Appendix F

Tailings storage facility risk assessment

REGIS
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LFB Resources NL

McPhillamys Tailings Storage Facility (TSF) Risk Assessment

Prepared for:	**LFB Resources NL, McPhillamys Gold Project**
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Key Supporting Documentation

- AS/NZ ISO 31000:2018 *Risk Management – Principles and Guidelines* (Standards Australia, 2009);
- HB 203:2006 *Environmental Risk Management – Principles and Process* (Standards Australia, 2006);
- Australian Department of Industry, Tailings Management, September 2016
- MDG1010 Minerals Industry Safety and Health Risk Management Guideline (Department of Trade and Investment, 2011).

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1 INTRODUCTION

1.1 OVERVIEW

LFB Resources NL is seeking development consent for the construction and operation of the McPhillamys Gold Project (the project), a greenfield open cut gold mine and water supply pipeline in the Central West of New South Wales (NSW) approximately 8 km north-east of Blayney, within the Blayney and Cabonne local government areas (LGAs). The project application area is illustrated at a regional scale in Figure 1.1.

As shown in Figure 1.1, the McPhillamys Gold Project comprises two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from approximately 90 km away near Lithgow to the mine site (the pipeline development).

This report represents a Preliminary Hazard Analysis (PHA) for the mine development component of the McPhillamys Gold Project prepared in accordance with *Applying SEPP 33 - Hazardous and Offensive Development Application Guidelines*, (DoP 2011). References to 'the project' throughout this report are therefore referring to the mine development only. A PHA has not been prepared for the pipeline development as the minor quantities of hazardous goods associated with the construction of the pipeline do not exceed the Preliminary Risk Screening Assessment thresholds (DoP 2011). The potential hazards and risks associated with the pipeline development component are addressed in the main report of the Environmental Impact Statement (EIS) (Volume 1, EMM 2019a).

LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (referred herein as Regis). The mine development project boundary (referred herein as the project area) is illustrated in Figure 1.2.

The purpose of the PHA is to assess whether the project represents offensive or hazardous development, as defined by *State Environmental Planning Policy No 33 – Hazardous and Offensive Development* (SEPP 33) thereby posing an unacceptable risk to the surrounding land uses.

This PHA report forms part of the EIS. It documents the assessment methods, results and the considerations given to measures built into the project design to avoid and minimise impacts to people, property and the environment, and identify any areas of additional study to confirm that executed operational management plans will help to avoid these types of risks arising from the project.

1.2 PROJECT OVERVIEW

A full project description is provided in Chapter 2 of the EIS (EMM 2019). The key components of the project are as follows:

- Development and operation of an open cut gold mine, comprising approximately one to two years of construction, approximately 10 years of mining and processing and a closure period (including the final rehabilitation phase) of approximately three to four years, noting there may be some overlap of these phases. The total project life for which approval is sought is 15 years.

- Development and operation of a single circular open cut mine with a diameter of approximately 1,050 metres (m) and a final depth of approximately 460 m, developed by conventional open cut mining methods encompassing drill, blast, load and haul operations. Up to 8.5 Million tonnes per annum (Mtpa) of ore will be extracted during the project life.

- Construction and use of a conventional carbon-in-leach processing facility with an approximate processing rate of 7Mtpa to produce approximately 200,000 ounces per annum of product gold. The processing facility will comprise a run-of-mine (ROM) pad and crushing, grinding, gravity, leaching, gold recovery, tailings thickening, cyanide destruction and tailings management circuits. Product gold will be taken off-site to customers via road transport.

- Placement of waste rock into a waste rock emplacement which will include encapsulation of material with the potential to produce a low pH leachate. A portion of the waste rock emplacement will be constructed and rehabilitated early in the project to act as an amenity bund.
- Construction and use of an engineered tailings storage facility to store tailings material.
- Construction and operation of associated mine infrastructure including:
  - administration buildings and bathhouse;
  - workshop and stores facilities, including associated plant parking, laydown and hardstand areas, vehicle washdown facilities, and fuel and lubricant storage;
  - internal road network;
  - explosives magazine and ammonium nitrate emulsion storage facilities;
  - topsoil, subsoil and capping stockpiles;
  - ancillary facilities, including fences, access roads, car parking areas and communications infrastructure; and
  - on-site laboratory.
- Establishment and use of a site access road and intersection with the Mid Western Highway.
- Construction and operation of water management infrastructure, including water storages, clean water and process water diversions and sediment control infrastructure.
- A peak construction workforce of approximately 710 full-time equivalent (FTE) workers. During operations, an average workforce of around 260 FTE employees will be required, peaking at approximately 320 FTEs in around years four and five of the project.
- Construction and operation of a water supply pipeline approximately 90 km long from Centennial's Angus Place and SCSO; and EA's MPPS operations near Lithgow to the mine project area. The pipeline development will include approximately 4 pumping station facilities, a pressure reducing system and communication system. Approximately 13 ML/day (up to a maximum of 16 ML/day) will be transferred for mining and processing operations.
- Environmental management and monitoring equipment.

Progressive rehabilitation throughout the mine life. At the end of mining, mine infrastructure will be decommissioned, and disturbed areas will be rehabilitated to integrate with natural landforms as far as practicable consistent with relevant land use strategies of the relevant local government areas (LGAs).

