

# 7 Risk assessment and management



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Cover photograph: Collecting Quinine Bush (Petalogstigma quadriloculare) seeds



# GLOSSARY

Below are key terms that are used in this section.

Key term	Definition
As Low As Reasonably Achievable	Abbreviated to ALARA. As low as reasonably achievable, economic and social factors being taken into account.
Risk	The chance of something happening that will have an impact on objectives.
	NOTE 1: A risk is often specified in terms of an event or circumstance and the consequences that may flow from it.
	NOTE 2: Risk is measured in terms of a combination of the consequences of an event and their likelihood.
	NOTE 3: Risk can be a threat or an opportunity, but only threats or potential risk events are addressed in the MCP.
Risk Analysis	Systematic process to understand the nature of and to deduce the level of risk.
	NOTE 1: Provides the basis for risk evaluation and decisions about risk treatment.
Risk Assessment	The overall process of Risk Identification, Risk Analysis and Risk Evaluation and shall be retained in accordance with procedure.
Risk Control	The process of elimination or minimisation of risks.
Risk Evaluation	The process used to determine risk management priorities by comparing the level of risk against predetermined standards, target risk levels or other criteria.
Risk Management Process	The systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, analysing, assessing, controlling and monitoring risk.
Risk Priority Class	One of four categories where a hazard can be located on the ERA Ranger Risk Matrix – from CRITICAL to HIGH to MODERATE to LOW.
Risk Ranking	The level of risk allocated to a non-conformance if a corrective or preventative action is not carried out. The 5 x 5 Consequence/Probability model.
Risk Register	A register of risk information and controls kept at ERA, categorized into functional areas.



### ABBREVIATIONS & ACRONYMS

Below are abbreviations and acronyms that are used in this section.

Abbreviation/ Acronym	Description
ALARA	As Low As Reasonably Achievable
BPT	Best Practicable Technology
ER(s)	Environmental Requirements
ERA	Energy Resources of Australia Ltd
FS	Feasibility Study
HSE	Health Safety and Environment
HSEC	Health, Safety, Environment and Communities
IPCC	Intergovernmental Panel on Climate Change
ITWC	Interim Tailings water and closure
KKN	Key Knowledge Needs
MCP	Mine Closure Plan
mRL	Meters Relative Level
MOL	Maximum Operating Level
PFS	Prefeasibility Study
RBS	Risk Breakdown Structure
RP2	Retention Pond 2 – also denotes other retention ponds used on site – e.g. RP1, RP3, RP6
RPA	Ranger Project Area
RWD	Ranger Water Dam
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation



# 7 RISK ASSESSMENT AND MANAGEMENT

Risk assessment and management is a central element of the Energy Resources of Australia Ltd (ERA) business framework and is undertaken in accordance with the internal Hazard Identification and Risk Management Standard (ERS003) and ERA Closure Risk Management Plan (ERA, 2020). The Ranger Mine Closure Risk Management Plan applies a holistic suite of risk management techniques across all risk areas including strategic, technical, commercial, safety and environmental and establishes a framework for:

- Risk identification;
- Risk evaluation; and
- Risk treatment (actions).

The objectives of risk management are to improve execution and reduce risk exposure. To achieve these objectives, ERA has implemented a transparent, proactive, structured, and consistent process that provides a clear indication of the most significant risks and mitigating actions.

ERA also engages in a consultative process with key stakeholders to ensure there is transparency and that due consideration is given to the identification of closure threats, existing controls, and planned actions to address risks. Successful management of risks requires the implementation of a clear risk management strategy supported by adequate resources and a strong risk-aware culture. The Ranger Mine closure risk management strategy emphasises the development of purpose-specific, risk-based plans at various stages within the major project delivery functions, all within the context of a risk-based project plan that is integrated with and supported by the Health and Safety Quality and Environmental systems. This involves maintaining an up-to-date risk register that is regularly consulted and reviewed.

To support risk management during closure execution, specific risk management accountabilities and responsibilities are assigned to relevant project and support personnel. Additionally, the closure management team is responsible for ensuring that the management plans are implemented, and resources are made available when required.

