McArthur River Mine

Overburden Management Project

7

Project Risk Assessment

Draft Environmental Impact Statement

7 Project Risk Assessment

7.1 Introduction

This section of the Environmental Impact Statement (EIS) describes the risk identification, assessment and risk management process undertaken for the Overburden Management Project (the Project), and incorporates all relevant Project Domains and phases of activity (i.e. a whole-of-project approach) including Project specific:

- mining activities;
- operational activities; and
- decommissioning, rehabilitation and closure activities including adaptive management and long-term monitoring.

For each of these phases, McArthur River Mining Pty. Ltd. (McArthur River Mining) has identified and assessed the following types of risks that could potentially impact upon the wider social and natural environment:

- Environment (including risks related to air, land, water resources and biodiversity);
- Regulatory (or compliance) risks;
- Community and Stakeholder risks (including economic, social and cultural heritage);
- Human health and safety risks; and
- Cost/Financial risks (and the resultant impacts on Project viability and community investment).

Through the identification of environmental, social and cultural values in this EIS, the members of the community anticipated to be affected by residual risks have also been identified. Refer to the following chapters for further details:

- **Chapter 8 – Water Resources**;
- **Chapter 12 – Socio-economic Environment**;
- **Chapter 13 – Air Quality**; and
- **Chapter 14 – Health and Safety**.

Certain internal company related risks have not specifically been identified or assessed as part of this Project Risk Assessment, nor have those operational related risks that are not considered to have changed from the Phase 3 Development Project (Phase 3). Risks that were identified and assessed as part of Phase 3 are managed in accordance with McArthur River Mining's existing risk management framework (refer to **Section 7.2** for further details).

Key features of McArthur River Mining's risk management approach include:

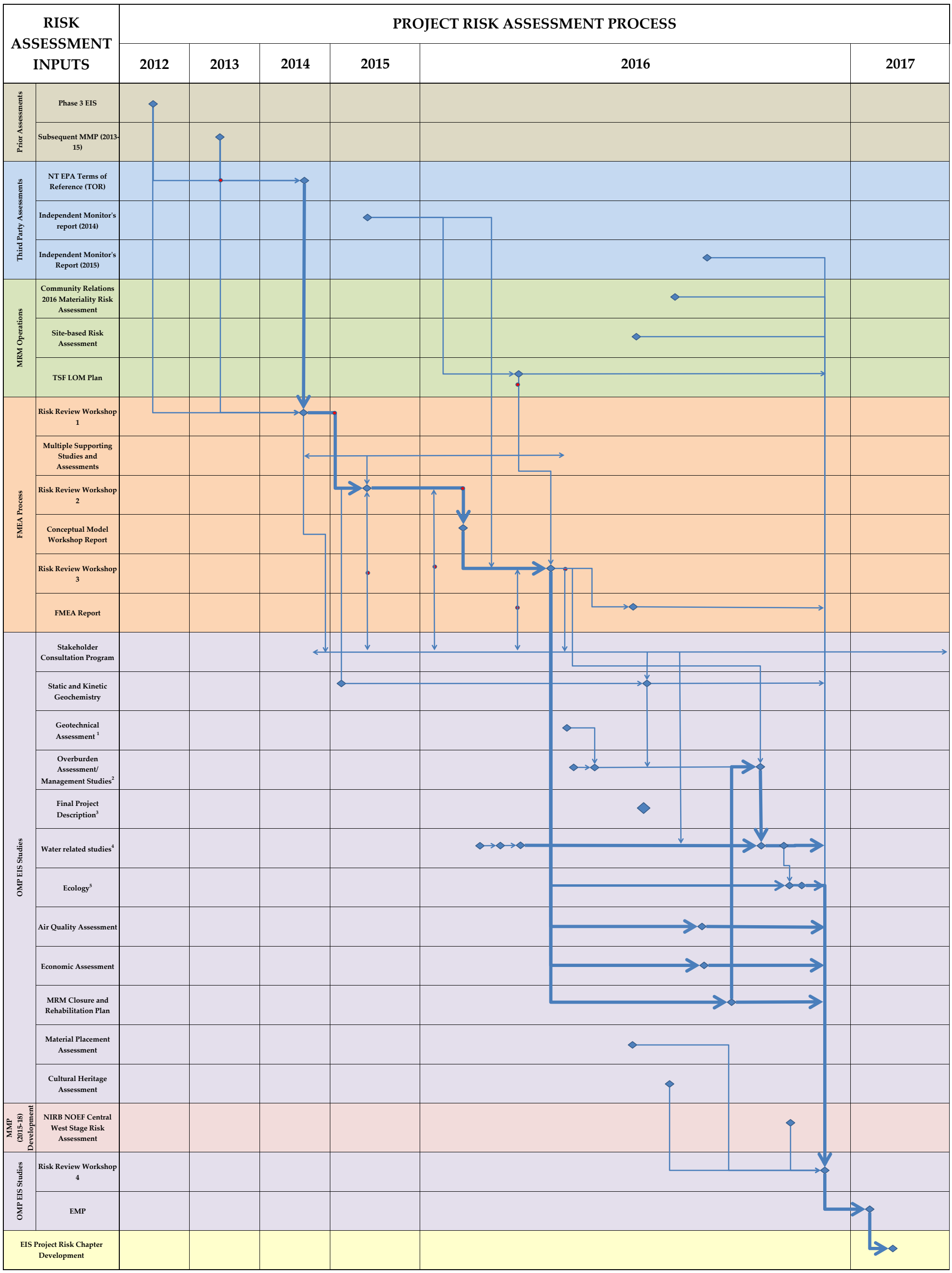
- management of the Project's domains in accordance with the Project design philosophy and closure objectives (refer **Chapter 3 – Project Description and Justification**). The design philosophy is driven by the closure objectives, and focusses on managing and mitigating key long-term environmental risks from the outset, as part of the Project design and operational phases. This approach reduces the reliance on mitigation in the post-mining phase by addressing potential long-term environmental risks in the short-term and design stages. Therefore Project risk identification, assessment and management has been and will continue to be an integral part of the life of the McArthur River Mine (MRM) site, especially as the site approaches key Project phases; and

- consideration of both short-term and long-term management timeframes, and an acknowledgement that the site will include residual environmental risks that will require ongoing monitoring and management post site closure. As a result, McArthur River Mining is proposing to establish a number of monitoring and management programs, including short-term adaptive management; long-term proactive monitoring and long-term reactive monitoring programs. These are described in further detail in **Chapter 3 – Project Description and Justification.**

This chapter:

- describes the risk identification, assessment and management methodologies adopted by McArthur River Mining for the Project;
- identifies and discusses the range of risks for the Project, including those that have been identified as of special concern to the community and other relevant stakeholders;
- quantifies and ranks each of these risks in accordance with industry accepted practice;
- discusses the level of uncertainty for each identified risk, and what measures have been taken to reduce this uncertainty; and
- documents the risk management and mitigation controls (including hazard specific and systems-based controls, and an assessment of their effectiveness) that McArthur River Mining will implement.

A number of sections of the EIS provide supporting information that has informed the risk identification and assessment process presented here. These sections are referenced throughout this chapter where relevant and summarised in **Figure 7-1**.



Notes:

1 Geotechnical assessments include NOEF Stability Analysis, Open Cut In-Pit Dumping (IPD) Stability Assessment and NOEF Compacted Clay Layer (CCL) Geotechnical Risk Assessment

2 Includes: Erosion Assessment of OEF Landform Configuration, Cover System and Landform Design and NOEF Performance

3 The development of the final Project Description was informed by selected EIS studies. Once finalised, the Project Description then provided input data/information to allow the impact assessment phases of other selected EIS studies to either be commenced or finalised. The various linkages between the Project Description and these selected EIS studies have not been shown here due to operational complexity.

4 Includes the: Managed Aquifer Recharge Feasibility Assessment, Final Void Limnology Assessment, Final Void Water Quality Assessment, Groundwater Assessment and Surface Water Assessment (which includes Water Balance, Flood Modelling, Site Wide Water Quality

5 Includes: Aquatic Ecology and Terrestrial Ecology

◆ Represents "Risk Assessment Input" completion date, however development may have occurred over an extended period and been subject to multiple iterations.

● Represents key design change/s resulting from MRM's risk and environmental assessment process.

→ Input and Output linkages

Figure 7-1 Project Risk Assessment Process

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7.2 Risk Identification and Assessment Methodology

7.2.1 Overview

The Project presents modifications to elements of Phase 3 and a continuation of existing operations; therefore a number of the risks previously identified and assessed within the Phase 3 EIS continue to be relevant to the Project. However, as a result of the improved understanding of the overburden geochemistry at the MRM site, and the subsequent revision of the overburden classification system (refer to **Chapter 6 – Materials Characterisation**) the Project's risk profile has changed.

McArthur River Mining has implemented a risk identification and assessment program over a two and a half year period to review these existing Phase 3 project risks, and identify and assess any new Project risks. This has been an iterative process that has been refined as the results of the Project's supporting technical study programs have been completed.

The program has also taken into consideration the risks identified by other third parties including the following:

- The Northern Territory (NT) Government, which identified a number of key risks as part of a preliminary assessment of the Project, and has prescribed in the EIS Term of Reference (TOR) that they be assessed (or re-assessed) as part of this Project EIS;
- The Independent Monitor (IM) reports. The ERIAS Group has been appointed by the NT Department of Primary Industry and Resources (DPIR) to develop annual Environmental Performance Reports on the MRM site, with the latest report having been released in 2016. The scope of these reports is to provide an independent monitoring assessment of the environmental performance of the MRM site. As part of these reports a site-wide environmental risk assessment has been developed, which is reviewed and updated on an annual basis; and
- The MRM Mine Risk Register report (2016). This mine site-wide report was developed by an external risk specialist and encompassed all areas of operational activities and proposed Project EIS scopes of work.

The program has incorporated a number of key components including:

- an extended technical study program;
- a comprehensive stakeholder engagement program (refer **Chapter 12 – Socio-economic Environment and Appendix Y – Economics Report**); and
- a hazard and impacts identification process and associated likelihood and consequence assessment in order to develop risk profiles comprising:
    - development of Project closure objectives (refer to **Chapter 4 – Decommissioning, Rehabilitation and Closure** and **Appendix S - Conceptual Mine Closure Plan**);
    - development of Project alternatives (refer to **Chapter 5 – Project Alternatives**);
    - refinement of the Project conceptual model and establishment of a preferred design (refer to **Chapter 3 – Project Description and Justification**);
    - completion of multiple risk identification and assessment workshops (refer to **Section 7.2.3**);
    - revisions/amendments to technical study scopes as knowledge gaps were identified; and
    - on-going engagement/consultation with relevant stakeholders to discuss preliminary findings.

Figure 7-1 provides an outline of the Project Risk Assessment process, including identification of key inputs and outputs and the linkages between each.

7.2.2 Project Risk Management Framework

The following section summarises McArthur River Mining's risk management framework for the Project, in terms of risk identification, risk evaluation (including timeframe, likelihood, consequence and level of confidence) and risk mitigation. The application of Glencore's Corporate Risk Matrix (refer to **Table 7-1** below) formed a central part of this process. It was an iterative process that included holding a number of technical risk review workshops (refer to **Section 7.2.3** for further details) to identify and assess Project risks.

The Glencore Corporate Risk Framework was adopted in order to undertake this Project risk assessment. This incorporated the following steps:

- risk identification;
- risk definition;
- timeframe definition;
- likelihood definition;
- consequence definition;
- level of confidence definition; and
- key assumptions.

These steps are further explained below.

7.2.2.1 Risk identification

A list of Project risks was initially identified by the Project team and refined over time as additional information became available. This process included:

- a review of previously identified risks within the Phase 3 EIS, and an assessment of whether those risks were still applicable to the proposed Project;
- incorporation of additional risks as identified by the NT Government as part of its preliminary assessment of the Project;
- incorporation of additional risks as identified by other third parties (e.g. the IM Report); and
- incorporation of additional risks as identified by the Project team either as a result of its risk review workshop findings, completed specialist technical studies and/or as identified by stakeholders throughout the Community Consultation program.

7.2.2.2 Risk definition

The process adopted for assessment of each identified risk included an assessment of the:

- inherent (or Pre-Project EIS) risk, based on existing mitigation measures, and
- residual (or Post-Project EIS) risk, based on proposed additional mitigation measures.

A combination of likelihood of occurrence and consequences of failure was considered for each risk event. The goal was to provide a useful analysis technique that could be used to assess the potential for (or likelihood of) failure of structures, equipment or processes. The analysis technique evaluated the effects of such failures on the larger systems, of which they formed a part, including:

- Environmental;
- Regulatory;
- Community and Stakeholder;

- Health and Safety; and
- Cost/Financial.

Failure was defined as any component of the preferred design which did not meet performance expectations or specific closure objectives.

The term 'risk' encompassed both the likelihood of failure and the severity of the expected consequences if such failures were to occur. It was an imprecise process because predictive risk assessment involves foreseeing the future. There was a difference between the risk of a failure and the uncertainty in the estimate of that risk. There were also separate uncertainties associated with both expected frequency and expected consequences. However, these uncertainties were identified and steps taken throughout the EIS process to reduce them to acceptable levels. This included refinement of technical study scopes to address any knowledge gaps, with a subsequent reassessment of the risk/s upon completion of these studies. In this way, the levels of uncertainly reduced over time.

The Glencore Corporate Risk Matrix was adopted, which combined the likelihood of occurrence with the severity of effects for each of the hazards and assigned an inherent and residual risk level to it as follows (also refer to **Table 7-1** below):

- High risks (comprising a risk score range of 17-25) were viewed as unacceptable and steps taken to reduce these risks;
- Moderate risks (comprising a risk score range of 7-16) were considered acceptable if they were As Low as Reasonably Practical (ALARP). For a risk to be ALARP it had to be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained; and
- Low risks (comprising a risk score range of 1-6) were broadly considered as acceptable.

7.2.2.3 Timeframe definition

Where possible, both “short-term” and “long-term” timeframes were adopted in order to undertake an evaluation of likelihoods.

- Short-term was defined as 0-100 years duration, and included:
    - a planning and execution (operation) phase of approximately 20-30 years duration; and
    - an adaptive management phase of approximately 70-80 years duration.
- Long-term was defined as 100-1,000 years duration, and included a:
    - proactive monitoring phase; and
    - reactive monitoring phase.