Figure 1.1 Project Application Area – Regional Setting

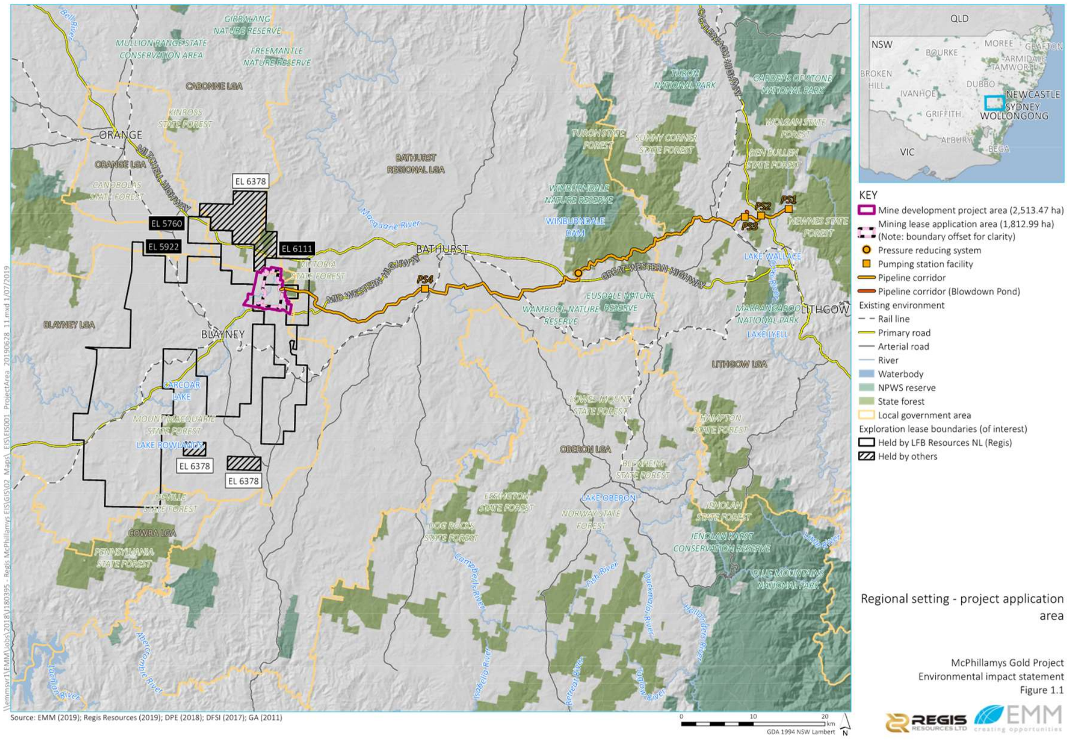
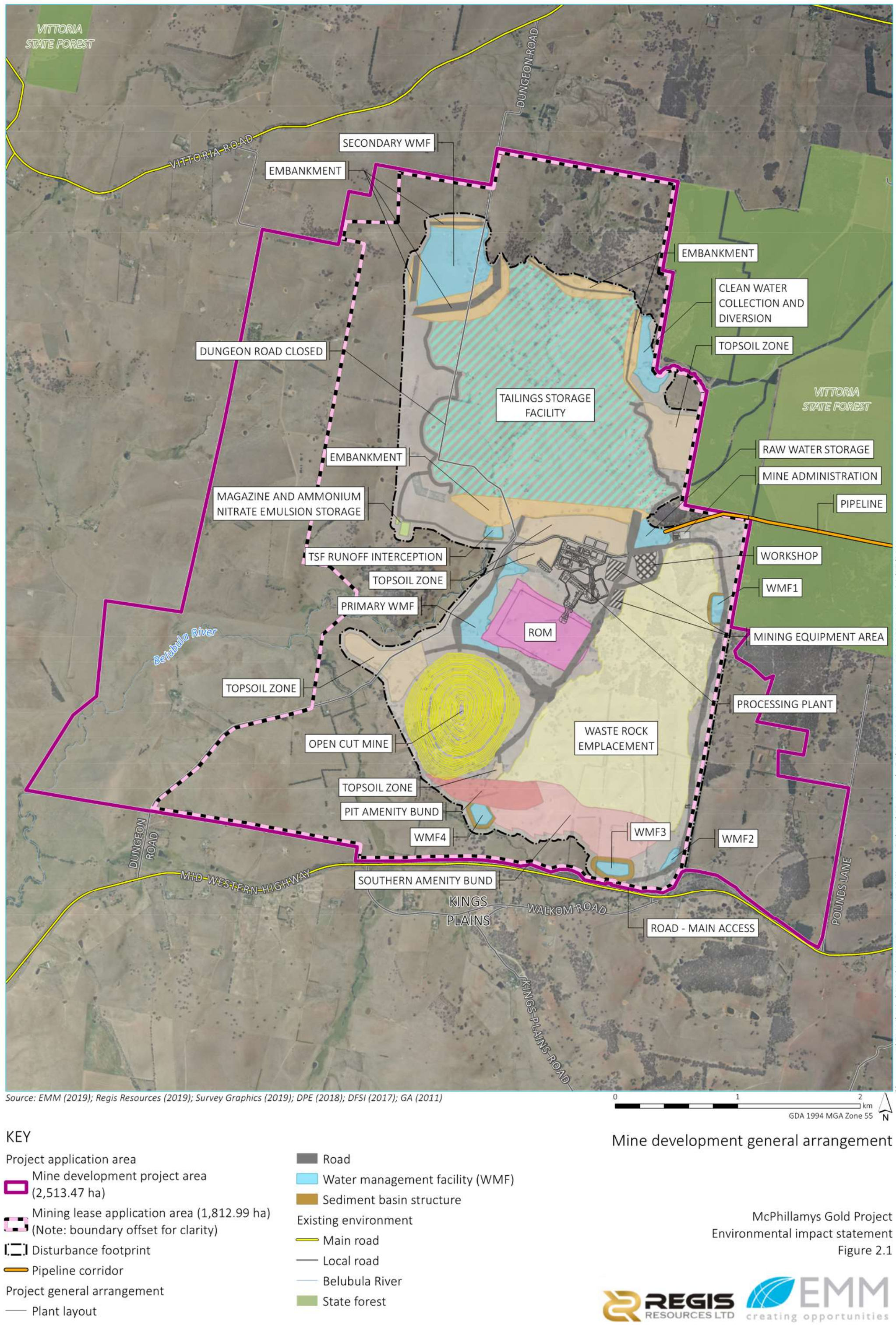


Figure 1.2 Project Area



1.3 Assessment Requirements

This TSF Risk Assessment has been prepared following the appropriate guidelines, policies and industry requirements, and following consultation with stakeholders including community members and relevant government agencies.

Guidelines and policies referenced are as follows:

- AS/NZ ISO 31000:2018 *Risk Management – Principles and Guidelines* (Standards Australia, 2009);
- HB 203:2006 *Environmental Risk Management – Principles and Process* (Standards Australia, 2006);
- MDG1010 Minerals Industry Safety and Health Risk Management Guideline (Department of Trade and Investment, 2011);
- ANCOLD 2012 Section 2.0 Key Management Considerations;
- Dams Safety Committee NSW, Tailings Dam. Ref - DSC3F, June 2012;
- International Cyanide Management Code – Accessible at https://www.cyanidecode.org/about-cyanide-code/cyanide-code, dated 2018 , accessed March 2019;
- Australian Department of Industry, Tailings Management, September 2016

This risk assessment has been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE). These were set out in DPE's Environmental Assessment Requirements (EARs) for the Project, issued on 24 July 2018 and revised on 19 December 2018. The EARs identify matters which must be addressed in the EIS and essentially form its terms of reference.

To inform the preparation of the EARs, DPE invited other government agencies to recommend matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the EARs. Copies of the government agencies' advice to DPE were attached to the EARs.

DPE, the Environment Protection Authority (EPA), Department of Industry – Division of Lands and Water (DoI) all requested a TSF Risk Assessment be carried out for the proposed TSF.

Table 1.1 lists individual requirements relevant to this TSF Risk Assessment and where they are addressed in this report.

Table 1.1 Technical assessment for TSF Risk Assessment Related EARs

Author	Paraphrased Requirement	How Addressed in this Document
DPE	A tailings risk assessment based on the tailings composition and identification, quantification and classification of the potential waste streams likely to be generated during construction and operation, including and not limited to non-production waste, reagent materials and cyanide compounds	Waste streams considered – together with reviewing technical references related to tailings composition and treatment options
DoI	Assess risk and potential impacts to downstream surface and ground water users. Consider ability to monitor TSF performance and confirm affected users and water sources are known.	Downstream issues and users identified in the risk ranking table and associated identified issues.
EPA	Liner policy requirements to achieve a hydraulic permeability of 10^{-9} m/s	Achieving TSF lining integrity flagged as a potential risk and control measures identified as being considered.