Since 2008, ERA has held regular risk assessment workshops to identify key risks relating to the closure of the Ranger Mine. A workshop was held in August 2016 to identify specific closure environmental risks in relation to Best Practicable Technology assessments. This was followed by several assessments undertaken as part of the Ranger closure feasibility study during 2018, with the outcomes presented in the 2018 Mine Closure Plan (MCP). In 2019, following the completion of another closure risk review and release of the 2018 MCP, the risk register was updated to incorporate the comments received from stakeholders. The closure risk register continues to be regularly reviewed and updated. Another detailed review of the closure environmental risks is planned for 2023.

The current closure environmental risk register is provided in Appendix 7.1. For each identified risk event, Appendix 7.1 lists the causes, consequences, existing controls, effectiveness of controls, rationale for this effectiveness rating, how the risk is trending, the risk



class/classification, planned actions and the date the particular risk event was last reviewed and updated.

## 7.1 Standards and requirements

ERA developed the Hazard Identification and Risk Management Standard (ERS003) to ensure that all hazards and opportunities for a particular project are identified, assessed and strategies are developed to manage risks (ERA, 2018). The standard is integrated within element three of the ERA Health, Safety and Environmental Management System, which has been certified to meet the requirements of the AS/NZ ISO14001:2015 and AS4801 national standards (AS4801 has been superseded by AS45001 and ERA will be moving to AS45001 in late 2022). The basic AS/NZS ISO 31000 process as illustrated in Figure 7-1 forms the procedural framework for the management of risks at the Ranger Mine.



Figure 7-1: ISO 31000 Risk Management Process

The management process applied to risk assessments at the Ranger Mine is consistent with the following national and corporate management standards:

 AS/NZS ISO 14001 Environmental management systems – specification with guidance for use;



- AS48012 Occupational health and safety (OHS) management systems specification with guidance for use;
- AS ISO 31000:2018 Risk Management– Principles and guidelines;
- Environmental risk management Principles and processes (HB 203:2012);
- Rio Tinto Risk Policy and Risk Management Standard (Rio Tinto, 2019) Rio Tinto Health, Safety and Environment (HSE) management system – Element 3 hazard identification and risk assessment; and
- Rio Tinto HSE performance standards.

In addition, ERA is required to comply with the Commonwealth Environmental Requirements (ERs), set out in the Ranger Authorisation 0108-18 (the Authorisation), to minimise risk through the implementation of effective controls that enable:

- the protection of attributes for which the Kakadu National Park was inscribed on the World Heritage list;
- protection of ecosystem health of wetlands listed under Ramsar Convention on Wetlands;
- protection of health of the members of the regional community; and
- maintenance of the nature and biological diversity of aquatic and terrestrial ecosystems of the Alligator Rivers Region, including ecological processes.

### 7.2 Previous closure risk assessments

ERA has used the risk assessment process to identify potential environmental closure risks through several risk assessments completed to date.

The outcome of past and recent risk assessments and modelling studies inform the assessment, along with sources, pathways and receptors as discussed previously with stakeholders (Bartolo *et al.* 2013). This fundamental approach that was used in 2013, of identifying and assessing risks based on sources, pathways and receptors, will be undertaken again in 2023.

A review of the respective risk assessments was completed in 2019 with an objective of incorporating relevant risks from these earlier registers into an updated register to reflect the current status of the Ranger Mine closure strategy. Since this time, the resulting register continues to be reviewed and update to ensure currency. Section 7.3.7 discusses the timings and triggers for these regular reviews. The following provides a summary of the more specific risk assessments and reviews that have been undertaken:

• Pit 1 Interim Tailings, Water and Closure (ITWC) Prefeasibility study (PFS) risk register, 2008: The purpose of this risk analysis was to identify and evaluate threats and opportunities associated with the options considered for Pit 1 closure to PFS level. The output of this risk analysis helped determine the appropriate closure method to be advanced to feasibility level.