It was not practical to define every risk event in these terms. These terms are further explained in **Chapter 3 – Project Description and Justification**.

7.2.2.4 Likelihood definition

A quantitative likelihood approach was adopted for evaluating Project risks (refer to **Table 7-1**), with the actual chance of occurrence being dependent on the timeframe being evaluated (i.e. short-term or long-term). At times, to address operational issues, failure modes were evaluated over a short-term timeframe that was divided into 0-30 years and 30-100 years (for adaptive management).

7.2.2.5 Consequence Definition

The severity of effects (or consequences) of specific hazards was assessed based on an evaluation of expected responses following failure. These effects could have physical, biological, socio-economic and/or health and safety consequences. Criteria pertaining to assessment of severity of consequences specific to the McArthur River Mine were identified during the risk review workshops (refer to **Table 7-1)**. Criteria were agreed upon by the risk review workshop participants at the beginning of risk review workshop 3, following a review of the July 2015 Failure Modes and Effects Analysis (FMEA) workshop (risk review workshop 2) consequence definitions, as well as consideration of Glencore corporate risk evaluation documentation.

7.2.2.6 Level of Confidence Definition

For each hazard identified and resultant impact a consensus on the level of confidence for the risk ranking determined was developed. This level of confidence varied based on available site information at the time and the failure mechanism. The level of confidence of workshop participants for each evaluation was identified and documented using the designations described in **Table 7-2**. As additional information was gathered throughout the EIS process the level of confidence in assigned risk rankings increased. This was particularly relevant between risk review workshop 3 (when supporting EIS technical studies were still in the preliminary stage) and risk review workshop 4 (when technical studies including modelling programs were either completed or at an advanced stage).

In addition, the proposed adoption of an adaptive management program in the short-term, combined with longer term proactive and reactive monitoring programs lead to increased levels of confidence that risks could be managed in the longer term. This was based on the fact that:

- the 20-30 year operational life of the mine provided opportunities for continual improvement;
- following the cessation of mining, the 70-80 year adaptive management phase allowed for the adoption of a flexible management approach in response to closure and rehabilitation monitoring results and regulatory requirements; and
- long-term proactive and reactive monitoring provided:
    - the opportunity to confirm site environmental performance is in compliance with site closure objectives; and
    - the mechanism to respond to particular events (e.g. cyclones or floods) and evaluate mitigation requirements.

7.2.2.7 Key Assumptions

The development of the Project conceptual model and preferred design philosophies (as described in **Section 7.2.3.1.3**) formed the basis of the key assumptions made when assessing the Project risks.

Table 7-1 Glencore Corporate Risk Matrix

Consequence	Health & Safety	Environment	Financial Impact	Image & Reputation/Community	Legal & Compliance	Likelihood: E - Rare	Likelihood: D - Unlikely	Likelihood: C - Possible	Likelihood: B - Likely	Likelihood: A – Almost Certain
						Unlikely to occur during a lifetime; or very unlikely to occur; or no known occurrences in broader worldwide industry	Could occur about once during a lifetime; or more likely not to occur than to occur; or has occurred at least once in broader worldwide industry	Could occur more than once during a lifetime; or as likely to occur as not to occur; or has occurred at least once in the mining/ commodities trading industries	May occur about once per year; or more likely to occur than not occur; or has occurred at least once within Glencore	May occur several times per year; or expected to occur; or has occurred several times within Glencore
5 Catastrophic	• Multiple fatalities (≥5) • Multiple cases (≥5) of Permanent Damage Injuries or Diseases that result in permanent disabilities in a single incident	• Unconfined and widespread • Environmental damage or effect (permanent; >10 years) • Requires major remediation	• Unsustainable effect on company finances and budgeting, and creates an inability to continue operations, leading to Project closure	• Loss of multiple major customers or large proportion of sales contracts • Sustained campaign by one or more international NGOs resulting in physical impact on the assets or loss of ability to operate • Security incident resulting in multiple fatalities or major equipment damage • Formal expression of significant dissatisfaction by government • Grievance from any stakeholder alleging human rights violation resulting in multiple fatalities	• Major litigation/ prosecution at Glencore corporate level • Nationalisation/ loss of licence to operate	**15 (M)**	**19 (H)**	**22 (H)**	**24 (H)**	**25 (H)**
4 Major	• Fatality or permanent incapacity/health effects	• Long-term (2 to 10 years) impact • Requires significant remediation	• Major effect on company finances and budgeting, and poses major restrictions on operations, leading to sub-optimal Project development	• Negative media coverage at national level • Scrutiny from government and NGOs • Complaints from multiple "final" customers • Loss of major customer • Loss of community support • Negative impact on share price	• Major litigation/ prosecution at Division level	**10 (M)**	**14 (M)**	**18 (H)**	**21 (H)**	**23 (H)**
3 Moderate	• Lost time/disabling injury/occupational health effects/ multiple medical treatments	• Medium-term (<2 years) impact • Requires moderate remediation	• Moderate effect on company finances and budgeting, and poses moderate restrictions on operations, which could lead to sub-optimal development	• Negative media coverage at local/regional level over more than one day • Complaint from a "final" customer • Off-spec product • Community complaint resulting in social issue	• Major litigation/ prosecution at Operation level	**6 (L)**	**9 (M)**	**13 (M)**	**17 (H)**	**20 (H)**
2 Minor	• Medical Treatment Injury/occupational health effects • Restricted Work Injury	• Short-term impact • Requires minor remediation	• Minor undesirable effect on company finances and budgeting, and poses minor restrictions on operations	• Complaint received from stakeholder or community • Negative local media coverage	• Regulation breaches resulting in fine or litigation	**3 (L)**	**5 (L)**	**8 (M)**	**12 (M)**	**16 (M)**
1 Negligible	• First Aid Injury (FAI)/illness	• No lasting environmental damage or effect • Requires minor or no remediation	• Can be funded within current budget, with no negative impact on profitability, workforce numbers or community investment projects.	• Negligible media coverage	• Regulation breaches without fine or litigation	**1 (L)**	**2 (L)**	**4 (L)**	**7 (M)**	**11 (M)**

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Table 7-2 Levels of Confidence Designated by Workshop Participants

Confidence	Description
Low (L)	Do not have confidence in the estimate or ability to control during implementation.
Medium (M)	Have some level of confidence in the estimate or ability to control during implementation, conceptual level analyses.
High (H)	Have a high level of confidence in the estimate or ability to control during implementation, detailed analyses following a high standard of care.

7.2.3 Risk Review Workshops

The completion of four risk review workshops formed a key component of Project closure planning. These workshops served the following purposes:

- consideration of a number of conceptual model alternatives; and
- risk identification and assessment of preferred designs.

These formally facilitated workshops were held over a two and a half year period. **Table 7-3** provides details of workshop participants with **Sections 7.2.3.1 and 7.2.3.2** providing further details on each workshop's scope.

Table 7-3 Risk Review Workshop Participants

Name	Company	Discipline
Mike O'Kane	O'Kane Consultants	FMEA Specialist (Risk Review Workshops 1-3 facilitator)
Dr Peter Standish	Operational Risk Mentoring	Principal Consultant (Risk Review Workshop 4 facilitator)
Sam Strohmayr	McArthur River Mining	General Manager
Gary Taylor	McArthur River Mining	Environmental Projects Manager
Atul Jamwal	McArthur River Mining	Project Controls Manager
Jamie Hacker	McArthur River Mining	Senior Mining Engineer
Drew Herbert	McArthur River Mining	Senior Mining Engineer
Pyramo Marianelli	McArthur River Mining	Geochemist – Environmental Projects
Scott Rathbone	McArthur River Mining	Senior Hydrogeologist
Tyson Lavender	McArthur River Mining	Environmental Engineer
Karen Heazlewood	McArthur River Mining	Project Civil Engineer
John Andreatidis	McArthur River Mining	Process and Port Manager

Name	Company	Discipline
Jon Nortier	McArthur River Mining	Mining Superintendent
Ryan Pascoe	McArthur River Mining	Manager – Environment, Safety and People
Steven Rooney	McArthur River Mining	Mining Manager
Jason Jones	Mount Isa Mines	Superintendent – Environmental Strategy and Regulation
Elise Anderson	McArthur River Mining	Executive Assistant
Peter Scott	O'Kane Consultants	NOEF Landform, and cover system design and unsaturated flow modelling
Phil Garneau	O'Kane Consultants	NOEF Landform, and cover system design and unsaturated flow modelling
Brent Usher	KCB	Groundwater, Geology and Geochemistry
Chris Langton	KCB	Groundwater, Geology and Geochemistry
Alireza Naderian	AECOM	Geotechnical Engineer
Julian Orth	WRM	Surface Water Assessment
Dave Moss	MET Serve	EIS Project Manager
Jim Barker	MET Serve	Principal Consultant - Environment
Stan Blanks	Pando Australia	Geotechnical Engineer

7.2.3.1 Risk Review Workshops 1-3

An FMEA risk identification and assessment approach was initially adopted by McArthur River Mining for the first three risk review workshops to support the impact and risk assessment of the Project's life of mine including closure planning. These workshops were facilitated by Mr. Mike O'Kane (President of O'Kane Consultants and an FMEA risk specialist) and included selected Project team members including McArthur River Mining technical specialists and subject matter specialist consultants. This FMEA approach (as reported by OKC 2016):

- was based on international best practice, and in accordance with accepted industry standards including AS/NZS ISO 31000:2009;
- provided essential Project context input data through establishment of Project closure objectives and preferred design detail;
- was an engineering tool, which was used to inform and support the design process of the Project;
- was a top-down, expert-system approach, which systematically identified risk(s), quantified potential risk magnitude, and prioritised risks that were identified; and
- developed and identified mitigation measures as well as further studies in order to manage the risk(s).

As information was developed during the different stages of the Project's planning and design, a number of steps were undertaken including:

- review of failure modes and effects;
- amendments to risk scores if warranted;
- where appropriate, development of more cost effective means to manage the risk; and
- communication of revised risks to relevant stakeholders.

Refer to **Appendix F – Failure Mode and Effects Analysis Report** for a full description of the FMEA process and outcomes.

Based on the outcomes of this FMEA approach, a draft Project Risk Register was developed following completion of risk review workshop 3.

7.2.3.1.1 Risk Review Workshop 1

An initial risk identification and assessment workshop was held in 2014, to commence the identification and preliminary assessment of North Overburden Emplacement Facility (NOEF) risks, based on current information at that time.

7.2.3.1.2 Risk Review Workshop 2

The second risk review workshop was held over multiple days in 2015 and expanded its focus to a site-wide assessment. This workshop's objective was to develop and agree on conceptual base case designs for all three Project domains and to determine the most appropriate way in which this could be communicated to the NT Government and other decision makers and stakeholders. Groundwater and surface water qualities were identified as the key interactions between the domains which pose the greatest Project closure risk in terms of the potential adverse impact to aquatic receptors downstream of the mine. The workshop utilised water quality guidelines as a means to address the risks, where water quality was evaluated in terms of spatial extent, magnitude and frequency.

7.2.3.1.3 Risk Review Workshop 3

In May 2016, McArthur River Mining conducted a third multi-day risk review workshop, which was designed to identify and assess the Project's key processes and mechanisms, and determine appropriate controls for these processes and mechanisms. The base cases for closure of the Project domains were re-evaluated using a four-stage process to brainstorm solutions/alternatives, identify risks, focus these risks and develop alternatives to address these risks. As a result, amendments to the base cases were made which then provided the basis for the technical assessments.

The preferred Project design was subsequently identified, with the open cut, NOEF and Tailings Storage Facility (TSF) domain design philosophies summarised below (refer to Section 3.3 in **Chapter 3 - Project Description and Justification** for further details).

<u>Domain #1 – Open Cut</u>

- considers long-term (100-1,000 years) risks as well as operational/short-term risks;
- is economically viable to construct and maintain, considering the full life cycle (up to 1,000 years) of the facility;
- enables safe and productive mining operations at rates required for processing;
- the open cut and major quarries to be located inside the mine levee wall;
- safely and securely store non-benign materials in both the remnant open cut walls, and any materials placed in it after mining operations cease; and
- provide a landform that is consistent with the MRM closure objectives.

Domain #2 – NOEF

- addresses the environmental risks presented by the existing NOEF by encapsulating and flood proofing non-benign material to above the 100 year ARI level;
- considers long-term (100-1,000 years) risks as well as operational/short-term risks;
- is economically viable to construct and maintain, considering the full life cycle (up to 1,000 years) of the facility;
- restricts the footprint extent to reduce the potential environmental impacts, including seepage;
- avoids diversion of major watercourses;
- leaves a landform that has slopes similar to surrounding natural landforms, with flatter lower slopes and steeper upper slopes;
- reduces the reliance on an external cover system for satisfactory performance, through internal design and construction practices;
- has an internal architecture that places the materials with the highest risk of creating environmental harm furthest away from the receiving environment, with progressively lower risk materials placed toward the final outer surface;
- regulates both the generation of oxidation products and the transport of these products, with the materials used in oxygen and water management controls to be resilient or easily renewed/replaced considering the life of the facility;
- promotes infiltration and net percolation entering the NOEF to preferentially report as toe seepage rather than transmission into basal seepage, to facilitate collection and management;
- exhibits a high degree of constructability using readily available skills, methods, equipment and materials;
- incorporates staged construction so as to allow early, progressive rehabilitation; and
- is amenable to remediation and/or mitigation in the case of the MRM objectives not being achieved.

Domain # 3 – TSF

- amalgamation of Cells 1 and 2 and subsequent operation as a conventional wet tailings storage facility;
- minimise gas entry into the tailings to assist with tailings consolidation;
- reduce seepage by maintaining a small decant pond and through optimised tailings placement and management to remove water at the surface (by evaporation) and achieve sufficiently moist but unsaturated tailings beaches;
- intercept seepage at necessary locations to reduce risk of unacceptable environmental impact;
- maintain conservatively stable slopes;
- achieve and maintain consistent target tailings density by managing tailings deposition, ponded water and tailings drainage;
- achieve a low rate of rise (less than 1.5 m/year) by having a sufficiently large deposition footprint;
- maintain an appropriate level of saturation/moisture within the tailings beach during the cycling between spigots to reduce the potential for oxidation of tailings;
- maintain a uniform beach profile to consistently provide the design stormwater storage capacity;
- maintain beach freeboard (and therefore low piping risk) by constructing a new spillway that will be progressively raised to match the tailings rate of rise;
- manage long-term risks posed by tailings oxidation and landform stability by removal of the tailings from the TSF after the open cut is completed, with subsequent reprocessing and transfer of reprocessed tailings into the open cut final void for sub-aqueous disposal with effectively no ongoing oxidation; and
- deconstruction of the TSF walls, then reprofiling and revegetation of the TSF site.

