevent further deterioration of the system.

Wheel of Safe Production (Nertney Wheel)

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

Figure 22 : Wheel of Safe Production

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

Competent People

- Supervision and managers
- Technical as well as operators and managers
- Training programs (the manuals are the documentation included in Safe Work Practices – people then have to be trained and assessed as competent on an ongoing basis);
- Skills and experience required, selection and placement

Fit For Purpose Equipment

- Special gear and hardware required
- Equipment suited to task (e.g. loaders, drills – include specification)
- PPE (personal protective equipment)
- Warning devices such as sirens, alarms, lights, signs, fencing
- Monitoring systems, interlocks with PLCs etc.

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
- Audits and reviews

Safe Work Practices

- All documentation
- Procedures, standards and training manuals
- Maintenance programs/schedules
- Plans, schematics, wiring diagrams
- Risk assessments, JSAs
- Design processes and standards

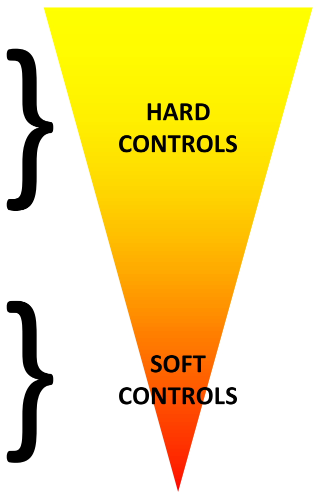
Sequence of Barriers (Hierarchy of Controls)

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

Figure 23 : 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)



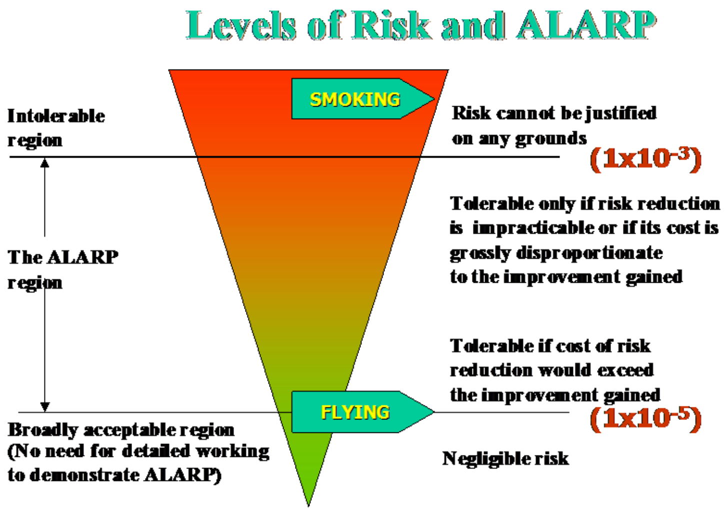
Risk Acceptability and Risk Criteria

Legislation and good practice is targeted to reduce risk to *"As Low as Reasonably Practicable"* (ALARP), this 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 that 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 in the following figure. 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 24 : Risk Criteria "ALARP"



9.6 ABOUT YOUR REPORT

Your report has been developed on the basis of your unique and specific requirements as understood by ***SP Solutions*** and only applies to the subject matter investigated. Your report should not be used or at a minimum it MUST be reviewed if there are any changes to the project and Key Assumptions. ***SP Solutions*** should be consulted to assess how factors that have changed subsequent to the date of the report affect the report's recommendations. ***SP Solutions*** cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

To avoid misuse of the information contained in the report it is recommended you confer with ***SP Solutions*** before passing your report on to another party who may not be familiar with the background and the purpose of the report.

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The report as a whole presents the findings of the site specific assessment or study (such as an investigation) and the report should not be copied in part of altered in any way.

SP Solutions is familiar with a variety of techniques and approaches that be used to identify and reduce a broad range of risks over the life of projects and operations. It is common that not all approaches will be necessarily dealt in your report due to concepts proposed, recommendations by the team at the time or the scope determined by you. Speak with ***SP Solutions*** to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

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- valid and factual inputs supplied by all third parties;
- key assumptions outside the influence of ***SP Solutions***; and
- the results of any team based approach to review the topic and are therefore not the result of any one individual or organisation (including ***SP Solutions***).

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