- ITWC PFS risk register, 2011: The purpose of this risk analysis was to identify and evaluate threats and opportunities associated with all aspects of closure across a 14-year schedule (2012 to 2026) and 10,000-year tailings containment period.
- Tailings transfer risk register, 2012: The purpose of this risk analysis was to identify and evaluate threats and opportunities associated with elements of the tailings transfer process from the Ranger Water Dam (RWD) to Pit 3, including dredging, Pit 3 pumping system, power requirements and procurement.
- PFS brine injection prefeasibility operational risk register, 2012: The purpose of this risk analysis was to identify and evaluate the risks associated with the brine injection aspect of the Ranger Mine closure project.
- Feasibility study (FS) tailings and brine management closure risk register, 2013: The purpose of this risk analysis was to identify and evaluate the risks associated with the tailings and brine management aspect of the Ranger Mine closure project. Elements assessed during this risk assessment included brine injection, tailings transfer and implications for both Pit 3 and the tailings dam during the activity, dredging, Pit 3 pumping system and operational readiness.
- Ranger Mine Pit 1 closure risk environmental register, 2016: The purpose of this risk analysis was to identify and evaluate the consequences and significance of the opportunities and threats on the surrounding environment, associated with the closure of Pit 1, and the final average tailings deposition in the pit to a level of 7 mRL.
- Ranger MCP risk assessment, 2016: this risk assessment was presented in the 2018 MCP and at the time incorporated all other risk assessments undertaken over the life of the Ranger Mine. As part of the scoping, the Best Practicable Technology (BPT) options were considered in the risk assessment.
- Ranger Closure Feasibility Study, 2018: This risk assessment rolled all previous closure risk assessments up into a single register that is now hosted on the Rio Tinto risk platform 'Archer'. This risk register is actively reviewed and managed as part of the Ranger Closure Project.
- Ranger Closure Risk Review, 2019: This risk review was completed to address the comments received on the risk identified and included within the 2018 MCP.
- Social Risk Review, 2020: This risk review was completed to address the threats or opportunities that may result from how the business/project impacts upon and interacts with communities and stakeholders.
- Annual Ranger Closure Risk Review, 2020; this risk review was completed to challenge the risk profile and provide confidence that the most material risks to achieving the strategic objectives and targets are understood. The risk threshold is reviewed against the business's objectives and targets, the risk profile is challenged due to external or internal influences/decisions, the control effectiveness is reviewed based on assurance outcomes and implemented actions, new risks are captured and existing risks are closed or tolerated.



- Ranger Closure Quarterly Risk Reviews: The purpose of these risk reviews is to ensure that the information remains current, including risk trend update, control effectiveness, overall control effectiveness, action status and overall action status.
- Multiple ad hoc reviews: Determined by business need, risk owner or other with the aim to ensure that information is current and material risks are being actively managed, meaning new risks can be identified or existing risks reviewed.
- Annual Ranger Closure Risk Review, 2021; the annual process mentioned above for 2020 was repeated in 2021.
- Operations and closure risk review, 2021. This risk review was completed to address the changes to the operational health, safety, environment and communities (HSEC) risk profile due to the cessation of operations.
- Pit 3 Capping and Backfill, 2022. The aim of which was to identify risks (including design and implementation) which have the potential to impact the achievement of the Pit 3 Capping and Backfill objectives. These were then reviewed against the project portfolio to ensure material risks to project are being monitored at the right level in the business and risks have been incorporated into the risk register provided in Appendix 7.1 of this MCP.

### 7.3 ERA closure risk assessment methodology

All closure risk assessments have been facilitated by competent personnel, involved a range of technical and subject matter experts, and followed the standard processes described above. The key elements of this methodology are:

- setting the context and scope for the assessment;
- identifying key objectives and assumptions;
- setting risk acceptances and thresholds;
- identifying key stakeholders and participants;
- generating a list of applicable risk scenarios (threats) and consequences based on potential risk exposure pathways between identified hazards (causes/triggers) and receptors (i.e. person or environment);
- identifying the existing control measures available to mitigate each threat and the control effectiveness (rating);
- evaluating the risk likelihood and maximum reasonable consequence for each threat using the descriptors included within the Rio Tinto HSEC 5 x 5 risk determination matrix to establish an overall risk class, which can range from Class I (Low) to Critical IV (Critical);
- identifying additional control measures for significant threats rated as either Class III (High) or Class IV (Critical) to ensure the residual risk rating is as low as reasonably achievable (ALARA);



- recording outcomes within the ERA closure risk register to ensure active management is maintained during implementation and execution;
- developing action plans as required to support the implementation of effective control measure and assign accountabilities;
- communicating risk information; and
- reviewing and updating risk events, controls and action status.