7.2.3.2 Risk Review Workshop 4

The fourth (and final) risk review workshop was held in December 2016 and facilitated by Dr. Peter Standish (Principal Consultant and Director of Operational Risk Mentoring). This workshop was conducted to:

- confirm the findings from the first three risk review workshops;
- incorporate the outcomes of additional technical assessments;
- update draft results with additional information as identified through the stakeholder engagement programs;
- incorporate the outcomes of third party risk reviews including the IM Report (there was a slightly different risk framework adopted for the IM Report, however it was broadly consistent with Glencore's corporate risk framework and could therefore be amalgamated with other risk assessment findings into the overall risk register);
- confirm that all knowledge gaps were closed and levels of uncertainty were at acceptable levels;
- confirm all risk related TOR requirements were addressed;
- confirm all identified risks had been evaluated in accordance with Glencore's corporate risk framework; and
- finalise the Project Risk Register.

Refer to **Appendix G – Final Risk Assessment Report** for a copy of the risk review workshop 4 risk assessment report, as prepared by the independent facilitator. A copy of the final Project Risk Register can be accessed at:
http://www.mcarthurrivermine.com.au/EN/EIS/Documents/Project-Risk-Register.xlsx.

7.3 Project Risk Assessment Findings

The following section identifies and discusses the key risks identified for the Project.

7.3.1 Presentation of Findings

As detailed in **Section 7.2.1**, the Project's key risks presented below have been identified as a result of:

- the NT Government review;
- the IM report 2016;
- the MRM Mine Risk Register report (2016), and
- the McArthur River Mining Project EIS risk assessment process.

Table 7-4 provides a summary of the key Project risks identified, and where within the EIS they have been addressed (i.e. management measures proposed based on impact assessment). For the purposes of the EIS, key Project risks have been defined as those with a residual qualitative risk ranking of medium or higher (i.e. a residual quantitative risk ranking of greater than or equal to seven (7)).

Table 7-5 provides a breakdown of all identified key Project risks and their subsequent risk evaluations. A discussion of these findings is provided in **Section 7.3.2**. The complete risk assessment worksheet developed for the Project (which presents all risk assessment results) can be referenced at http://www.mcarthurrivermine.com.au/EN/EIS/Documents/Project-Risk-Register.xlsx.

This worksheet has not been reproduced within the body of this EIS chapter due to the size/dimensions of the worksheet, and subsequent difficulty in presenting it in hard copy version. This worksheet should be considered a working document that was compiled as a result of risk review workshop 4. It should be reviewed as such or if further details are sought on low risk hazards. Low risk hazards have not been identified in **Table 7-4** or **Table 7-5**, although they have been identified and assessed within the respective EIS chapters, with proposed mitigation and monitoring controls detailed as required.

Figure 7-2 provides a Project risk profile, summarising all of the identified Project risks in order of risk ranking. Pre-Project EIS inherent risk rankings and post-EIS residual risk rankings have been provided for comparison purposes.

Figure 7-3 and **Figure 7-4** provide respective breakdowns of the inherent and residual risks summarised in **Figure 7-2**, and details the proportions of low, medium and high risks.

Table 7-4 Key Project Risks

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
1	BB50	Site-wide	Site-wide flood and overload of adaptive management controls (Long-Term).	16 (M)	Section 8.6.3 Section 8.6.4.4
2	BB96	NOEF	Inappropriate storage and disposal of overburden leads to contamination of surface and groundwater systems.	14 (M)	Sections 6.6 to Section 6.9
3	BB38	TSF	Accumulation of surface waters on the TSF leads to piping through wall and subsequent contaminant release.	14 (M)	Section 8.5.1.3 Section 10 of Appendix R – Tailings Storage Facility Life of Mine (LOM) Plan
4	BB41	Open Cut	Poor mine pit lake water chemistry leading to inability to relinquish site.	14 (M)	Section 8.5.3.1 Section 8.7.2.2.3
5	BB63	TSF	Storage of tailings and process water creates excessive settlement of the embankments and/or overtopping and resultant release of tailings to the environment.	14 (M)	Section 14.6 Sections 10 and 13 of Appendix R – Tailings Storage Facility LOM Plan
6	BB58	Open Cut	Spontaneous combustion in walls of the open cut results in increased geochemical loading on waters in the open cut, leading to deterioration of water quality.	14 (M)	Section 3.4.4.2.1.2.1
7	BB91	TSF	TSF high rate of rise leads to embankment failure which leads to a release of contaminants.	14 (M)	Section 14.6 Sections 10 and 13 of Appendix R – Tailings Storage Facility LOM Plan

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
8	BB93	TSF	Earthquake/seismic activity lead to TSF embankment failure and release of tailings/contaminants.	14 (M)	Section 14.6 Sections 10 and 13 of Appendix R – Tailings Storage Facility LOM Plan
9	BB84	Site-wide	EIS rejected by regulator, resulting in inability to continue mining for ore beyond current approval period, and ultimate closure of the mine with resultant loss of jobs and investment in the community.	14 (M)	Section 12.6
10	BB65	TSF	Injuries to personnel during tailings re-mining due to mine face or embankment failure.	14 (M)	Section 14.6
11	BB90	Site-wide	Clearing of vegetation, leading to a reduction in habitat for certain species of fauna and flora.	13 (M)	Section 9.7
12	BB95	Open Cut	Mining below groundwater level can lead to potential drawdown in adjacent McArthur River and waterholes, with reduction in habitat availability.	13 (M)	Section 8.5.1 Section 9.7 Section 10.8.2 Sections 4.2 and 5.3.2 of Appendix W – Aquatic Ecology Report
13	BB80	Site-wide	Major changes in the design of the NOEF and other final landform features resulting in community benefits being less than previously expected due to the increased costs to McArthur River Mining associated with management requirements of the problematic material.	13 (M)	Section 5.5 Section 12.6
14	BB42	TSF	Injury during construction activities (e.g. tailings delivery pipeline movement on crest of embankment).	13 (M)	Section 14.6

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
15	BB75	Site-wide	Changes to values within the site's current waste discharge license (WDL) may have an impact on the mine's ability to meet any new proposed trigger values.	13 (M)	Section 8.1.3 Appendix U – Surface Water Impact Assessment Report
16	BB83	Site-wide	Premature closure and rehabilitation of structures if operations are forced to cease prior to originally planned. This could potentially create an ongoing environmental, social and/or economic legacy.	13 (M)	Section 4.12 Section 5.4
17	BB88	Site-wide	Lack of appropriate fluvial sediment management, leading to impacts on aquatic environments and ecology, and potentially health of people consuming fish.	12 (M)	Section 9.7
18	BB98	TSF	Increased holding capacity creates groundwater mound, with potential impacts on surface water flow regimes, surface water quality and aquatic habitat.	12 (M)	Section 8.5.1.3 Section 8.5.3.3 Section 9.7
19	BB15	Open Cut	Water treatment plant's inability to treat seepage waters (closure) leading to change in chemistry within the groundwater and inability to meet water quality criteria.	11 (M)	Section 8.5.3.1
20	BB61	NOEF	A change in the block model resulting in a change to the non-acid forming (NAF) and potentially acid forming (PAF) ratio (NAF/PAF ratio) during construction (e.g. insufficient clean layers available), triggering the need for a further EIS, resulting in cessation of operations and subsequent loss of jobs and community investment.	10 (M)	Section 6.6 to Section 6.9

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
21	BB33	Open Cut	Geotechnical failure of the open cut wall with the mine pit lake partially filled, leading to loss of western levee functionality. Resultant water inflows in flood and releases after flood event and failure to meet downstream water quality objectives.	10 (M)	Section 3.4.4.2.1.2.1 Section 7 of Appendix N - Geotechnical Report
22	BB35	TSF	Water erosion or scouring of TSF embankment toe, leading to embankment failure and tailings release.	10 (M)	Section 14.6 Section 8.5.1.3 Section 10 of Appendix R – Tailings Storage Facility LOM Plan
23	BB34	Open Cut	Open cut wall failure compromises long term mine pit lake water quality leading to loss of functionality of western levee, incorrect location of McArthur River inflow, levee failure and failure to meet downstream water quality objectives.	10 (M)	Section 3.4.4.2.1.2.1 Section 7 of Appendix N - Geotechnical Report
24	BB94	TSF	Differential settlement of tailings which creates cracking, a reduction in shear resistance, increase in potential for water infiltration and/or embankment piping failure, leading to unplanned releases.	10 (M)	Section 10 of Appendix R – Tailings Storage Facility LOM Plan
25	BB92	TSF	TSF embankment failure with subsequent release of tailings and sediment causing environmental damage, cost from lost production, clean-up and reconstruction costs, regulatory restrictions, community discontent, and a potential fatality or permanent incapacity.	10 (M)	Section 14.6 Section 10 of Appendix R – Tailings Storage Facility LOM Plan
26	BB97	NOEF	Seepage from NOEF including PAF material giving rise to acid and metalliferous drainage and potential impacts on surface water quality and aquatic habitat.	9 (M)	Sections 3.4.4.3, 3.4.5.3. and 3.4.6.3 Sections 8.4.5, 8.5.1, 8.5.2, 8.5.3 and 8.7.2 Section 9.7

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
27	BB53	NOEF	Geotechnical failure of existing landform leading to loss of cover system functionality and resulting in sedimentation and loss of gas and water management functions.	9 (M)	Section 3.4.4.3 Section 7 of Appendix N - Geotechnical Report
28	BB25	NOEF and TSF	Generation of acid and metalliferous drainage with potential impacts on wildlife through exposure to (and accumulation of) metals and other toxicants, and resultant potential impact on public health (e.g. through consumption of contaminated aquatic fauna).	9 (M)	Sections 3.4.4.3, 3.4.5.3 and 3.4.6.3 Sections 3.4.4.4, 3.4.5.4 and 3.4.6.4 Section 9.7 Sections 8.4.5, 8.5.1, 8.5.2, 8.5.3 and 8.7.2 Section 14.6
29	BB48	NOEF	Spontaneous combustion of overburden with release of sulphur dioxide and other products of combustion and affecting nearby receptors.	9 (M)	Section 3.4.4.3.1 Section 13.4 Section 14.6
30	BB02	Site-wide	Major changes in the design of the NOEF and other final landform features resulting in community benefits being less than previously expected due to the increased costs to McArthur River Mining associated with management requirements of the problematic material.	9 (M)	Section 12.6 Section 5.5.3
31	BB01	NOEF and TSF	Release of contaminated waters above acceptable levels, with potential negative social and economic impacts to the Roper-Gulf region and the NT associated with environmental degradation.	9 (M)	Section 12.6

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
32	BB31	NOEF	NOEF construction around existing NOEF leads to potential spontaneous combustion in new NOEF and desiccation of barrier layers, leading to cracking, ingress of water and high oxidation rates, with release of contaminants.	9 (M)	Section 3.4.4.3.1 and 3.4.4.3.2 Section 13.4
33	BB39	NOEF	Placement of non-benign overburden material in the growth medium leading to revegetation failure.	9 (M)	Sections 3.4.4.3.3.6.6, 3.4.4.3.5.3 and 3.4.4.3.5.4 Section 6.6 to Section 6.9
34	BB08	Open Cut	Ingress of Largetooth Sawfish into the mine pit lake resulting in fish kills due to lack of suitable habitat available.	8 (M)	Section 10.5.14 and Section 10.8.2
35	BB49	Site-wide	Site-wide flood as a result of the McArthur River overtopping the levee (short-term; 30-100 years) leading to widespread erosion, overwhelming of water treatment facilities, disruption of operations and lack of access.	8 (M)	Section 8.6.3 Section 8.6.4.4
36	BB72	NOEF	Failure of surface water management system within/around the NOEF, impeding ability to achieve acceptable downstream water quality.	8 (M)	Numerous sections within the Water Resources Chapter 8, including Sections 8.4.2, 8.4.3, 8.4.5, 8.5.1, 8.5.2, 8.5.3, 8.6.2, 8.7.1, 8.7.2 and 8.7.3.
37	BB43	Open Cut	Spontaneous combustion during in-pit dumping rehabilitation works leading to sulphur dioxide exposure to site personnel.	8 (M)	Section 13.4 Section 14.6

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
38	BB64	TSF	Exposure of tailings to atmosphere during re-mining leads to generation of AMD and/or sulphur dioxide.	8 (M)	Section 8.5.2.3 Section 14.6 Section 10 of Appendix R – Tailings Storage Facility LOM Plan
39	BB57	Open Cut	Poor water quality in mine pit lake due to slow filling, leading to a change in water chemistry and inability to meet water quality criteria.	8 (M)	Section 8.5.3.1
40	BB21	TSF	Insufficient availability of suitable construction materials, with requirement to expand borrow materials sources.	8 (M)	Section 5.6.2 Section 6.5.2.2 and Section 6.6.1.3 Section 7.2.1 and Appendix C of Appendix R – Tailings Storage Facility LOM Plan Appendix T – Groundwater Impact Assessment
41	BB47	Site-wide	Changed vegetation due to operations and rehabilitation, including spread of invasive/feral species that may have a potential impact on significant species/habitat.	8 (M)	Section 9.7

Risk No.	Risk Identification	Project Domain	Key Project Risk	Residual Risk Score	EIS Section No.
42	BB82	Site-wide	Fugitive dust emissions and metals introduced into food chain as a result of operations. Resulting in emissions from the TSF, haul roads, run-of-mine pad, concentrate stores and other aspects of operations, and seepage from the TSF, SPROD, run-of-mine sump and NOEF affects water and fluvial sediment quality in McArthur River and Barney, Little Barney and Surprise Creeks. Reduction in water quality reduces diversity and abundance of aquatic fauna. Metals bio-accumulate in aquatic fauna, which are then consumed by humans, causing potential morbidity and/or health effects. Contaminants migrate downstream from the mine site. Contaminated biota move from exposed sites around the MRM to regional reference sites.	7 (M)	Numerous sections within the Water Resources Chapter 8, including Sections 8.4.2, 8.4.3, 8.4.7, 8.5.1, 8.5.2, 8.5.3, 8.6.1, 8.6.2, 8.6.4 and 8.7. Section 9.7 Section 10.8 Section 13.4 Section 14.6
43	BB45	TSF	Spontaneous combustion of tailings due to improper handling during dam construction, leading to potential health impacts.	7 (M)	Section 14.6