Author	Paraphrased Requirement	How Addressed in this Document
EPA	Give consideration to alternate tailings disposal methods.	Loss scenarios were developed for all currently known techniques of tailings disposal – and were risk ranked as well as considered in the technical memo on tailings options (D Noble, March 2019)
EPA	Consider risks for estimated tailing composition – and provide sufficient information to allow a peer review process to be applied.	Alternative methods of disposal were considered and compared on a pro/con and matrix ranked basis. Results are presented in the options comparisons at sections 4.3.2 and 4.3.3

2 Risk Analysis

The scope of the TSF Risk Assessment workshop was to:

Identify the potential hazards related to the McPhillamys Gold Project tailings storage facility (TSF) and identify issues for inclusion in approvals submission materials.

The stated purpose of the study was to:

Identify areas that need to be documented, formalised or analysed in more detail - and to demonstrate that alternative processing and disposal options have been assessed.

2.1 Clarifying Points

The following clarifying points regarding the scope were made:

- Geographical extent was limited to the McPhillamys Gold Project Area TSF location and associated downstream receivers.
- Transport and general cyanide usage related issues were outside the scope of this work – which is focussed only on tailings composition and behaviour during transport and once stored.

2.2 Risk Assessment Process

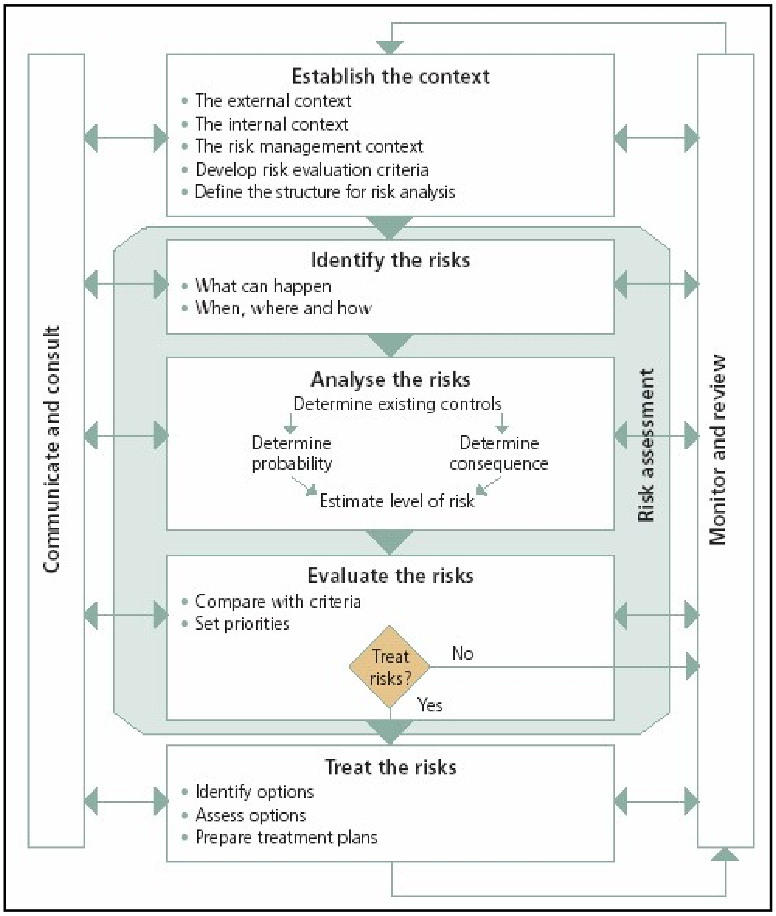
The risk assessment process was based on the framework provided on Figure 2 (based on AS/NZS ISO 31000:2018, MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* [NSW Department of Trade and Investment, 2011] and HB 203:2006 *Environmental Risk Management – Principles and Process* [HB 2003:2006]).

2.3 Resourcing, Schedule and Accountabilities

The following resources were allocated in order to effectively conduct the TSF risk assessment:

1. a team of personnel with suitable experience and knowledge of mining operations and environmental issues in the area associated with the mine development;
2. a team of subject matter experts available to review the online version of the modified report;
3. external facilitators for the risk assessment and write-up of results; and
4. aerial photographs, drawings, the relevant agency's assessment requirements and various technical reports provided for consideration by the team.

Figure 2 - Risk Management Process (AS/NZS ISO 31000:2018)



Source: after AS/NZS ISO 31000:2018.

The outcomes of the risk analysis and associated accountabilities were understood by the team as intended to be integrated into the EIS and overall LFB Resources management systems so that they are effectively reviewed, implemented and monitored.

2.4 METHODOLOGY

2.4.1 Framework

Figure 2 outlines the overall framework utilised for the TSF RA.

2.4.2 Key Steps

The key steps in the process included:

1. confirming the scope of the TSF Risk Assessment study;
2. listing any identified assumptions on which the RA is based;
3. reviewing available data on the TSF including reports, plans, maps and aerial photos (both prior to and during the workshop);
4. conduct a team-based risk assessment that:
   a) drew on the knowledge base of the team members who had extensive experience in TSF design, construction and operation (in Australia and internationally) to identify issues to consider;

b) considered the range of available options – as described in the technical papers prepared prior to the session (Noble, 2019);
c) identified hazards and plausible loss scenarios then assessed the level of risk; and
d) developed a list of intended or recommended controls to treat the risk (through further study as part of informing the EIS on intended controls related to prevention, monitoring, management and rehabilitation strategies);

5. reviewing documentation and presentations by LFB Resources personnel on the intended McPhillamys Gold Project TSF features;

6. preparing a draft report in accordance with AS/NZS ISO 31000:2018 and MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011) for review by LFB Resources personnel and TSF RA team members;

7. incorporate comments from LFB Resources and the assessment team; and

8. finalise the report and issue as controlled copy for ongoing use.

With respect to the overall framework (Figure 2), steps 1 to 3 above represent the 'establish the context' phase and step 4 represents the 'identify risks', 'analyse risks', 'evaluate risks' and 'treat risks' phases.

As described in Section 2.2, the outcomes of the TSF RA and associated accountabilities will be integrated into the EIS and overall LFB Resources management systems so that they are effectively reviewed, implemented and monitored.

2.4.3 External Facilitation

The team was facilitated through the process by ***Risk Mentor*** – a company specialising in Risk Assessment and strategic risk management programmes. The facilitator, Dr Peter Standish, is experienced with open cut gold mining and many aspects of environmental monitoring and rehabilitation.

The team was encouraged and "challenged" to identify a wide range of environmental impacts or hazards.

It is important to understand that the outcomes of this analysis:

1. are process driven;

2. challenge current thinking and may not necessarily appear appropriate or reflect "pre-conceived" ideas; and

3. are the result of the team assembled to review the topic and not the result of any one individual or organisation.

3 ESTABLISH THE CONTEXT

3.1 PROJECT SUMMARY

The main activities associated with the development of the Project TSF and overall mine development are described earlier in this report and more thoroughly throughout the EIS and supporting assessments.

3.2 RISK MANAGEMENT CONTEXT

This TSF risk analysis has been conducted in accordance with the assessment requirements for the Project (see section 1.3 earlier in this report).