Further detail relating to each of these elements is provided within the following sub-sections. The closure risk assessment will continue to be reviewed and updated following further internal or external workshops and as material changes to the planned closure activities are required. Therefore, the closure risk portfolio is an evolving tool that is integrated into daily planning and operations. The outcomes of the ERA closure risk assessment will continue to be used for evaluating priorities and management strategies throughout the closure process.

### 7.3.1 Purpose and scope

The purpose of the ERA closure risk assessment is to identify threats and consequences associated with mine closure activities and evaluate the significance of the potential threats to the environment on and surrounding the Ranger Project Area (RPA). The risk assessment considered the threats that may occur during the closure (decommissioning, rehabilitation, early monitoring) and monitoring and maintenance phases.

Closure commenced at the scheduled completion of processing in January 2021. Closure includes decommissioning, the general works associated with rehabilitating the site to an agreed standard of environmental protection and the re-contouring and revegetation of the final landform.

The monitoring and maintenance phase is the period post-decommissioning where active works have generally ceased and the progression towards the development of a long-term viable ecosystem and meeting closure criteria has commenced. This phase may require initial management as landform settling, subsidence and erosion occur, and vegetation establishes. Passive water management techniques may be implemented where required.

### 7.3.2 Assumptions

The following assumptions were made in undertaking the closure risk assessment:

- technical advice, generated from both internal and external sources (e.g. contractors, consultants, associates, government agencies and research partners), was assumed to be appropriate;
- existing ERA controls will continue to be applied where applicable; and
- all standard ERA risk controls will be applied.



### 7.3.3 Risk Management Tool

Mine Closure risks are managed using the RSA Archer Integrated Risk Platform. This tool provides the project and the business with a consolidated and clear view of risks, including version and history tracking and unique identification of risks and their components for future tracking purposes.

### 7.3.4 Risk Identification

The aim of risk identification is to generate a comprehensive list of credible risk events related to mine closure based on planned closure activities. Beyond the routine risk reviews and updates discussed in **Section 7.3.7**, material changes to planned activities (e.g. directional drilling from the wall of Pit 3 for brine disposal) trigger a review and update of relevant risks.

### 7.3.5 Risk Relationships

All risks have a Risk Breakdown Structure (RBS) element assigned within the risk database at the time of evaluation. The RBS element aligns the risks with the high-level project work breakdown structure, which assists in categorising the risks for the various project reporting needs. A standard risk numbering convention is also assigned that allows for tracking and identification of similarly themed risks.

### 7.3.6 Risk Evaluation

ERA has established an extensive suite of environmental management controls, processes and standards that have been implemented during operations and remain applicable during closure. Existing controls are taken into account when determining the risk ranking, thus the 'residual' rather than the 'inherent' (baseline or un-mitigated) risk is used in the risk ranking (as per ISO 31000). Control effectiveness is also assessed as an indicator of successful risk mitigation and provides a prompt for additional controls to be considered.

A 5 x 5 risk matrix (Table 7-1) is used to determine the overarching risk classification for each identified risk event. The risk classification is a function of the consequence and likelihood ratings determined in accordance with AS ISO 31000:2018 and ERA Standard: HSEC Hazard Identification and Risk Management. The overarching risk classification is determined to be either; Class I (Low), Class II (Moderate), Class III (High) or Class IV (Critical).

The risk classification identifies the level of management action that must be taken to mitigate the risk (Table 7-2). A risk that results in Class III or Class IV is a material risk that requires active management and consideration of additional control measures.