Table 7-5 Risk Identification and Evaluation

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB50	Site-wide flood	Overload of adaptive management controls (Long-Term).	Site-wide	Phase 3 - an isolated void with passive filling	Env, Reg & Comm	B	4	H-21	H - existing systems in place and working.	Site closure strategy. Adoption of adaptive management and reactive management principles.	A	Env 1 Reg 2 Comm 2	M - 11 M - 16 M - 16	M - assumes lake is flow-through quality	Inherent basis – likelihood of low quality mine pit lake water with a slow fill. Assumes no >500 year flood to rapid fill with fresh water until lake is already full of poor quality water. Residual basis - long-term site plan is for flow-through mine pit lake so levee overtopping is not as relevant apart from power station damage. Assumes successful transition from Alternative 6 (isolated mine pit lake) to flow through scenario.
BB96	Inappropriate storage and disposal of overburden	Contamination of surface water and groundwater systems through exposure to metalliferous or high acidity contaminants or outflow of contaminated waters. Extensive and long-term effects on downstream water quality (adjacent creeks and McArthur River) and exceedance of WDL trigger values. Influence on water pH and thus metal bioavailability and toxicity. Extensive adverse lethal and sub-lethal effects on aquatic fauna including listed threatened species. Extensive adverse effects on aquatic habitat quality.	NOEF	NOEF design includes encapsulation of high risk materials to limit oxidation and seepage of oxidation products into groundwater and surface water systems. NOEF performance objectives include physical stability of structure.	Env	C	4	H-18		NOEF performance objectives include chemical stability through material placement and compaction techniques, cover system designs, seepage collection and treatment structures. In-pit grade control of all overburden at the blast block level is undertaken to validate classification prior to load and haul operations. The geochemistry of benign rock used as cover on OEFs is monitored monthly to ensure correct waste placement. Ongoing periodic monitoring of NOEF stability and maintenance. Ongoing frequent monitoring of groundwater and surface water in proximity to the NOEF and downstream. This should include fate and transport studies to determine pathways and rates of transport of contaminants of concern. Adaptive management allows for contingency planning and remediation if unacceptable impacts on the receiving environment are predicted or measured.	D	4	M-14		The internal architecture of the NOEF places highest risk materials furthest away from the receiving environment, with progressively lower risk materials placed toward the final outer surface. Despite the proposed encapsulation some interaction of non-benign material and groundwater may still occur. The MRM waste classification system sees various classifications of waste handled and stored under conditions specific to the classification. Seepage collection and treatment structures aim to reduce volumes of water entering groundwater or surface water systems. Design will limit the seepage of water through NOEF to reduce destabilising effects and cartage of contaminants.

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB38	Accumulation of surface waters on the TSF	Leads to piping through wall and subsequent contaminant release.	TSF	Design stipulates minimum beach length/freeboard and improved beach and water management (operating controls on water level) to help mitigate piping risk. Monitoring of decant pond level. Piezometers Operating Management System (OMS) with training, audits, inspections, critical operating parameters of water height (and proximity of water to embankment - monitored via an online system with alarm set points). New spillway proposed to decrease risk associated with high pond level during spill event. Dam spillway for removing excess water in the wet season.	Env, Reg, Comm & H&S	D	Env 4 Reg 4 Comm 4 H&S 4	M - 14 M - 14 M - 14 M - 14	H - given current operating knowledge.	Transition to combined Cell 1/Cell 2 storage will ultimately reduce risk of high pond level (greater surface water storage capacity). Freeboard between decant pond and minimum beach level at perimeter embankment identified as a Critical Operating Parameter with Trigger Action Response Plan to be documented in TSF OMS manual. Improved tailings management practices. Undertake regular routine and intermediate surveillance inspections during operation.	D	Env 4 Reg 4 Comm 4 H&S 4	M - 14 M - 14 M - 14 M - 14	H - given current operating knowledge.	Inherent basis – potential for a significant tailings release, harm to personnel proximate to the dam, significant community discontent - mitigated by multiple levels of water control at the TSF. Residual basis - similar to pre-Project EIS measures, with improved engineering controls.
BB41	Poor mine pit lake water chemistry	Leading to inability to relinquish site.	Open Cut	Phase 3 approval - an isolated void	Env and Cost	C	Env 5 Cost 1	H - 22 L - 4	H - based on slow fill of final void and long term certainty of over topping the levee	Option to maintain or revert back to open cut closure Alternative 6 (isolated void) - water level management and/or ongoing treatment.	D	Env 3 Cost 4	M-9 M-14		Inherent basis high probability of low quality open cut lake water with a slow fill. Residual basis - ongoing water management being able to restrain the environmental impact, but elevated media attention (and subsequently costs) with inability to meet commitment.
BB63	Storage of tailings and process water creates excessive settlement of the embankments and/or overtopping	Resultant in release of tailings to the environment.	TSF	The MRM Operational Management System that includes: • Regular inspections of the TSF and surrounds; • Construction standards of TSF walls and foundations; and • Trigger Action Response Plans for high rainfall events - with ability to initiate pumping from the TSF if required.	Env, Reg, Comm & H&S	D	Env 4 Reg 4 Comm 4 H&S 4	M -14 M - 14 M - 14 M - 14	H - known conditions	Operational management plan covers placement, monitoring and control of tailings pipelines and embankment conditions. Design allows for rock armoring of toe of embankment adjacent to waterway and spillways. Monitoring of toe of TSF during/following extreme flood events. Relocation of tailings to the final void as part of tailings reprocessing and rehandling.	D	Env 4 Reg 4 Comm 4 H&S 4	M -14 M - 14 M - 14 M - 14	H - Known behaviour of similar TSFs and flood modelling velocities.	Inherent basis – overtopping or other event undercuts the dam wall leading to a significant release - with exceedances at SW11 and potential impact on flora and fauna. Residual basis - release of tailings prior to completion of reclamation operations and site rehabilitation.
BB58	Spontaneous combustion in walls of open cut	Increased geochemical loading on waters in the open cut, leading to deterioration of water quality.	Open Cut	Phase 3 has isolated void with slow filling, so long wall exposure times.	Env and Cost	C	Env 4 Cost 1	H - 18 L - 4	H - based on slow fill of final void and long term certainty of over topping the levee	Rapid filling, isolated void with water treatment until quality is suitable for flow-through options. Maintenance of levee as required by adaptive and reactive management.	D	Env 1 Cost 4	L - 2 M - 14	M - modelling conducted - with a large range of inputs and some uncertainty	Inherent basis - high probability of low-quality open cut lake water with a slow fill. Mine levee wall will fail as it is not maintained. Residual basis - ongoing water management being able to limit the environmental impact - but elevated media attention (and subsequently costs) with inability to meet commitment.

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB91	TSF high rate of rise	Leads to embankment failure which leads to a release of contaminants.	TSF	Design stipulates minimum beach length/freeboard and improved beach and water management (operating controls on water level) to help mitigate piping risk. Monitoring of decant pond level. Piezometers OMS with training, audits, inspections, critical operating parameters of water height (and proximity of water to embankment - monitored via an online system with alarm set points). New spillway proposed to decrease risk associated with high pond level during spill event. Dam spillway for removing excess water in the wet season.	Env, Reg, Comm & H&S	C	Env 4 Reg 4 Comm 4 H&S 4	H - 18 H - 18 H - 18 H - 18	H - given current operating knowledge.	Transition to combined Cell 1/Cell 2 storage will ultimately reduce risk of high pond level (greater surface water storage capacity). Freeboard between decant pond and minimum beach level at perimeter embankment identified as a Critical Operating Parameter with Trigger Action Response Plan to be documented in TSF OMS manual. Improved tailings management practices. Undertake regular routine and intermediate surveillance inspections during operation.	D	Env 4 Reg 4 Comm 4 H&S 4	M - 14 M - 14 M - 14 M - 14	H - given current operating knowledge.	Inherent basis – separate cells with smaller area requires a higher rate of rise. MRM continue at maximum rate of production leading to high RoR, settlement and failure of embankment. Residual basis – Merged cells have larger area and lower RoR for same production rate. Consider same settlement and failure of embankment.
BB93	Earthquake/ seismic activity	Leads to TSF embankment failure and release of tailings/contaminants.	TSF	The MRM Operational Management System that includes: • Regular inspections of the TSF and surrounds; and • Construction standards of TSF walls and foundations. TSF design considerations including Dam Safety (seismicity) allowances.	Env, Reg, Comm and H&S	D	Env 4 Reg 4 Comm 4 H&S 4	M -14 M - 14 M - 14 M - 14	H - known conditions	As per pre-Project EIS plus Observational method.	D	Env 4 Reg 4 Comm 4 H&S 4	M -14 M - 14 M - 14 M - 14	H - Known behaviour of similar TSFs and flood modelling velocities.	Earthquake damages the dam wall leading to a significant release - with exceedances at SW11 and potential impact on flora and fauna.
BB84	EIS rejected by regulator	Resulting in inability to continue mining for ore beyond current approval period, and ultimate closure of the mine with resultant loss of jobs and investment in the community	Site-wide	Development and roll-out of effective and timely consultation process with regulatory agencies (incl. NT DME and NT EPA). To cover such issues as closure planning and objectives; key technical aspects of the Project; EIS schedule.	Env Reg. Comm	D	Env – 1 Reg – 4 Comm - 4	L – 2 M – 14 M - 14	L - outside McArthur River Mining's control	EIS mitigation measures are directed towards meeting currently known criteria.	D	Env – 1 Reg – 4 Comm - 4	L – 2 M – 14 M - 14	L - outside McArthur River Mining's control	Inherent basis - EIS process has considered stakeholder inputs and covered flagged issues adequately. Residual basis - inability to meet changed/ unknown regulatory requirements due to design and planning towards earlier target values.
BB65	Mine face or embankment failure	Injuries to personnel during tailings re-mining	TSF	No re-mining in Phase 3 plan	N/A					There will be an operating management system in place for tailings re-mining, which covers procedures and monitoring. Work Method Statements will be in place for any works. Geotechnical analysis will be undertaken. Bench heights are limited to 10m. Embankments and adjacent tails will be de-constructed using conventional methods.	D	Env 2 H&S 4	L - 5 M - 14	M - no specialist site specific analysis yet undertaken	Credible lost time injury, with remote possibility of a fatality (would require multiple coincidental events).

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB90	Clearing of vegetation	Leading to a reduction in habitat for certain species of fauna and flora.	Site-wide	The MRM Rehabilitation Management System includes revegetation and other land stabilisation measures. The Phase 3 EIS closure plan has a general requirement for vegetation to be established, with monitoring and management of revegetated areas. Delaying clearing as long as practicable and clearing only the minimal area required. Adoption of the MRM revegetation strategy, including progressive rehabilitation to recreate suitable habitat whilst meeting the rehabilitation constraints. All vegetation clearing will be conducted in accordance with McArthur River Mining's "Permit to Clear" procedure. Vegetation will be burnt only after receipt of a "Permit to Burn". Contractor and operator awareness programs on potential presence of endangered or vulnerable species and will be instructed to temporarily cease clearing if these species are identified. As the Permit to Clear procedure vegetation clearing activities will occur in an appropriate direction through the vegetation, to direct animals into adjacent habitat. Performing regular pest controls in conjunction with local authorities. Implement measures to minimise accumulation of putrescible waste outside of animal-proof designated areas. Maintaining cattle exclusion areas along McArthur River channel and expanding these into woodland habitats with implementation of fencing maintenance program after each wet season to minimise potential for cattle to enter exclusion areas.	Env	B	3	H-17	M - conceptual design not yet implemented.	As for Pre-Project EIS controls, with additional updated ecological assessments and controls. Small-scale trials will be undertaken to determine optimal site preparation, seed mixes and application rates for favourable establishment of local grass species and other key flora. The existing vegetation monitoring program will be reviewed and updated.	C	3	M-13	H - more extensive modelling and success of the intended process in other similar facilities	Inherent basis - the inability to achieve effective rehabilitation was considered. Under current clearing processes, habitat is checked prior to approval to clear. Residual basis - ongoing rehabilitation works until adequate and self-sustaining vegetation cover with adequate connectivity is established. Project EIS identifies and sets aside critical habitat.

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB95	Mining below groundwater level	Mining below groundwater level can lead to potential drawdown in adjacent McArthur River and waterholes with reduction in habitat availability.	Open Cut	Monitoring of groundwater levels. Groundwater drawdown modelling.	Env	A	3	H - 21		Assessment of drawdown effects during mining phase including change in river height and fauna response. This will include a comparison to historical dry season water heights at permanent waterholes (e.g. Djirrinmini Waterhole). Supplementary flow provided to permanent refuge pools (e.g. Djirrinmini Waterhole) should water level adjacent to the open cut be seen to be atypical of seasonal variation.	C	3	M-13	M - modelling conducted - with a large range of inputs and some uncertainty	Inherent basis – drawdown predicted to occur during mining and open cut filling phases (up to 2047). Modelling predicts groundwater drawdown at Djirrinmini to be a maximum of 0.7 m and that recovery will occur within ten years after termination of mining (KCB 2016a). As a majority of Djirrinmini has less than two metres water depth in the late dry season, a decrease of 0.7 m will reduce available habitat. Slow filling of open cut. Residual basis – As per inherent but have rapid filling. Open cut drawdown decreases rapidly once filling has commenced (KCB 2016b).
BB80	Long-term closure monitoring cannot be achieved	Management of the site declines and failure to undertake regular maintenance results in failure of cover system and/or structures resulting in impacts to terrestrial and aquatic environments.	Site-wide	Current closure costs allow for period of 25 years closure water monitoring with limited costs associated with management and maintenance of the site.	Env & Reg & Comm	B	Env 4 Reg 4 Comm 4	H - 21 H - 21 H - 21		Revised mine closure plan including cost estimates. Long-term adaptive management (AM) and reactive management (RM) phases included. The new closure monitoring timeframe is vastly different.	C	Env 3 Reg 3 Comm 3	M - 13	L - outside McArthur River Mining's control.	Inherent basis – funding only for 25 years. Long-term overtopping and failure of levee is a certainty so mine pit lake will mix with receiving environment eventually. Residual basis - early monitoring and feedback to estimates continually update closure costs and reduce the risk of unforeseen major costs. Funding mechanisms agreed with regulators to provide for adaptive management and reactive management phases.
BB42	Construction activities (e.g. tailings delivery pipeline movement on crest of embankment)	Injury	TSF	OMS for tailings deposition - that covers procedures and monitoring. Work Method Statements in place for any construction works (e.g. - Spigots to be operational from safe side of pipe; - Pipe restraints included). OMS with inclusion of required controls for operating vehicles, conducting complex tasks - favouring engineering/isolation type controls. Ranking basis - credible lost time injury - with remote possibility of a fatality (would require multiple coincidental events).	H&S	C	3	M - 13	H - operating knowledge/ history conducting similar tasks.	As for pre-Project EIS OMS for tailings deposition - that covers procedures and monitoring. Work Method Statements in place for any construction works (e.g. Spigots to be operational from safe side of pipe; - Pipe restraints included).	C	3	M - 13	H - operating knowledge/ history conducting similar tasks.	Credible lost time injury - with remote possibility of a fatality (would require multiple coincidental events).
BB75	Changes to values within the site's WDL	Leading to site's potential inability to meet any new proposed trigger values.	Site-wide	The MRM Water Management Plan has the capacity to collect and redirect contaminated waters. Release only occurs with water that meets discharge requirements.	Env, Reg & Comm	C	Env 1 Reg 3 Comm 3	L - 4 M - 13 M - 13	M - not under McArthur River Mining's direct control, but can present justification for EIS basis	EIS mitigation measures are directed towards meeting currently known criteria & presenting case for current conditions.	C	Env 1 Reg 3 Comm 3	L - 4 M - 13 M - 13	M - not under McArthur River Mining's direct control, but can present justification for EIS basis	Inherent basis- Contaminated water is retained on site and only released when treated or when discharge requirements are met. Inability to meet changed regulatory requirements due to design and planning towards earlier target values.