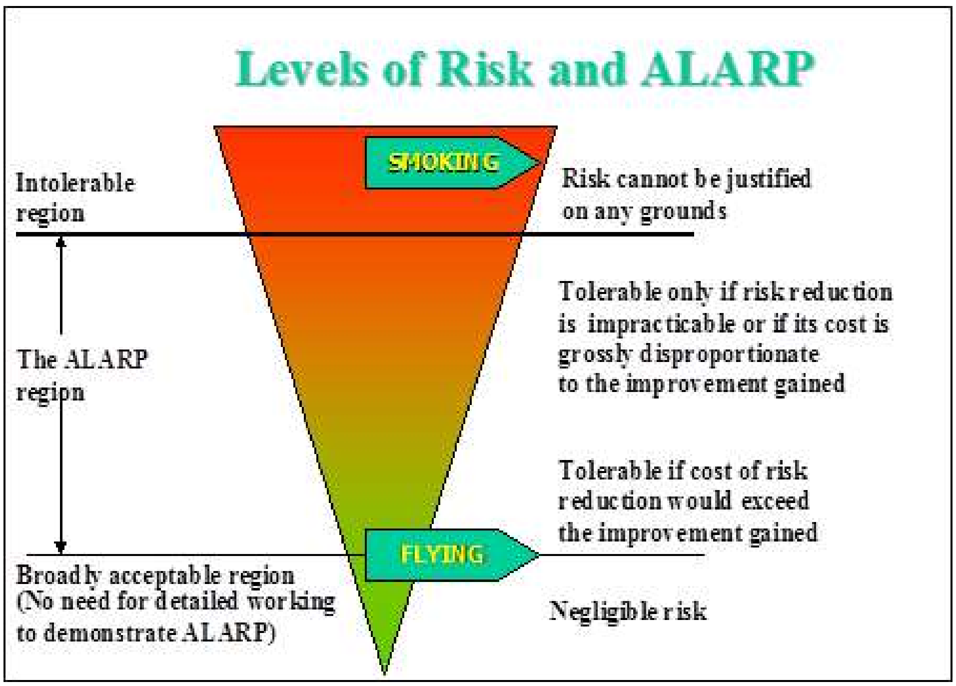
In addition, the TSF RA was prepared cognisant of the following documents:

- Leading Practice Handbook: Tailings Management: September 2016[1];
- AS/NZ ISO 31000:2018;
- HB 203:2006; and
- MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011).

3.3 RISK CRITERIA

The risk criteria utilised is to reduce the risk to As Low As Reasonably Practicable (ALARP) or lower. Figure 4 schematically shows the three risk management zones *viz*. intolerable, ALARP and tolerable. The middle zone is referred to as the ALARP zone.

Figure 3 - Risk Criteria "ALARP"



Flying is an example of a risk considered by most people to be a tolerable risk; whilst smoking is generally considered to be an activity which cannot be justified from a risk perspective. This is shown graphically in Figure 4. Intolerable items such as smoking are at the top of the pyramid where much lower risks, such as flying, sit at the lower end of the ALARP zone (close to tolerable).

The risk ranking matrices used during the TSF RA workshop are presented in Section 4.

[1] Accessed online at this link (https://www.industry.gov.au/data-and-publications/leading-practice-handbook-tailings-management).

4 IDENTIFY RISKS

4.1 OVERVIEW

The identification of risks involved the use of risk assessment "tools" appropriate for identifying potential loss scenarios associated with the TSF. The tools used were:

- Introduction – before the potential issues were brainstormed it was important that the whole team had a good understanding of the, different tailings disposal methods, alternative TSF design and location options as well as an understanding of rational behind the selected design and tailings disposal method for the proposed TSF. This was confirmed by the facilitator.
- Brain/writing-storming – this was used to draw out the main issues using the understanding, relevant experience and knowledge of the team. This session also used prompt words to build on the experience base of the team and identify any potential environmental issues and potential loss scenarios.
- Option analysis – considering the various options presented in the technical reports and conducting a pro's and con's type analysis to allow for comparison between the options.
- Modified Hazard and Operability (HAZOP) analysis – this involved the review of key words (drawn from the assessment requirements. for the Project relevant to the TSF) and aerial photographs, plans, and the consequent identification of potential environmental issues at each location during each phase of operation.

4.2 TSF RISK ASSESSMENT TEAM

The review team met across two locations on the 8th and 12th of March, 2019. A team based approach was utilised in order to have an appropriate mix of skills and experience to identify the potential environmental issues and potential loss scenarios. Details of the team members and their relevant qualifications and experience are included in Table 2 below.

Table 2 – Team Information

Name	Role / Affiliation	Experience, Training and Skills I bring to the team session
Russel Staines	Principal Geochemist, SRK Consulting	Formal qualifications and over 20 years industrial experience
Liz Webb	EMM Consulting - Ground Water	Formal ground water qualifications and over 15 years industrial experience
Dayjil Finchan	HEC Consulting - Surface Water Specialist	Formal qualifications Senior Water Resources Engineer with 10 years mining industry experience
Paul Thomas	Chief Operating Officer - RR	B Eng (Extractive Met). Over 25 years industrial experience Attended peer review
Andrew Wannan	Approvals Manager - RR	B Town Planning. Over 35 years industrial experience
Frank Botica	McPhillamys Study Manager	B Business, Project Development experience for over 20 years
Wade Stephenson	General Manager Project Development Mining RR	B Eng (Mine) and over 30 years industrial experience
Drew Noble	Group Metallurgist	B Eng (Extractive Met). Over 20 years industrial experience
Nicole Armit	Project Director, EMM, Environmental Scientist	B Eng, M En BLaw, and over 19 years industrial experience

Name	Role / Affiliation	Experience, Training and Skills I bring to the team session
Tony McPaul	LFB Resources NL, Manager Special Projects	Over 35 years mining industry experience
Rod Smith	LFB Resources NL, General Manager NSW	B Sc (Met), over 35 years industrial experience - operational and consulting
Janet Krick	EMM Consulting Senior Environmental Planner - EIS	B.DevS, Grad Dip Natural Resources, Grad Cert Enviro Mangt. 12 years Environmental Approvals experience.
Peter Standish	Facilitator / RM	Formal mining qualifications (PhD, B.Eng), statutory manager qualifications and over 25 years industrial experience. Facilitator for over 30 environmental and approval risk analyses
Ralph Holding	TSF Design Engineer, ATC Williams	B Eng (Civil), and over 25 years industrial experience

4.3 Risk Identification

4.3.1 Brainstorming

The brainstorming process is intended to allow for a relatively unstructured, free flowing series of issues and ideas to be generated. It is enhanced through the use of key word association processes based on work by Edward de Bono and is intended to generate a wide range of data on losses, controls and general issues related to the TSF and associated tailings.

No "filtering" of the data is allowed during the process – and the reader should be conscious of the intent of not missing a potential "left field" issue/loss scenario when reading through the material.

Issues identified during the brainstorming session are presented in the consolidated listing of issues identified in the Issues Register (Table 9) later in this report.

4.3.2 Cyanide Detoxification Option Analysis

A key interest area of approving bodies and the broader community is around the presence of Cyanide on site (and potential to exit the site). The stated intent for the project is to detoxify any tailings and there are a range of available options (referring to Noble 2019 and Cyanide Management, Leading Practice Sustainable Development Program for the Mining Industry, May 2008) available:

- Alkaline Chlorination
- Hydrogen Peroxide
- SO2/Air
- Ferrous Sulphate
- Ozonation
- Caro's Acid

When compared against sustainable and operational parameters – the following table can be generated. The review team endorsed the assessment and recommendations provided in Noble 2019. SO2/Air cyanide detoxification was therefore determined the most suitable method for the project.