ID*	Hazard	Impact	Domain	Existing (Pre Project EIS) Mitigation Measures	Risk Type	Inherent Risks				Additional (Post-EIS) Mitigation Measure	Residual Risks				Ranking Basis
						Likelihood	Consequence	Risk Ranking	Confidence Level		Likelihood	Consequence	Risk Ranking	Confidence Level	
BB83	Premature closure and rehabilitation of structures if operations are forced to cease prior to originally planned	This could potentially create an ongoing environmental, social and/or economic legacy.	Site-wide	Not ranked - related to the EIS approval.	Comm			N/A		EIS mitigation measures are directed towards meeting currently known criteria.	C	Comm 3	M - 13	L - outside MRM control	Inability to meet changed/unknown regulatory requirements due to design and planning towards earlier target values.
BB88	Lack of appropriate fluvial sediment management	Leading to impacts on aquatic environments and ecology, and potentially health of people consuming fish.	Site-wide	A Dust Management Plan prescribes use of water carts and fixed sprays to suppress dust, which is applied during construction of the NOEF and other structures. The MRM site maintains a dust monitoring program. McArthur River Mining maintains an environmental management system, which includes sediment monitoring and capacity to react to identified issues.	Env Reg Comm H&S	B	Env 2 Reg 1 Comm 2 H&S 1	M – 12 M-7 M-12 M-7	H - operating experience over full life of mine and observed success of capping etc.	Construct sump in the mine infrastructure area and regrade catchments. Barney Creek sumps and pumping will be upgraded. The cleaning regime will be upgraded. Continued education of public about real hazards and human health risks.	B	Env 2 Reg 1 Comm 1 H&S 1	M-12 M-7 M-7 M-7	H - operating experience over full life of mine and observed success of similar controls elsewhere	Dust and sediment washed from around Barney Creek bridge into Barney Creek, where it is taken up by fauna and enters the food chain. Human consumption of fish can occur when fish migrate downstream and are caught.
BB98	Increased holding capacity creates groundwater mound	Increased mass of tailings raises groundwater level/expression leading to altered flow regime of adjacent ephemeral creeks; Increased release of earth laden and mine derived sulphates leading to increase in EC in adjacent ephemeral creeks; Adverse effect on Surprise Creek aquatic habitat quality through increase in EC; Alteration of natural flow and drying regimes via alteration of groundwater level; Adverse effect on fauna distribution and dispersal through exceedance of fauna tolerance.	TSF	Tailings management includes limiting ponding of water on the TSF, improving barrier systems to seepage and groundwater recovery.	Env	A	2	M-16		Ongoing groundwater and surface water monitoring over operational phases which is continued well after rehabilitation of TSF. End of mine reprocessing of tailings will see complete removal of tailings reducing long-term impact and limit risk period. Rehabilitation and decommissioning of the TSF will see mining landscape left safe and secure for humans and animals in long-term (i.e. 100-1,000 years). Extensive closure objectives are outlined in Section 2.4 of GHD (2016) with environmental values and ecosystems maintained. Post-closure monitoring undertaken in accordance with GHD (2016).	B	2	M-12		Groundwater monitoring has indicated that ponding of water on TSF has resulted in a water table mound which has interrupted natural groundwater flow and caused prolonged discharge in Surprise Creek. Recent (2015) improvements in TSF surface water management including removal of large water volumes has led to improvements. Sections of Surprise Creek which atypically held water in the late dry season were observed to have dried by October 2016 which was historically the case. Despite improved management of the TSF to reduce mass, the expansion will lead to significantly larger volumes being stored. As such mounding is still likely to occur.
BB15	Water treatment plant's inability to treat seepage waters (closure)	Leading to change in chemistry within the ground waters and inability to meet water quality criteria.	Open Cut	Water treatment plant - capable of producing discharge at acceptable levels of contaminant, coupled with the broader water management system.	Env	B	3	H - 17	H - existing long-term strategy is no longer acceptable	Encapsulation of sources of contamination and water filling of void to manage contaminants and allow achieving water quality criteria - and establishment of a flow through topography to the McArthur River.	A	1	M - 11	M - modelling conducted - with a large range of inputs and some uncertainty	Inherent ranking - inability to meet surface water release requirements - and downstream contamination arises. Residual ranking - releasing acceptable water quality into downstream waters with the intended improvements in the site's water management system and reduced release of contaminants from built features on the site.

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BB61	A change in the block model resulting in a change to the NAF/PAF ratio during construction (e.g. insufficient clean layers available), triggering the need for a further EIS	Resulting in cessation of operations and subsequent loss of jobs and community investment.	NOEF	Source Controls - Waste grade control plus long-term waste characterisation sampling. Community consultation.	Env & Comm	E	Env 2 Comm 4	L – 3 M - 10	H - EIS studies informed	Source Controls: Waste grade control plus long-term waste characterisation sampling. Community consultation.	E	Env 2 Comm 4	L – 3 M - 10	H - EIS studies informed	The key risk that has driven the need for this EIS. Have conducted static & dynamic geochemistry testing, extensive sampling, and developed a revised block model. Conducted extensive consultation with technical specialists, regulators and the community.
BB33	Geotechnical failure of the open cut wall with the mine pit lake partially filled, leading to loss of western levee functionality	Resultant water inflows in flood and releases after flood event and failure to meet downstream water quality objectives.	Open Cut	Phase 3 EIS presented knowledge on open cut wall design and stability engineering requirements - existing geotechnical monitoring and installation of shear pins - leading to a long-term stable slope.	Env & Reg	D	Env 3 Reg 4	M - 9 M - 14	H - very unlikely to have gross failure of the Western wall.	Geotechnical modelling - and response to refined analysis and if required buttressing of wall to reduce likelihood of wall failure.	E	Env 1 Reg 4	L - 1 M - 10	H - based on the duration of stability of the area in question at the time of closure/ filling.	Inherent basis - poor water quality in the final void prior to filling and an inflow from the McArthur River, leading to a diluted (but still poor quality) water flow from the final void to the River when the water recedes. Residual basis - rapidly filled mine pit lake with reduced contaminants.
BB35	Water erosion or scouring of TSF embankment toe	Leading to embankment failure and tailings release.	TSF	McArthur River Mining's Operational Management System that includes: • Regular inspections of the TSF and surrounds; and • Construction standards of TSF walls and foundations.	Env, Reg & H&S	D	Env 4 Reg 4 H&S 4	M - 14 M - 14 M - 14	H - known conditions	Flood studies of Surprise Creek and Little Barney Creek undertaken to assess flood levels and flow velocities. Design allows for rock armoring of toe of embankment adjacent to waterway (i.e. Surprise Creek). Monitoring of toe of TSF during/following extreme flood events. Relocation of tailings to the final void as part of tailings reprocessing and rehandling.	E	Env 4 Reg 4 H&S 4	M - 10 M - 10 M - 10	H - Known behaviour of similar TSF's and flood modelling velocities.	Inherent basis -lateral movement of Surprise Creek undercuts the dam wall leading to a significant release - with exceedances at SW11 and potential impact on flora and fauna. Residual basis - release of tailings prior to completion of tailings rehandling operations and site rehabilitation.
BB34	Open cut wall failure compromises long- term mine pit lake water quality	Leading to loss of functionality of western levee, incorrect location of McArthur River inflow, levee failure and failure to meet downstream water quality objectives.	Open Cut	The Phase 3 EIS presented knowledge on the open cut wall design and stability engineering requirements. Existing geotechnical monitoring and installation of shear pins leads to a long-term stable slope.	Env & Reg	E	Env 2 Reg 4	L - 3 M - 10	H - low likelihood of contaminated water concurrent with levee breach (i.e. early life failure)	Team discussion highlighted the similarities with the pre-Project EIS state and the high likelihood of early detection and subsequent managing using buttresses etc.	E	Env 2 Reg 4	L - 3 M - 10	M - based on modelling	Poor water quality in the mine pit lake after long-term inflows from the McArthur River, leading to a diluted (slightly poorer quality) water flow from the mine pit lake to the river when the water recedes.

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BB94	Differential settlement of tailings which creates cracking a reduction in shear resistance, increase in potential for water infiltration and/or embankment piping failure	Leading to unplanned releases.	TSF	McArthur River Mining's Operational Management System that includes: • Regular inspections of the TSF and surrounds; • Construction standards of TSF walls and foundations; and • Trigger Action Response Plans for high rainfall events - with ability to initiate pumping from the TSF if required.	Env & Reg	D	Env 4 Reg 4	M -14 M - 14	H - known conditions	Operational management plan covers placement, monitoring and control of tailings pipelines and embankment conditions. Design allows for rock armoring of toe of embankment adjacent to waterway and spillways. Monitoring of toe of TSF during/following extreme flood events. Relocation of tailings to the void as part of tailings reprocessing and rehandling.	E	Env 4 Reg 4	M - 10 M - 10	H - Known behaviour of similar TSF's and flood modelling velocities.	Inherent basis – overtopping or other events undercut the dam wall leading to a significant release - with exceedances at SW11 and potential impact on flora and fauna. Residual basis - release of tailings prior to completion of reclaims operations and site rehabilitation.
BB92	TSF embankment failure with subsequent release of tailings and sediment	Causing environmental damage, cost from lost production, clean-up and reconstruction costs, regulatory restrictions, community discontent, and a potential fatality or permanent incapacity.	TSF	McArthur River Mining's Operational Management System that includes: • Regular inspections of the TSF and surrounds; • Construction standards of TSF walls and foundations; and • Trigger Action Response Plans for high rainfall events - with ability to initiate pumping from the TSF if required.	Env & Reg	D	Env 4 Reg 4	M -14 M - 14	M - multiple possible causes	Construction QA/QC. EIS flood studies. Restrict pump out rates. Combine cell 1 & 2 to lower rate of rise.	E	Env 4 Reg 4	M - 10 M - 10	H - Known behaviour of similar TSFs and flood modelling velocities.	Overtopping or other event undercuts the dam wall leading to a significant release - with exceedances at SW11 and potential impact on flora and fauna.

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BB97	Seepage from NOEF including PAF material giving rise to acid and metalliferous drainage	Creation of groundwater mound affecting flow regime in adjacent creeks. Seepage results in contaminant transfer in groundwater with adverse effects on groundwater and surface water quality. Seepage of metals, sulphates and/or acids results in direct toxicity to aquatic fauna including listed threatened species. Adverse impacts on aquatic habitat in adjacent creeks and downstream including the McArthur River. Loss of Barney Creek and McArthur River habitat. Non-compliance with SW11 WDL trigger values.	NOEF	NOEF design includes encapsulation of high risk materials to limit oxidation and seepage of oxidation products into groundwater and surface water systems. NOEF design aims to manage key risks including generation of acid by encapsulating high risk materials and reducing exposure to oxygen.	Env	C	4	18-H		The NOEF is designed to limit seepage through basal foundation preparation, construction methodologies (including alluvial barriers) and the final cover system (see O'Kane 2016b). Seepage mitigation systems as required to meet the MRM objective. These may include interceptor drains and recovery bores. Ongoing monitoring of groundwater bores surrounding the NOEF. Ongoing monitoring of surface water in Barney Creek and downstream. Installation of sumps in Barney Creek (mainly BCS2) will ultimately capture seepage which had entered Barney Creek.	D	3	M-9		Significant overburden buffering capacity, therefore not anticipated to produce large amounts of AMD. Upon closure, the NOEF cover system design is based on a moisture 'store-and-release' and 'barrier' concept. A dense low permeability clay layer will reduce percolation through the NOEF. Seepage results in high sulphate (and zinc) concentrations in Barney Creek. Barney Creek sumps will effectively capture runoff during low flow periods and prevent its entry into the McArthur River. Modelling predicts that upon closure (and after TSF rehabilitation) monthly median sulphate concentrations within Barney Creek will exceed the SW11 WDL trigger values between January and August 2101-2500. Maximum concentrations are recorded when river discharge is at its lowest. Modelling predicts sulphate concentrations will only exceed the WDL trigger values in Barney Creek in months of lowest discharge. *Pristis pristis* has not been captured in Barney Creek during targeted surveying conduced since 2006, and Barney Creek does not represent favourable habitat for the species. As such the likelihood of occurrence is considered to be very low. Barney Creek is ephemeral and is not considered critical habitat for any species in the McArthur River catchment. In the event Barney Creek habitat become unsuitable for sustaining aquatic fauna this is unlikely to have a population level effect on any species. Capture of seepage in the Barney Creek will prevent waters entering the main channel McArthur River. During peak flows water entering the McArthur River from Barney Creek will be highly diluted.
BB53	Geotechnical failure of existing landform	Leading to loss of cover system functionality and resulting in sedimentation and loss of gas and water management functions.	NOEF	Toe seepage collection system. Water collection from Barney Creek. Existing knowledge (including from Phase 3 EIS) gained of material geotechnical properties, engineering standards and design requirements. This has been used in the construction of the existing NOEF.	Env & Reg	E	Env - 2 Reg - 3	L - 3 L - 6	H - known performance of NOEF	Additional geotechnical test work and stability modelling completed. Revised slope angles, placement methodology and monitoring. Adaptive management of landform.	D	Env - 2 Reg - 3	M - 9	M - based on modelling only (industry best practice) - and reliant on construction methodology meeting designs.	<u>Inherent basis -</u> Pre-Project EIS NOEF has 1:4 batters and intercepting discharge. <u>Residual basis -</u> Steeper slopes on upper batters. Monitoring would limit the scale of the problem. Repaired NOEF would have negligible releases of contaminated water (with reliable monitoring and repair capacity) - reducing potential for non-conformances at SW11.

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BB25	Generation of acid mine drainage	Potential impacts on wildlife through exposure to (and accumulation of) metals and other toxicants, and resultant potential impact on public health (e.g. through consumption of contaminated aquatic fauna).	NOEF and TSF	Toe seepage collection system. Water collection from Barney Creek. Existing knowledge (including from Phase 3 EIS) gained of material geotechnical properties, engineering standards and design requirements. This has been used in the construction of the existing NOEF.	Env & Reg.	E	Env - 2 Reg - 3	L - 3 L - 6	H - known performance of NOEF	Additional geotechnical test work and stability modelling completed. Revised slope angles, placement methodology and monitoring. Adaptive management of landform.	D	Env - 2 Reg - 3	M - 9	M - based on modelling only (industry best practice) - and reliant on construction methodology meeting designs.	Inherent basis - Pre-Project EIS NOEF has 1:4 batters and intercepting discharge. Residual basis - Steeper slopes on upper batters. Monitoring would limit the scale of the problem. Repaired NOEF would have negligible releases of contaminated water (with reliable monitoring and repair capacity) - reducing potential for non-conformances at SW11.
BB48	Spontaneous combustion of overburden	Release of sulphur dioxide and other products of combustion affecting nearby receptors.	NOEF	Changing geometry of batters - using existing fleet to remediate hot spots. Covering of OEFs with alluvial material and clay. Compacted batters and alluvial blanket (in process December 2016). Monitoring and communication strategy. Mine Management Plan (MMP) that describes operational controls for creating OEFs. Dust management plan (addresses any fugitive dust/ash emissions) that requires dust suppression activities on site.	H&S Comm	B	Comm 3 H&S 1	H–17 M - 7	H - known and monitored conditions on-site	Updated OHS protocols and Site Air Quality Management Plan, including: • Source Controls: Geochemical classification of materials and correct placement of materials in the OEFs so that non-benign rock is isolated from oxygen by a compacted clay layer and protective cover material. The NOEF is designed with consideration for water migration. Waste is segregated using purposely designed PAF cells, so that most-reactive material has least contact with oxygen and water; and • Transport Controls: McArthur River Mining's Water Management System retains contaminated waters and achieves compliant release.	D	Comm 3 H&S 1	M - 9 L - 2	M - based on modelling only (industry best practice) - and reliant on construction methodology meeting designs.	Inherent basis - existing controls and potential exposure of site personnel (wearing appropriate PPE) to elevated levels of sulphur dioxide during their tasks and by members of the public using the highway for short durations (addressed by PPE and health systems on-site) and unfavourable perception of NOEF management by community and media. Residual basis - the sources of spontaneous combustion are well constrained and low emissions of sulphur dioxide are expected.
BB02	Major changes in design of the NOEF and other final landform features	Benefits to the community may be less than previously expected as a result of the increased costs to McArthur River Mining associated with changes to management requirements of the problematic material.	Site-wide	Whilst a social and economic assessment will be carried out which will address employment, housing etc., this particular point will be addressed by clarifying that the commitments made to the community through the MRM Community Benefits Trust (CBT) will not change from the funding and review schedule originally committed to.	Comm	C	3	M - 13	M - not under McArthur River Mining's control	Whilst a social and economic assessment will be carried out which will address employment, housing etc., this particular point will be addressed by clarifying that the commitments made to the community through the MRM CBT will not change from the funding and review schedule originally committed to.	D	3	M - 9	M - issues related to constraints not under McArthur River Mining's control	Current commitment to provide benefits to the local communities will not change
BB01	Release of contaminated waters above acceptable levels	Potential negative social and economic impacts to the Roper-Gulf region and the NT associated with environmental degradation.	NOEF and TSF	Social involvement, through a Community Engagement Plan, provides information on the status of the mine, and avenues of communication to confirm that benefits of and objections to the mine are achieved. Short-term, acute rehabilitation capacity during active rehabilitation phase. Site controls that limit releases of unacceptable levels of contaminant beyond trigger levels at SW11.	Comm	D	3	M - 9	H - existing systems in place and working.	Social involvement, through a Community Engagement Plan, provides information on the status of the mine, and avenues of communication to confirm that benefits of and objections to the mine are achieved. Site controls limit releases of unacceptable levels of contaminant beyond trigger levels at SW11.	D	3	M - 9	H - existing systems in place and working.	Well controlled surface waters, releasing within acceptable levels, and ongoing liaison during operations/ active management on the status of controls and early warnings of any problems that may arise.

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BB31	NOEF construction around existing NOEF	Leads to potential spontaneous combustion in new NOEF and desiccation of barrier layers, leading to cracking, ingress of water and high oxidation rates, with release of contaminants.	NOEF	Reshaping of the NOEF, leading to flatter batters. Advection barrier. Ongoing monitoring and remediation capability for identified hot spots. Site Water Management System, with ability to capture and prevent releases of highly contaminated waters.	Env & Reg.	D	Env 2 Reg 3	L – 5 M - 9	H - proven operation of existing technology on site	Construction of advective barriers to isolate the old OEF, and construction will go over existing advective barriers (further restricting oxygen through burial). Upgrade of water management system. Implementation of further seepage collection measures as required. Reactive management phase during closure.	D	Env 2 Reg 3	L – 5 M - 9	M - modelling conducted - with a large range of inputs and some uncertainty	Likelihood supported by observed behaviour of existing NOEF when encapsulated by clay, and ability to largely contain and manage contaminated waters with the site Water Management System.
BB39	Placement of non-benign overburden material in the growth medium	Leading to revegetation failure.	NOEF	Existing material classification and selective handling management and monitoring procedures. Dispatch and GPS tracking of truck movements that optimises placement of materials.	Env & Reg	D	Env 1 Reg 3	L - 2 M - 9	H - existing system well known	Existing material classification and selective handling management and monitoring procedures. Dispatch and GPS tracking of truck movements that optimises placement of materials.	D	Env 1 Reg 3	L - 2 M - 9	H - existing system well known	Quality assurance and control processes and GPS-tracking with geo-fencing are in place to monitor and correct errors made by geological surveys or by truck drivers. Incorrect material being placed may result in localised impacts of poor construction of the NOEF. Incorrect placement is likely to be detected by the visible difference in material for placement. Impact on the environment is unlikely, although perception of the MRM site may attract regulator attention.
BB08	Ingress of Largetooth Sawfish to the open cut lake	Fish kills including Largetooth Sawfish, due to: • to their entry to the open cut lake; and • unsuitable habitat (water quality, physical features of the lake's edges, amount of available food) present.	Open cut	The open cut lake was to remain isolated from the McArthur River via intact levees.	Env	B	2	M - 12	H - existing monitoring and knowledge of the systems	Flow-through system maintains benign water quality within the open cut lake with respect to sawfish. Barrages at entries to the open cut lake will deter sawfish entry. Shallow benches will be built along the edge of the open cut lake to provide suitable feeding habitat for sawfish. If any harm arose it would be unlikely to harm a large percentage of the sawfish population.	C	2	M-8	M-modelling conducted with a large range of inputs and some uncertainty	Inherent basis - long-term stability of the levee is not guaranteed in Phase 3, so it will fail with possibly poorer water quality for a short period. However, relatively low populations of the endangered fish were likely to be exposed. Residual basis - flows through the mine pit lake, without imposing any risk to aquatic life (Largetooth Sawfish and other species).
BB49	Site-wide flood as a result of McArthur River overtopping the levee (short-term; 30-100 years)	Leading to widespread erosion, overwhelming of water treatment facilities, disruption of operations, and lack of access.	Site-wide	Site controls that limit releases of unacceptable levels of contaminant beyond SW11 trigger levels.	Env, Reg & Comm	C	Env 2 Reg 3 Comm 2	M - 8 M - 13 M - 8	H - existing systems in place and working.	Social Involvement/Community Engagement Plan - that provides information on the status and avenues of communication to confirm that benefits of and objections to the mine are achieved. Site controls that limit releases of unacceptable levels of contaminant beyond SW11 trigger levels.	C	Env 2 Reg 2 Comm 2	M - 8 M - 8 M - 8	M - impacts depend on when it occurred	Well controlled surface waters - releasing within acceptable levels and ongoing liaison during operations/ active management on the status of controls and early warnings of any problems that may arise.
BB72	Failure of surface water management system within/around the NOEF	Impeding ability to achieve acceptable downstream water quality.	NOEF	The MRM Water Management Plan has the capacity to collect and redirect contaminated waters. Piezometers and other devices will be in place to monitor and track groundwater composition and movements.	Env, Reg & Comm	C	Env - 2 Reg - 3 Comm - 3	M - 8 M - 13 M - 13	M - some uncertainty around seepage vs runoff amounts and split between toe and base flows.	Additional water management capacity and infrastructure. QA/QC for cover and drain construction. Maintenance program. Regulator and community relationships and transparency.	C	Env - 1 Reg - 2 Comm - 2	L - 4 M - 8 M - 8	M - some uncertainty around seepage vs runoff amounts and split between toe and base flows.	Event is described as resulting from a shorter period at high flow, in combination with a high load that results in a spill of contaminated water. For example, to reach 200-250t/day sulphate, sulphate concentrations would need to increase to 100mg/L for a short period. During high flows, there is a potential for mixture with high sediment load from event, requiring minor repairs to surface water management system.

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BB43	Spontaneous combustion during in-pit dumping rehabilitation works	Leading to sulphur dioxide exposure to site personnel.	Open Cut	McArthur River Mining's Safety Management System has requirements for analysis of risks of conducting activities and generation of appropriate engineering and procedural controls. For sulphur dioxide exposure, they would include ventilation; trigger points for withdrawal and worst-case use of appropriate PPE.	H&S	B	2	M - 12	H - based on historic experience at the MRM site	McArthur River Mining's Safety Management System has been updated to incorporate a combination of engineering and administrative controls, with requirements for analysis of risks of conducting activities and generation of appropriate engineering and procedural controls. For sulphur dioxide exposure, they would include ventilation; trigger points for withdrawal and worst-case use of appropriate PPE. Highly reactive material will be stored in the EOEF until cessation of operations. Rapid flooding of the open cut final void to inundate reactive materials.	C	2	M-8	H - based on historic experience at the MRM site	Requirement for medical treatment of a worker overcome by noxious gases.
BB64	Exposure of tailings to atmosphere during re-mining	Leads to generation of AMD and/or sulphur dioxide.	TSF	No re-mining in Phase 3 plan.	Comm & H&S			N/A		Hydraulic re-mining to be a continuous operation to limit the exposure time of the tailings to the atmosphere. Operating protocols will include a procedure for monitoring and irrigating the TSF surface to prevent spontaneous combustion.	C	Comm 2 H&S 2	M – 8 M - 8	H - known activity and occurrences represent maximum reasonable outcomes	Medium-scale spontaneous combustion that is very visible from highway. Release of sulphur dioxide as a result of heating in tailings and tailing surface oxidising and generating dust. This is to be mitigated by hydraulic mining and operational controls.
BB57	Poor water quality in mine pit lake due to slow filling	Leading to a change in water chemistry and inability to meet water quality criteria.	Open Cut	Phase 3 - an isolated void with passive filling.	Env	B	Env 4	H - 21	H - based on slow fill of final void and long term certainty of over topping the levee	Option to maintain or revert back to open cut closure Alternative 6 (isolated void) - water level management and/or ongoing treatment. Ranked on the basis of ongoing water management being able to restrain the environmental impact - but some media attention with inability to meet commitment.	**C**	Env **2** Comm 1	M - 8 L - 4	M - modelling conducted - with a large range of inputs and some uncertainty	Inherent basis - high probability of low quality water with a slow fill. Assumes no >500 year flood to rapid fill with fresh water. Residual basis – Rapid filling of pit results in better quality lake water.
BB21	Insufficient availability of suitable construction materials	Requirement to expand borrow materials sources.	TSF	McArthur River Mining's Operational Management System includes developing conceptual designs of the TSF with no borrow sources or required volumes identified and execution of same.	Env	C	3	M - 13	M - no clear identified items - so could be less extensive.	Design and material specification has been developed to enable use of as wide a range of material as possible. LOM borrow plan has been developed for LOM material requirements based on geotechnical investigations. Construction using tailings so less material is required, with long-term requirement to remove the tailings dam. Geochemical characterisation before extraction.	C	2	M - 8	M - based on modelling criteria.	Inherent basis - Phase 3 had a range of additional materials required for drainage lines (and liners) and would have required more clay and competent rock to achieve design. Demand for clay and other material is based on the extent of time required for revegetation. Residual basis - reduced footprint of required disturbance/revegetation requirements.
BB47	Changed vegetation due to operations and rehabilitation, including spread of invasive/feral species	Significant species/habitat negatively impacted by MRM landform state.	Site-wide	McArthur River Mining's Environmental Management System includes compliance with valid and current permits and rigorous, formal site-clearing processes.	Reg & Env.	B	Reg 1 Env 2	M-7 M-12	H - well understood mechanisms for revegetation	McArthur River Mining's Environmental Management System includes compliance with valid and current permits and rigorous, formal site-clearing processes.	C	Reg 1 Env 2	L – 4 M - 8	M - not under McArthur River Mining's control	Ranking basis - Net loss of suitable habitat. The final goal for the MRM site is for low-intensity pastoral/grazing (woodland and pasture grasses) and ability for indigenous land use. There is a potential for offsets to be provided for values that cannot be maintained on the MRM site. Loss is defined as final landforms that do not meet regulatory expectations, or a reduction in environmental values as a result of weed infestation.