Table 3 – Endorsed Cyanide Destruction Option Comparison

Variables	SO_2/Air	Alkaline Chlorination	Hydrogen Peroxide	Ferrous Sulphate	Ozonation	Caro's Acid
Capital Cost	Low	High	High	Low	High	Med
Operating Cost	Med	High	High	Med	High	Med
System Complexity	Low	Low	Low	Low	Med	Low
Reagent – Safety	Med	Low	Low	High	Med	Low
Slurry Treatment	Yes	No	Yes	No	No	Yes

4.3.3 Tailings Disposal Options Comparison

The team reviewed the nature of the tailings (although at the time this was still subject to further Geomet analysis) and considered a technical paper on choice of reagents (Noble, 2019). A table, provided in this paper was considered by the team and generally endorsed as reflecting an optimal choice for the McPhillamys project.

The team then considered available technical information and referred to Noble 2019 and the Leading Practice Sustainable Development Program work on tailings (Australian Government 2016). A key comparison table in Noble 2019 was considered and analysed – producing the comparison model as a cross mapped table (Table 4) for the potential TSF options.

The potential options are:

- Slurry Disposal (proposed option)
- Sub- Aqueous Disposal
- Paste Disposal
- Filtered Tailing (Cake)
- Co-mixing (crushed waste with filtered tailings)

Each of these options were then mapped against relevant parameters related to their potential sustainability – which are:

- Water Use
- Liner/Seepage Complexity
- Cyanide Breakdown Rate
- AMD Risk (if PAF Tailings)
- Tailings Stability
- Energy Use
- Tailings Footprint
- Location Suitability
- Capital Cost
- Operating Cost

Using a High/Med/Low metric – this leads to the following instructive comparison between methods.

Table 4 – Comparative Pro's and Con's for Tailings Storage Options

Variables	Slurry Disposal	Sub- Aqueous Disposal[2]	Paste Disposal	Filtered Tailing (Cake)	Co-mixing (crushed waste with filtered tailings)
Water Use	Med	High	Low	Low	Low
Liner/Seepage Complexity	Med	High	Med	Low	High
Cyanide Breakdown Rate	High[3]	High	Low	High	High
AMD Risk (if PAF Tailings)	Med	Low	Med	Med	Med
Tailings Stability	High	Low	High	High	Med
Energy Use	Low	Low	High	High	High
Tailings Footprint	Low	Low	High	Med	High
Location Suitability	High	Low	Low	High	Med
Capital Cost	Med	High	High	High	High
Operating Cost	Low	Med	Med	High	High

4.3.4 Modified HAZOP

The next "tool" applied with the team was that of a modified HAZOP. In this process the aerial photographs and plans of the site and surrounding district were referred to along with a consideration of the phases of operation and the potential impacts that could arise.

The generic key words used in the HAZOP process representing environmental issue subject areas (generally based on the headings in the assessment requirements. for the TSF aspects of the Projects) were:

- Surface Water;
- Groundwater;
- Air Quality;
- Soil and Land Resource;
- Fauna (Terrestrial and Aquatic);
- Flora;
- Visual;
- Land Contamination, and;
- Geochemistry.

Output from this process informed the description of the loss scenarios (see Table 8 below) and also generated items for further follow up which are presented in Table 9 later in this document. Geochemical risks associated with the tailings have only been quantified for the proposed slurry disposal method which will be used for the project. Therefore geochemical risks are only assessed in Table 8 for Slurry disposal.

4.3.5 Referred Issues

Where issues raised during the TSF RA workshop brainstorming were: outside the scope of the TSF RA; outside of the Project scope; and/or beyond the control of LFB Resources NL, and therefore not considered to be key

[2] There are no available water bodies available within the subject area that could be used for sub-aqueous disposal – so this option is not further considered in Table 8, below.
[3] Note that the High and Low values can change in valance from good (**green**) to bad (**red**) depending on the subject being considered.

potential environmental issues, these "referred issues" were considered to not warrant analysis in the development of the EIS.

The team did not identify any referred issues, however it was clarified that community engagement issues were (and are continuing to be) addressed during community consultation activities and confirmed that all community concerns in relation to the TSF have been captured in the risk identification process (provided as input from the LFB Resources NL personnel involved in the analysis).

5 ANALYSE RISKS

5.1 PROBABILITY AND MAXIMUM REASONABLE CONSEQUENCE

Potential loss scenarios (primarily based on the identified key potential environmental issues) were ranked for risk by the TSF RA team. A tabular analysis was used for this risk ranking process, based on the probability and consequence of a loss scenario occurring as decided by the TSF RA team.

The following definition of risk was used:

- the combination of the probability of an unwanted event occurring; and
- the maximum reasonable consequences (MRCs) should the event occur.

The following three tables present the risk ranking matrix tools that were utilised for ranking risks.

Table 5 – Qualitative Measures of Probability

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

Table 6 – Qualitative Measures of Maximum Reasonable Consequence

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

Note: Maximum Reasonable Consequences: The worst-case consequence that could reasonably be expected, given the scenario and based upon experience at the operation and within the mining industry.

Table 7 – Risk Ranking Table

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

Notes:

L = Low; M = Moderate; H = High
Risk Numbering:
1 = highest risk, 25 = lowest risk

Legend:

Risk Levels:

(green)	Tolerable
(yellow)	ALARP
(orange)	Intolerable

5.2 RISK RANKING

Risk ranking was undertaken by the team on loss scenarios based on the key potential environmental issues which are presented in Table 8 below.

Note that in this table there is a logical break shown as a double horizontal line when the subject area (tailings disposal option) considered changes.

Table 8 – Risk Ranking Results

TSF Type	Loss Scenario	Ranking Discussion	P	C	Risk
Slurry	Uncontrolled seepage from Dam	Inability of wall or floor to contain flowing materials as per design and a release to surface/ground waters. Mitigated by geotechnical investigation, design and construction to achieve required permeability levels, dam construction quality confirmation, emplacement of slurry at nominated water contents (free water in recovery facilities only). Downstream monitoring trenches / bores would detect leakage and allow for pumping/return of solution. Credible consequence of uncontrolled seepage would be low flows - so it is likely that the quantum of harm will be low and based on the construction and operation controls - the likelihood of occurrence is Unlikely. Information prepared by the geochemistry and hydrology subject matter experts also highlights the expected very low rates of seepage – which even without any form of mitigation are predicted to meet relevant guidelines[4].	D	5	**24 (L)**

[4] See GWA Executive Summary – "The watertable is predicted to become elevated underneath the TSF. Without mitigation measures (ie seepage interception bores and interception trench), seepage from the TSF is predicted to flow south and south-west towards the Belubula River, however the distance that the seepage will migrate over 100 years is not significant (seepage will flow at a rate of around 50 m per 100 years). Without mitigation, the TSF seepage water will mix with groundwater and by the time TSF seepage is predicted to migrate to the Belubula River, the seepage water chemistry will become diluted along the flow path and will undergo other hydrogeochemical reactions. As such, the results of this assessment indicate that even without all seepage management measures in place, any seepage that may migrate through the HSU and discharge to the Belubula River will have concentrations below the observed baseline surface water quality concentrations, ANZECC (2000) livestock drinking water and ANZECC (2000) 80% protection level for freshwater aquatic ecosystem guideline values (for analytes with elevated concentrations in the tailings liquid fraction results). Once groundwater discharges to the Belubula River, any leachate that may be present within the groundwater will become further diluted, given that groundwater discharge is predicted to represent around 3-5% of the overall surface flows in the Belubula River. Mitigation measures (seepage interception bores) will further reduce the likelihood and significance of seepage migrating to the Belubula River and any potential impacts on downstream users". And, at Section 6.5.1 – the calculated concentrates of analytes were: Sulphate – 213 mg/L; Selenium 0.01 mg/L; Total CN 0.06 mg/L; WAD CN 0.04 mg/L; Aluminium 0.03 mg/L.

TSF Type	Loss Scenario	Ranking Discussion	P	C	Risk
Slurry	Dam wall failure - catastrophic	Gross failure of dam wall leading to uncontrolled release of stored tailings and associated solutions. Mitigated by geotechnical investigation, design and construction to achieve a factor of safety Factor of Safety (FoS) above generally accepted guidelines. Relatively viscous tailings (low potential for downstream flows). Operational processes use wall spigot discharge (no water near the dam wall). Emergency spillway to protect wall in the event of excess water/solution on surface. Regular site and independent inspections/audits of wall. Instrumented piezometers and minimum 2 x shiftly dam inspections. Freeboard controls - no tailings deposition when freeboard less than specified levels. Mitigating controls would include evacuation of downstream areas. Credible consequence of gross dam wall failure would be slumping of tailings affecting an area downslope until the beach was formed (similar to Cadia at about 200 to 300 metres) so would remain within the project area. Probability of this occurring is rare.	E	2	**16 (L)**
Slurry	Over-topping	Poor operating practices or a major rainfall event and/or failure of clean water diversions. Addressed by: dam design; operating practices; clean water diversion design, construction and regular monitoring; emergency pumping and pipework capacity (back to secondary Water Management Facility (WMF)). Credible consequence would be a loss of solution (that would be very dilute in this scenario). Probability of this occurring is rare.	E	2	**16 (L)**
Slurry	Failure of the up-slope secondary WMF into the TSF	Gross failure of dam wall leading to uncontrolled release of 3GL of run-off into the TSF. Mitigated by geotechnical investigation, design and construction to achieve a FoS above generally accepted guidelines. Emergency spillway to protect wall in the event of excess water in the secondary WMF. Addressed by: Regular site and independent inspections/audits of wall; Instrumented piezometers and minimum 2 x shiftly inspections; under normal operating conditions the entire volume would be contained within the TSF. Credible consequence of gross dam wall failure would be flow of water into the TSF and subsequent release of dilute solution downstream. Probability of this occurring is rare.	E	4	**23 (L)**
Slurry	Release from pipelines	Failure or damage of pipeline. Addressed by design and quality of construction; flow meters capable of detecting leakage; regular inspections of pipelines; secondary containment (trenches and bunds) features. Credible consequence would be release of solutions/tailings leading to downstream release and/or compromise dam wall if the leak goes undetected for an extended period. Likelihood of this occurring would be Unlikely.	D	3	**17 (L)**

TSF Type	Loss Scenario	Ranking Discussion	P	C	Risk
Slurry	Rehabilitation/Final	The mine development is intended to produce a sustainable landform (including the TSF) post decommissioning. The typical challenge for a slurry – where low settlement rates lead to unconsolidated tailings inside the TSF is intended to be addressed through the areal extent of the facility. This leads to thin layers of deposition over large areas i.e. raises of less than 2m per year – which will augment rehabilitation as optimum settlement (and strength) of the tailings will be achieved. Ranked where a credible consequence was an inability to effectively rehabilitate the TSF surface – and a subsequent ongoing maintenance requirement for LFB Resources – a level 5 type impact. Given the tailings deposition intended this would be an unlikely occurrence.	D	3	**17 (L)**
Paste Disposal	Uncontrolled seepage from Dam	Inability of wall or floor to contain flowing materials as per design and a release to surface/ground waters. Mitigated by geotechnical investigation, design and construction to achieve required permeability levels, dam construction quality confirmation, emplacement of slurry at nominated water contents (free water in recovery facilities only). Downstream monitoring bores would detect leakage and allow for pumping/return of solution. Credible consequence of uncontrolled seepage would be low flows - so it is likely that the quantum of harm will be low and based on the construction and operation controls - the likelihood of occurrence is possible given the broader extent of water ponding at the wall from the central spigot position that the paste is discharged from.	C	3	**13 (M)**
Paste Disposal	Dam wall failure - catastrophic	Gross failure of dam wall leading to uncontrolled release of stored tailings and associated solutions. Mitigated by geotechnical investigation, design and construction to achieve a FoS above generally accepted guidelines. Operational processes use wall spigot discharge (no water near the dam wall). Emergency spillway to protect wall in the event of excess water/solution on surface. Regular site and independent inspections/audits of wall. Instrumented piezometers and minimum 2 x shiftly inspections. Freeboard controls - no tailings deposition when freeboard less than specified levels. Mitigating controls would include evacuation of downstream areas. Credible consequence of gross dam wall failure would be slumping of tailings and minor spread of solution affecting an area downslope until the beach was formed and possibly beyond the project area. Probability of this occurring is rare.	E	3	**20 (L)**
Paste Disposal	Over-topping	Poor operating practices or a major rainfall event and/or failure of clean water diversions. Addressed by: dam design; operating practices; clean water diversion design, construction and regular monitoring; emergency pumping and pipework capacity (back to secondary Water Management Facility (WMF)). Credible consequence would be a loss of solution (that would be very dilute in this scenario). Probability of this occurring is rare.	E	4	**23 (L)**

TSF Type	**Loss Scenario**	**Ranking Discussion**	**P**	**C**	**Risk**
Paste Disposal	Failure of the up-slope secondary WMF into the TSF	Gross failure of dam wall leading to uncontrolled release of 3GL of run-off into the TSF. Mitigated by geotechnical investigation, design and construction to achieve a FoS above generally accepted guidelines. Emergency spillway to protect wall in the event of excess water in the secondary WMF. Addressed by: Regular site and independent inspections/audits of wall; Instrumented piezometers and minimum 2 x shiftly inspections; under normal operating conditions some of the volume would be contained within the TSF. Credible consequence of gross dam wall failure would be flow of water into the TSF and subsequent release of solution downstream. Probability of this occurring is rare.	E	4	**23 (L)**
Paste Disposal	Release from pipelines	Failure or damage of pipeline, possibly arising due to the high pressures required for pumping - addressed by design and quality of construction; flow meters capable of detecting leakage; regular inspections of pipelines; secondary containment (trenches and bunds) Credible consequence would be release of paste leading to minor downstream release if the leak goes undetected for an extended period. Likelihood of this occurring would be Possible	C	4	**18 (L)**
Filtered Tailing (Cake)	Uncontrolled seepage from stockpile area	Inability of water control structures to contain run-off as per design and a release to surface/ground waters. Mitigated by geotechnical investigation, design and construction to achieve required permeability levels/drainage lines, construction quality confirmation, emplacement of tailings at nominated water contents. Downstream monitoring bores to detect leakage and allow for pumping/return of solution. Credible consequence of uncontrolled seepage would be low flows - so it is likely that the quantum of harm will be low and based on the construction and operation controls - the likelihood of occurrence is Rare.	E	5	**25 (L)**
Filtered Tailing (Cake)	Dam wall failure - catastrophic	Not a credible loss scenario			
Filtered Tailing (Cake)	Over-topping	Poor operating practices or a major rainfall event and/or failure of clean water diversions leads to gross surface flows from the tailings storage area. Addressed by: drainage design; operating practices; clean water diversion design, construction and regular monitoring; emergency pumping and pipework capacity (back to secondary Water Management Facility (WMF)). Credible consequence would be a migration of tailings (as a sediment) which would lead to longer term contamination downstream of the TSF (more general levels of harm than release of dilute solution so a level 3 consequence). Probability of this occurring is rare.	E	3	**20 (L)**