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BB82	Fugitive dust emissions and metals introduced into food chain as a result of operations	Dust emissions from the TSF, haul roads, run-of-mine pad, concentrate stores and other aspects of operations, and seepage from the TSF, SPROD, run-of-mine sump and NOEF affects water and fluvial sediment quality in McArthur River and Barney, Little Barney and Surprise Creeks. Reduction in water quality reduces diversity and abundance of aquatic fauna. Metals bio-accumulate in aquatic fauna, which are then consumed by people, causing unknown morbidity and/or health effects. Contaminants migrate downstream from the MRM operations. Contaminated biota move from exposed sites around McArthur River Mine to regional reference sites.	Site-wide	A Dust Management Plan prescribes the use of water carts and fixed sprays to suppress dust, which is applied during construction of NOEF and other structures. A Safety Management System is employed, which identifies hazards and work methods to avoid exposure or to be protected whilst working in proximity to hazards (cabins, PPE, etc.).	H&S and Comm	B	Comm 1 H&S 1	M - 7 M - 7	H - known activity and occurrences represent maximum reasonable outcomes	As for current operations.	B	Comm 1 H&S 1	M - 7 M - 7	H - known activity and occurrences represent maximum reasonable outcomes	Exposure of personnel to spontaneous combustion fumes and potential for exposure of members of the public on the highway. Small, isolated heating that typically occurs is considered.
BB45	Spontaneous combustion of tailings due to improper handling during dam construction	Leading to potential health impacts.	TSF	Dust Management Plan - use of water carts and fixed sprays to suppress dust - applied during construction of NOEF and other dumps and as required elsewhere. Work method statement for conduct of tailings construction activities (e.g. avoiding loose tailings being left in stockpiles). Tailings being rehandled are track rolled (as per Operation, Maintenance and Surveillance Manual for the TSF). Safety Management System - identification of hazards and application of work methods to avoid exposure or to be protected whilst working in proximity to hazards (cabins, PPE, etc.).	H&S and Comm	B	Comm 1 H&S 1	M - 7 M - 7	H - known activity and occurrences represent maximum reasonable outcomes	As for current operations.	B	Comm 1 H&S 1	M - 7 M - 7	H - known activity and occurrences represent maximum reasonable outcomes	Exposure of personnel to spontaneous combustion fumes and potential for exposure of members of the public on the highway - small, isolated heating which typically occurs is considered.

*The risk number of the hazard as it is listed in the Project EIS risk register.

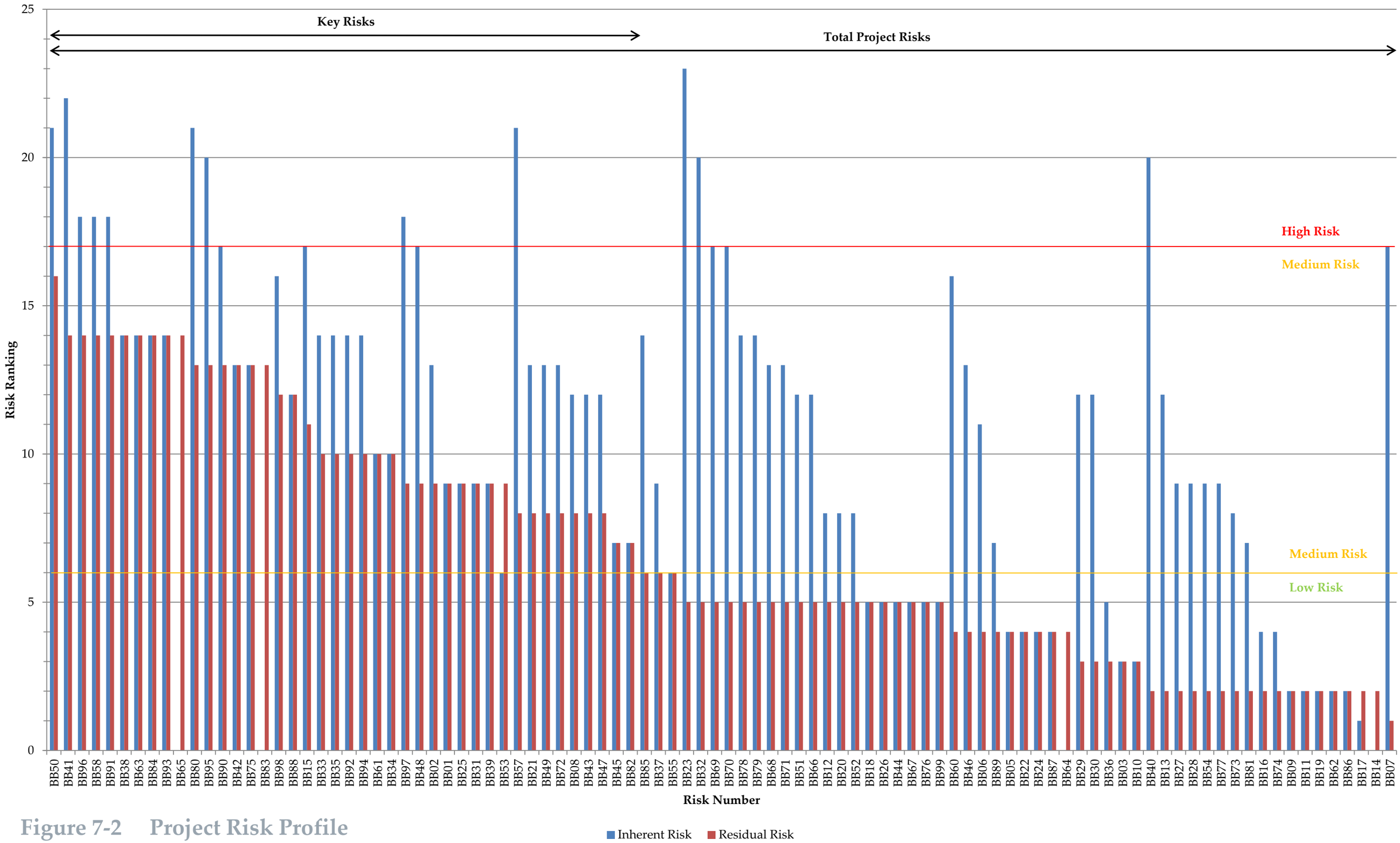

Figure 7-2 Project Risk Profile

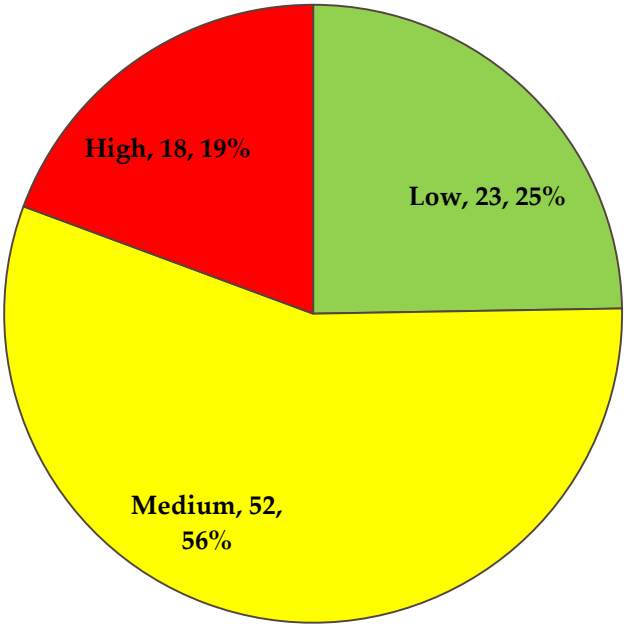

Figure 7-3 Proportion of Low, Medium and High Inherent Risks

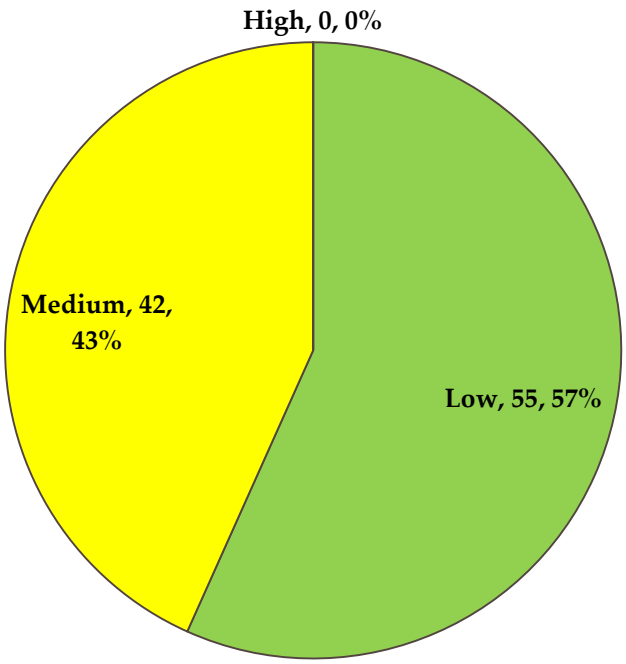

Figure 7-4 Proportion of Low, Medium and High Residual Risks

7.3.2 Discussion of Findings

Based on the results as presented in **Section 7.3.1** above, a discussion of the risk assessment findings is provided below.

7.3.2.1 Total number of Project risks identified

As detailed in **Figure 7-2**, a total of 97 Project risks have been identified as a result of the risk review workshops. Initially, over 200 risks were identified; however this number was reduced in risk review workshop 4 due to amalgamation of similar risks. The breakdown of residual risk scores includes:

- 55 low risks (approximately 57% of total risks identified);
- 42 medium risks (approximately 43% of total risks identified); and
- Nil (0) high risks.

The adoption of the mitigation measures proposed in this EIS will result in a shift in the risk profile. This has been summarised in **Figure 7-2** and **Figure 7-3**. This will result in the following changes to the Project risk profile pre and post adoption of proposed mitigation measures:

- High risks will decrease from 18 (inherent) to nil (0) (residual);
- Medium risks will decrease from 52 (inherent) to 42 (residual); and
- Low risks will increase from 23 (inherent) to 55 (residual).

Four of the key risks were not assigned inherent risk scores (BB14, BB64, BB65 and BB83). This was due to the fact that the specific activity/issue has not commenced (e.g. hydraulic mining of tailings).

The breakdown of risks by Project Domain can be summarised as follows:

- 15 Open Cut related risks;
- 40 NOEF related risks;
- 21 TSF related risks;
- 2 combined NOEF/TSF related risks; and
- 19 site-wide related risks.

7.3.2.2 Key Project risks identified

A total of 43 key Project risks (i.e. risks with a risk score of medium (7) or higher) have been identified including:

- 9 Open Cut related key risks;
- 8 NOEF related key risks;
- 13 TSF related key risks;
- 2 combined NOEF/TSF related key risks; and
- 11 site-wide related key risks.

These key risks are categorised in **Table 7-6**.

Table 7-6 Categories of Key Project Risks

No. of key Risks	Risk Description
Open cut	
9	• Groundwater drawdown • Mine pit lake water quality • Seepage water treatment • Open cut wall stability • Air quality (sulphur dioxide exposure, spontaneous combustion)
NOEF	
8	• Change in block model effecting change in NAF/PAF ratio • Geotechnical failure of landform • Air quality (sulphur dioxide exposure, spontaneous combustion) • Incorrect placement of non-benign materials • Surface water management system failure
TSF	
13	• Surface water management (seepage/infiltration) • Embankment failure including stability (piping or settlement or erosion) and overtopping • Injuries during construction or re-mining activities • Earthquake/seismic events • Air quality (sulphur dioxide, spontaneous combustion) • Insufficient construction materials
NOEF/TSF combined	
2	• Contaminated water management (potential social and economic impacts) • Contaminated water management (potential ecological impacts)
Site-wide	
11	• Habitat clearing (potential biodiversity impacts) • Flooding • Cessation of mining due to Regulator rejection of EIS approach and resultant social/economic/environmental legacy • Erosion and sediment management • Long term closure monitoring • Waste discharge licence criteria • Major design changes and associated implications • Invasive/feral species • Dust emissions

7.3.3 Consideration of Cumulative Impacts

There are a limited number of significant resource projects at various stages of development across the NT. The NT Department of Primary Industry and Resources (DPIR) website (https://dpir.nt.gov.au/mining-and-energy/mines-and-energy-publications-information-and-statistics/mining-environmental-reports) lists the NT's authorised producing mines (and the region in which they are located) as:

- Bootu Creek manganese mine (110 km north of Tennant Creek);
- Spinifex Bore garnet project (northeast of Alice Springs);
- Alcan Gove bauxite/alumina mine (Gove Peninsula);
- Cosmo gold ore project (160 km south of Darwin);
- Gemco manganese mine (Groote Eylandt in East Arnhem);
- McArthur River zinc lead mine;
- Ranger uranium mine (Jabiru, 260 km east of Darwin);
- Red Hill Alluvials gold project (8 km south of Grove Hill); and
- The Granites Gold Mine/Tanami Operations (560 km northwest of Alice Springs).

None of these operating mines are likely to have any influence on the local environment that may be potentially impacted by the MRM Project and therefore do not present a risk of contributing to negative cumulative impacts.

In addition to the above mining projects, oil and gas development is also progressing in the NT, with the potential to significantly contribute to the NT economy via generation of employment opportunities and government taxes and royalties. The potential revenue the NT Government may derive from the resources sector should provide the NT with a greater capacity to provide ongoing community services and development of community infrastructure.

Cattle grazing activities have resulted in some land degradation that has reduced the quality of habitat for some species. Mining and grazing activities have co-existed for many years in the McArthur River region. The effect of grazing has been captured in the assessment of baseline conditions with potential MRM impacts modelled in the consideration of these conditions.

This EIS has assessed the potential impacts of the Project both over time (with modelling work assessing potential impacts over a nominal 1,000 year timeframe) and on off-site, downstream environments. The results of these assessments in combination with the fact that the number of operating mines within the NT is comparatively limited and spread over a large geographical area, indicates that there are unlikely to be significant cumulative impacts across the region.

7.4 Project Risk Management

As detailed in Section 3.1.5 of **Chapter 3 – Project Description and Justification**, Project risk identification, analysis and mitigation will be an integral part of the life of the mine. The design philosophy will be driven by the closure objectives, and will focus on managing and mitigating key long-term environmental risks from the outset, as part of Project design and operations phases. This approach limits the reliance on the post mining phase to address potential long-term environmental risks and includes a combination of hazard specific risk mitigation and management measures and systems-based corporate risk management measures. These measures are explained in the following sections.