TSF Type	Loss Scenario	Ranking Discussion	P	C	Risk
Filtered Tailing (Cake)	Failure of the up-slope secondary WMF into the TSF	Gross failure of dam wall leading to uncontrolled release of 3GL of run-off into the TSF. Mitigated by geotechnical investigation, design and construction to achieve a FoS above generally accepted guidelines. Emergency spillway to protect wall in the event of excess water in the secondary WMF. Addressed by: Regular site and independent inspections/audits of wall; Instrumented piezometers and minimum 2 x shiftly inspections; under normal operating conditions the entire volume would be contained within the TSF. Credible consequence of gross dam wall failure would be flow of water into and across the TSF and subsequent release of tailings as a sediment contamination downstream. Probability of this occurring is rare.	E	3	**20 (L)**
Filtered Tailing (Cake)	Spillage from conveyors	A worst case scenario would be for a spillage to occur from a conveyor as it crosses a water course. This would lead to some dry material in a drainage line requiring clean up. If it occurs during a period when there are flows in the drainage line – then a small amount of contaminant could leave the site – at about a level 4 type loss. Mitigated by conveyor design (with spill trays), regular inspections, fixed cameras (at crossings), rip and slip conveyor detection and physical inspections to meet statutory requirements (shiftly inspection). Possibility with these measures in place is unlikely.	D	4	**17 (L)**
Filtered Tailing (Cake)	Dust make from stockpiled tailings	Dust generated from stockpiled tailings migrating off site and leading to contamination. Addressed by monitoring, dust control devices, emplacement to minimise wind fetch, progressive rehabilitation. Likely that this dust will not be able to be completely controlled and so will lead to downstream contamination to a low level - but likely to occur as a low level (chronic) issue during the TSF's operation.	B	4	**14 (M)**
Co Mixing - waste and filtered tailings	Uncontrolled seepage from Dam	Inability of water control structures to contain run-off as per design and a release to surface/ground waters. Mitigated by geotechnical investigation, design and construction to achieve required permeability levels/drainage lines, construction quality confirmation, emplacement of tailings at nominated water contents. Downstream monitoring bores to detect leakage and allow for pumping/return of solution. Credible consequence of uncontrolled seepage would be low flows - so it is likely that the quantum of harm will be low and based on the construction and operation controls - the likelihood of occurrence is Unlikely.	D	5	**24 (L)**
Co Mixing - waste and filtered tailings	Dam wall failure - catastrophic	Not a credible loss scenario			

TSF Type	Loss Scenario	Ranking Discussion	P	C	Risk
Co Mixing - waste and filtered tailings	Over-topping	Poor operating practices or a major rainfall event and/or failure of clean water diversions leads to gross surface flows from the tailings storage (waste rock) area. Addressed by: drainage design; operating practices; clean water diversion design, construction and regular monitoring; emergency pumping and pipework capacity (back to secondary Water Management Facility (WMF)). Credible consequence would be a migration of tailings (as a sediment) which would lead to longer term contamination downstream of the TSF (more general levels of harm than release of dilute solution so a level 3 consequence). Probability of this occurring is rare.	E	3	**20 (L)**
Co Mixing - waste and filtered tailings	Failure of the up-slope secondary WMF into the TSF	Gross failure of dam wall leading to uncontrolled release of 3GL of run-off into the TSF/Waste Rock emplacement. Mitigated by geotechnical investigation, design and construction to achieve a FoS above generally accepted guidelines. Emergency spillway to protect wall in the event of excess water in the secondary WMF. Addressed by: Regular site and independent inspections/audits of wall; Instrumented piezometers and minimum 2 x shiftly inspections; under normal operating conditions the entire volume would be contained within the TSF. Credible consequence of gross dam wall failure would be flow of water into and across the TSF and subsequent release of tailings as a sediment contamination downstream. Probability of this occurring is rare.	E	4	**23 (L)**
Co Mixing - waste and filtered tailings	Release from pipelines	Not a credible loss scenario			
Co Mixing - waste and filtered tailings	Dust make from stockpiled tailings	Dust and noise (from crushing) generated from stockpiled tailings migrating off site and leading to contamination. Addressed by monitoring, dust control devices, emplacement to minimise wind fetch, progressive rehabilitation. Likely that this dust will not be able to be completely controlled and so will lead to downstream contamination to a low level - but likely to occur as a low level (chronic) issue during the TSF's operation.	B	4	**14 (M)**

R= Risk - Ranking basis 1 (highest risk) to 25 (lowest risk).

Risk rankings defined as 1 to 6 – High; 7 to 15 - Medium (or ALARP) and 16 to 25 - Low.

6 MONITOR AND REVIEW

6.1 NOMINATED CO-ORDINATOR

The nominated client review facilitator is Rod Smith - General Manager NSW, LFB Resources NL.

It is understood the nominee will co-ordinate the inclusion of the key potential environmental issues into the various studies undertaken as part of the EIS and the overall LFB Resources NL management systems.

6.2 COMMUNICATION AND CONSULTATION

Consultation, involvement of personnel (LFB Resources NL and their specialists) and communication of the process and outcomes of the TSF RA are intended to be achieved by the inclusion of this report and the relevant specialist assessments addressing the key potential environmental issues in the EIS, and consideration of the report's outcomes in the overall LFB Resources NL management systems to be implemented for the .

6.3 CONCLUDING REMARKS

The risk assessment process conducted by the team was aligned with AS/NZS ISO 31000:2018 and MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011), with the intention of identifying the key potential environmental issues for the Project.

RM would like to thank all of the personnel who contributed to the risk assessment in particular those personnel from LFB Resources NL who prepared source material for the team session.

Peter Standish, March 2018

7 ATTACHMENT A – DEFINITIONS

ALARP	"As Low As Reasonably Practicable". The level of risk between tolerable and intolerable levels that can be achieved without expenditure of a disproportionate cost in relation to the benefit gained.
AS/NSZ ISO 31000:2018	Australian Standard/New Zealand Standard on Risk Management (see references in Section 6).
Cause	A source of harm.
Control	An intervention by the proponent intended to either Prevent a Cause from becoming an incident or to reduce the outcome should an incident occur.
EARs.	Environmental Assessment Requirements.
ERA	Environmental Risk Assessment.
Geomet	Common short form for describing the science of/professionals involved in Geological Metallurgy.
MDG1010	Department of Primary Industries guideline on risk management (see references in Section 6).
Outcome	The end result following the occurrence of an incident. Outcomes are analogous to impacts and have a risk ranking attached to them.
Personnel	Includes all people working in and around the site (e.g. all contractors, sub-contractors, visitors, consultants, project managers etc.).
Practicable	The extent to which actions are technically feasible, in view of cost, current knowledge and best practices in existence and under operating circumstances of the time.
RA	Abbreviation for Risk Assessment
Review	An examination of the effectiveness, suitability and efficiency of a system and its components.
Risk	The combination of the potential consequences arising from a specified hazard together with the likelihood of the hazard actually resulting in an unwanted event.
RM	An abbreviation used in place of Risk Mentor Pty Ltd.
TSF	Abbreviation for Tailings Storage Facility.

8 ATTACHMENT B - ISSUE IDENTIFICATION RESULTS

The output from the team's analyses which were noted as being useful inputs to other EIS studies or operational phase activities are presented below.

Table 9 – Issues Register

Ref	Issue	Comment on Current Controls
TSF001	Design - competence and reputation of design engineer producing a robust TSF design	CVs to be included
TSF002	Location of TSF - in the headwaters of the Belubula River - is it the most suitable location?	TSF Design Report
TSF003	Failure impacts on river health population and downstream users - particularly Carcoar Dam	TSF Design Report Geochemistry input needed
TSF005	Permeability of the inside of the dam (wall and floor)	TSF Design Report Geotech analysis
TSF006	Seepage - do we understand how much will occur, what the flow paths are and what the quality of the seepage will be (Confidence in ground and surface water modelling)	TSF Design Report Geotech analysis Ground water Surface Water Geochemistry
TSF007	Peer review of the designs (competence and reputation of the peer reviewer)	CVs to be included
TSF009	Legacy contamination of site and ongoing seepage issues	As for TSF006 Design and peer review Mine Closure/Rehabilitation Plan Ground Water study
TSF010	Seepage to meet EPA requirements	For EIS - Geochemistry and Ground Water studies
TSF011	Cyanide processing and effects of tailings not well understood by community	Consultation TSF Design Report EIS Commentary
TSF012	Tailings geochemistry - accuracy and confidence in the planned detox process (test work and outcomes)	TSF Design Report Geochemistry Processing/metallurgy
TSF013	Rehabilitation and closure - ensuring constructed to enable effective capping and produce a stable landform at the end of mine life	Mine Closure/Rehab TSF Design Report
TSF014	Tailings metallurgy (sizing and characteristics of the material post thickening and settling characteristics of the dam)	TSF Design Report Geochemistry processing/metallurgy
TSF015	Construction - quality of dam and floor and contractor personnel participating (QA/QC) (including estimating amount(s) and types of material required to meet permeability targets).	DFS TSF Design Report (discussed)
TSF016	Operation - robust procedures depositing tailings to meet design requirements (QA/QC)	DFS TSF Design Report (discussed)
TSF017	Robust change management to address any operational requirements which require variance to intent of TSF design	Not required - sits in next stage management plan requirements
TSF018	Changes in personnel lead to corporate memory loss - and a variance from TSF deposition practices/procedures on site	Not required - sits in next stage management plan requirements

Ref	Issue	Comment on Current Controls
TSF019	Human error/processing issues leading to failure to effectively detoxify tailings	Not required - sits in next stage management plan requirements
TSF020	Demonstrating that Regis is meeting leading practice in regards to tailings / TSF management	TSF Design Report
TSF021	Dust control during construction and operations (processing to achieve laminar rather than channeled flow of fluids on surface)	Air quality TSF Design Report Deposition Strategy – Operations and maintenance manual
TSF022	Surveillance and monitoring of TSF during operations	TSF Design Report Ongoing guidelines in management plans
TSF023	Visual amenity aspects of the TSF	Visual assessment
TSF024	Accuracy of water balance (overall process - getting it right between the pit, plant and TSF)	Ground water Surface water Processing metallurgy Management Plan
TSF025	Change in tailings characteristics (e.g. when processing a different ore stream)	Processing metallurgy Geochem Ongoing Geomet modelling (mine planning) Operations and maintenance manual
TSF026	Future modifications of tailings dam (increasing capacity)	Outside - addressed by modified/additional consent
TSF027	Considering different tailings processes (slurry vs dry stacking)	Covered
TSF028	Water recovery from TSF	Surface Water TSF Design Report Process design Operations and maintenance manual Management Plan
TSF029	Emergency Spillway - ability to demonstrate conformance with design standards and criteria (will it provide a valid contingency in an extreme event)	TSF Design Report
TSF030	Relatively robust operation of downstream vs upstream lifting - determination in design and what can flow from that	TSF Design Report
TSF031	Ability to intercept seepage at a secondary and tertiary level	TSF Design Report Ground Water
TSF032	Emergency action plan - warning systems and spill response capability	TSF Design Report
TSF033	Wildlife - preservation and protection of terrestrial and avian fauna	Biodiversity TSF Design Report Geochem Air Quality
TSF034	Clean water diversions around dam - capacity and design	Surface Water Closure Planning
TSF035	Wall design Factor of Safety (to meet or exceed standards)	TSF Design Report
TSF036	Understanding of management commitments to operational challenges (having Trigger Action Response Plans that require ceasing plant operation when detox system is unavailable etc.)	Management plans

Ref	Issue	Comment on Current Controls
TSF037	Inexperienced people in supervisory roles - not understanding implications of tactical decisions on back shifts	Management plans
TSF038	Applying learning from other TSF history	TSF Design Report
TSF039	Sabotage of dam	Management plans
TSF040	Seismic event	TSF Design Report
TSF041	Pipeline delivery failure, release and detection	TSF Design Report Management plans
TSF042	Return pipeline failure, release and detection	TSF Design Report Management plans
TSF043	Operator health and safety (width of crests to meet mobile equipment requirements, life saving/rescue for persons falling into dam)	TSF Design Report Management plans
TSF044	Public health and safety - inadvertent access to the dam by third parties	TSF Design Report Management plans
TSF045	Exposure to tailings - are there acute or long term impacts related to worker/community health	Management plans Processing, metallurgy, geochemistry
TSF046	Size and scale of dam - potential threat levels (is there a relationship between dam size and failure frequency)	TSF Design Report
TSF047	Impacts on natural springs and their downstream users	Ground water Surface water TSF Design Report Geochemistry
TSF048	Impact of dam on catchment and downstream water run-off	Ground water Surface water TSF Design Report Geochemistry
TSF049	Deliverability challenges - TSF not constructed in time to meet project requirements	DFS Execution studies TSF Design Report QA/QC in management plans
TSF050	Conformance with Australian Government Tailings Management Leading Practice Sustainable Management Guideline	TSF Design Report TSF Risk Analysis
TSF051	Options assessment (reviewing Drew's work)	TSF Design Report
TSF052	Geochem discussion - Questions about element levels. Controls will be seepage capture and return.	TSF Design Report to describe the length of time to drain for an encapsulated TSF. Noted that the pipeline failure issues will cover the return flows of contaminants from the downslope pond.
TSF053	Complication related to the under-floor drainage of the dam	TSF Design Report

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