7.4.1 Hazard Specific Risk Management Measures

Table 7-5 summarises the results of the Project Risk Assessment process, and details the 43 key Project hazards that were identified. For each of these hazards; both existing (pre-Project) management measures and proposed (post-Project) management measures are detailed. In addition, **Table 7-4** provides cross-references to the relevant sections of the EIS where further mitigation and management details are provided.

Chapter 3 – Project Description and Justification also provides selected details on specific management measures to be adopted.

All proposed risk management measures will adopt a combination of controls in order to align with McArthur River Mining's approach to life of mine management. This will include:

- Project design controls;
- operational engineering and administrative controls; and/or
- monitoring and reactive management controls.

Each of these classes of controls aims to limit the likelihood of a hazard eventuating and/or if it does eventuate, the management of the hazard consequence.

7.4.2 Systems-based Risk Management Measures

In addition to the hazard specific controls proposed to manage identified risks, McArthur River Mining has in place a well-established Risk Management Framework, which will be adopted in order to implement McArthur River Mining's corporate risk management measures, as described below.

Glencore manages business risks in order to create and protect value, to ensure continuous improvement and to provide support in decision-making in all aspects of its business.

Risk management is embedded through a structured framework that establishes a common approach throughout Glencore for identifying, assessing, treating and monitoring business risks.

To this end, Glencore and its assets and operations will:

- continually manage risks as part of day-to-day business through all levels of the organisation, and clearly define roles, responsibilities and key competencies pertaining to the management of risk;
- provide resources and training for employees and contractors on the risk management processes applicable across the business;
- manage change utilising risk management processes;
- integrate and embed risk management into business planning and decision-making processes;
- maintain a register of risks and treatment plans and continually monitor and review performance against these plans, and communicate risks and responsibilities to relevant stakeholders;
- undertake regular reviews of the effectiveness of risk management as part of our continuous improvement process; and
- apply the Glencore Corporate Risk Matrix as an integral component of risk management activities.

7.4.2.1 Types of Risk Assessment

In accordance with McArthur River Mining's corporate risk management procedure, risk assessments appropriate to the context and situation shall be undertaken at operations and assets, including:

- Pre-task risk assessments using simple tools such as S.L.A.M. (Stop, Look, Act, Manage), StepBack 2 x 2, Take 5 etc., prior to all operational tasks; and
- Job Safety Analysis (JSA) prior to conducting more complex tasks, or tasks in an unfamiliar environment and/or process, or where there is a substantial change to work conditions (in the absence of an approved Safe Work Procedure (SWP)).

Figure 7-5 provides an overview of the risk assessment decision process in place at the MRM site.

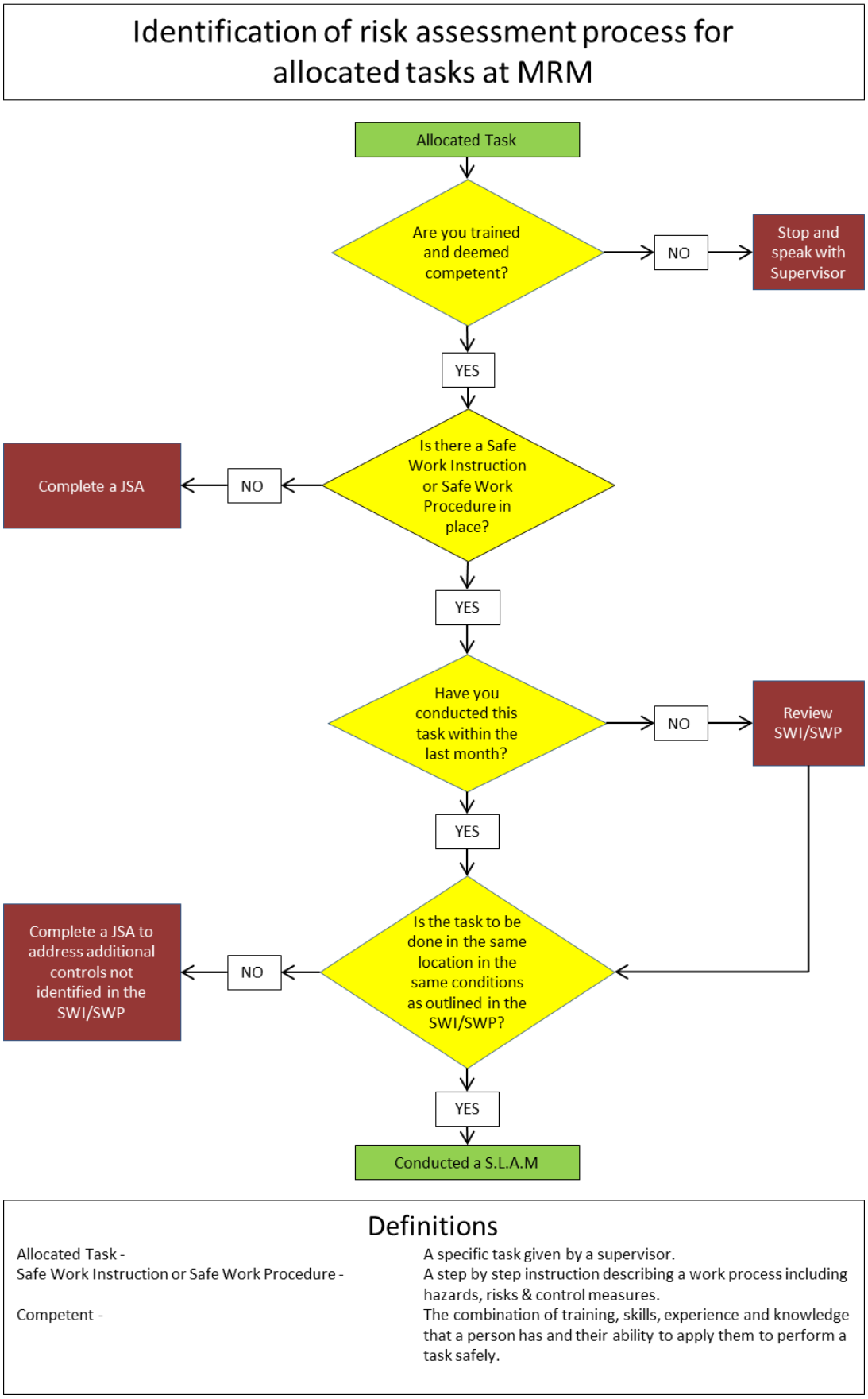

Figure 7-5 MRM Risk Assessment Decision Model

Formal team-based risk assessments shall be conducted for:

- management of change, including but not limited to changes to business, operations or processes;
- new equipment and processes;
- operations, projects, and business activities, e.g. business strategy and budgets; and
- meeting the requirements for risk assessments, as stated within Glencore policies and procedures (e.g. Fatal Hazard Protocols, Catastrophic Hazard Management Plans, Crisis Management Plans or legislation).

Required key outcomes of the process are:

- identified and controlled hazards in the workplace;
- clearly defined, assessed and documented risks, with allocated ownership;
- critical controls for fatal and catastrophic hazards, including safety equipment and inspection and maintenance regimes;
- controls, including line supervisor as a key player in enforcing controls;
- application of the "Hierarchy of Controls" in risk treatment plans;
- competence requirements for controls identified where applicable, i.e. knowledge, understanding, skills, qualifications and attitudes;
- identification of compliance requirements via supervision, monitoring, audit and review;
- consequence management linked to operating discipline and life-saving behaviours;
- corrective action management; and
- crisis management and emergency preparedness controls.

7.4.2.2 Application of the Glenore Corporate Risk Matrix

In general terms, risk management processes will be consistent with ISO 31000 *Risk Management – Principles and Guidelines* and any further guidance material provided by Glencore corporate functional departments or Divisions.

Risk assessments using the Glencore Corporate Risk Matrix (refer to **Table 7-1**) will consider and record:

- the risk event, causes and potential consequences;
- existing preventative and/or mitigative controls;
- the consequence categories in terms of the foreseeable outcome of the risk event, considering existing controls and their effectiveness (**Table 7-1**). Note, the consequence(s) of a potential foreseeable event and its likelihood shall be considered for each consequence type, with the resulting highest risk rank recorded;
- the likelihood of the event occurring with that consequence, considering existing controls and their effectiveness (**Table 7-1**);
- the risk rating (low, medium, high) and rank (1 to 25) (**Table 7-1**);
- potential Maximum Consequence (PMC) in terms of plausible worst-case consequence where all active/existing risk controls are assumed ineffective. This may be the same or higher than the foreseeable outcome; and
- adequacy of controls (control effectiveness) and any resultant risk treatment plans or actions **Table 7-7**).

Table 7-7 Adequacy of Controls and Risk Treatment Plans

Consequence Category	Consequence Type	Ownership	Action
Cat. 5	**Catastrophic Hazard**	Divisional/ Functional/ Operational/ Asset Leadership	• Quantitative or semi-quantitative risk assessment required. • Capital expenditure will be justified to achieve ALARP ('As Low As Reasonably Practicable'). • Catastrophic Hazard Management Plans (CHMP) must be implemented where practical, Crisis Management Plans (CMP) tested and Catastrophic Event Recovery Plans (CERP) developed.
Cat. 4 (Health & Safety consequence)	**Fatal Hazard**	Divisional/ Functional/ Operational/ Asset Leadership	• Glencore SafeWork Fatal Hazard Protocols or appropriate management plans must be applied. • Capital expenditure will be justified to achieve ALARP.
Risk Rank	**Risk Rating**	**Ownership**	**Action**
17 to 25	**High Risk**	Divisional/ Functional/ Operational/ Asset Leadership	• Install additional HARD and SOFT controls to achieve ALARP. • Capital expenditure will be justified to achieve ALARP.
7 to 16	**Medium Risk**	Operational/ Asset Leadership	• Install additional HARD and SOFT controls if necessary to achieve ALARP. • Capital expenditure may be justified.
1 to 6	**Low Risk**	Operational/ Asset Leadership	• Install additional controls if necessary to achieve ALARP. • Capital expenditure is not usually justified.

7.4.2.3 Catastrophic and Fatal Hazard Management

The Catastrophic and Fatal Hazard Management Policy provides a consistent and structured approach to the management of catastrophic and fatal hazards, so they remain under control. Management implement processes and promote the necessary culture and competencies to identify, analyse, evaluate and treat catastrophic and fatal hazards throughout the life cycle of the MRM site. **Table 7-8** provides a summary of McArthur River Mining's approach to catastrophic and fatal hazard management.

Table 7-8 Approach to Catastrophic and Fatal Hazard Management

Intent	Verifiable Outcomes
Catastrophic and fatal hazards and their related risks are identified using thorough processes.	The methodology used is consistent with Glencore's Risk Management Framework and tools are appropriate to the situation. There is evidence the process has used experienced facilitators and personnel, industry knowledge and learning's, and external expertise where appropriate.
Catastrophic and fatal hazards (individual or a combination of) associated with facilities, structures, activities or situations are regularly assessed.	A register is available and up to date identifying catastrophic and fatal hazards, for all workplaces.
Catastrophic and fatal hazards will be controlled at all times.	A management plan is in place for all relevant catastrophic hazards, and commonly encountered fatal hazards. Critical controls have been identified and developed for each catastrophic and fatal hazard and approved by senior management A rigorous monitoring and reporting process is in place for monitoring the effectiveness of catastrophic hazard critical controls. Conformances and non-conformances are reported to senior management and deficiencies are identified and corrected.
There is knowledge and awareness by those people directly exposed, and others who have a legitimate interest in the catastrophic and fatal hazards.	Records exist of regular communications (internal and external) and training of persons so they are aware of the hazards, and associated critical controls. They understand how the hazards are created and released, and why particular actions are required to control them. Processes to assess their understanding and awareness are developed and implemented e.g. competency assessment and safety interactions.
Accountabilities to manage critical controls are clear.	Managers, supervisors and employees/contractors have documented accountabilities in respect to maintenance of the critical controls.

7.4.2.4 Hazard Identification

The S.L.A.M. program is contained in the general site safety induction for new employees and contractors. Workplace Safety Observations training is provided to the nominated staff throughout the year. Personnel are trained to identify any hazards that may be present in the work area and appropriately manage that hazard. Hazard reporting is conducted through an electronic incident reporting process (Site Safe System) and remedial action requirements are emailed to the relevant personnel.

A risk register has been developed, encompassing all high level business, health, safety, environmental and community risks. The top ten risks of this register are reviewed monthly and reported to Glencore corporate. The remaining risks within this register are reviewed annually; however control verification is conducted throughout the year on all risks.

7.4.2.5 Job Safety Analysis and Standard Operating Procedures

Job Safety Analysis (JSA) is undertaken as required for specific tasks. JSAs are used in the development of Standard Operating Procedures (SOPs). SOPs are developed to maximise compliance with McArthur River Mining's Health Safety Environment and Community Management System (HSEC MS) Standards.

A McArthur River Mining intranet webpage and internal drive allow access by all employees (including contractors) to all JSAs, SOPs, risk assessments, training packages and related information. This system allows ease of access to all documentation for all personnel and has been established to facilitate effective document control. Updated versions of procedures will be maintained through the intranet and McArthur River Mining's document control system.

Hard copies are also available. Supervisors are given access to electronic copies of policies and procedures to ensure their personnel have the most recent update of relevant procedures. These procedures, and any changes to them, are reinforced through inductions and safety meetings.

7.5 Summary and Conclusions

McArthur River Mining has implemented a comprehensive risk identification and assessment program over a two and a half year period to review the existing Phase 3 Project risks, and identify and assess any potential new Project risks. This has been an iterative process that has been refined as the results of the Project's supporting technical study program have been completed.

The risk assessment process has been integrated with the Project design process. A series of successive risk review workshops were completed to test and evaluate Project design alternatives and to inform the refinement of Project proposals. A total of 97 Project risks were subsequently identified as a result of the risk review workshops.

The MRM site design philosophy is driven by the closure objectives, and focusses on managing and mitigating key long-term environmental risks from the outset, as part of Project design and operations phases. This approach reduces the reliance on the post mining phase to address potential long-term environmental risks. Therefore Project risk identification, assessment and management have been and will continue to be an integral part of the life of the mine.