#### Table 7-1: Risk Class Determination

Likelihood	Consequence Severity						
Likelinoou	Very low	Low	Moderate	High	Very high		
Almost certain	Class II	Class III	Class IV	Class IV	Class IV		
Likely	Class II	Class III	Class III	Class IV	Class IV		
Possible	Class I	Class II	Class III	Class IV	Class IV		
Unlikely	Class I	Class I	Class II	Class III	Class IV		
Rare	Class I	Class I	Class II	Class III	Class III		

#### Table 7-2: Risk management response

Risk Class	Response
Class I	Risks that are below the risk acceptance threshold and do not require active management.
Class II	Risks that lie on the risk acceptance threshold and require active monitoring.
Class III	Risks that exceed the risk acceptance threshold and require proactive management.
Class IV	Risks that significantly exceed the risk acceptance threshold and need urgent and immediate attention.

The criteria for assessing the likelihood rating (Table 7-3) are used to assign a qualitative probability of occurrence that ranges from 'rare' to 'almost certain'.

The consequence rating criteria (Table 7-4) provides a range of qualitative severity ratings that range from 'very low' to 'very high'. The consequence definitions are based on the ERA risk scheme and were customised to align with the particular environmental and cultural aspects of the Ranger Mine.

It is noted that some risks have the 10,000 year timeframe. The lowest likelihood band available under standard business risk processes is <1:100 years which is titled 'Rare'. It is considered not credible to obtain a higher degree of accuracy for even more remote risks. As such for these risks that refer to impacts in 10,000 year the likelihood (frequency) rankings and not used, rather the likelihood (probability) rankings are used. It should also be noted that the environmental impacts from these risks are assessed using modelling techniques that incorporate uncertainty analysis, to provide a higher degree of confidence.



#### Table 7-3: Likelihood qualitative criteria

		Likelihood				
	Rare	Unlikely	Possible	Likely	Almost certain	
Frequency interval (multiple events)	Less than once per 100 years	Once in ten to once in 100 years	Once per year to once in ten years	Twice per year to once per year	More than twice per year	
Probability (single events)	<5 %	5–20 %	20–50 %	50–75 %	>75 %	

A control effectiveness rating is determined for each risk event to evaluate whether they will sufficiently mitigate the risk (Table 7-5). If the controls for any given threat/risk event are rated as either C3 (Marginal) or C4 (Weak) then further assessment is required to determine feasible controls.



### Table 7-4: Consequence qualitative criteria

	Consequen			e		
Consequence Type	Very Low	Low	Moderate	High	Very High	
Licence to Operate / Stakeholders	2 - Informal disapproval from local stakeholders.	3 - Stakeholder actions resulting in days of operational impacts.	4 - Stakeholder actions resulting in weeks of operational impacts. Local reputation damage.	5 - Stakeholder actions resulting in months of operational impacts. National reputation damage.	6 - Stakeholder actions resulting in years of operational impacts. International reputation damage.	
Health & Safety	2 - Low level short term inconvenience or symptoms. Typically a first aid case.	3 - Injury or illness requiring medical treatment, that does not lead to restricted duties or lost time.	4 - Injury / illness with moderate damage or impairment to one or more persons.	5 - Single fatality or severe permanent impairment	6 - Multiple fatalities or severe permanent impairment to multiple people.	
Environment	2 - Harm to the environment that is localized, and is quickly and easily rectified.	3 - Harm that is localized, and is rectified or reversed within a few days to weeks.	4 - Harm that is largely localized but starts to be unconfined, rectified within weeks to months.	5 - Harm that is unconfined, and is rectified or reversed within months to years	6 - Widespread environmental harm that is rectified or reversed within several years to decades.	
Radiation (employees, contractors or public)	2 - Measurable increase in radiation dose with outcomes remaining below dose constraints.	3 - Increase in radiation dose above the dose constraints but still below international limits.	4 - Increase in radiation dose to above international limits.	5 - Radiation doses above 100 mSv to an individual and likely to significantly increase the risk of cancer to that individual.	6 - Radiation doses to multiple individuals above 100 mSv or acute radiation syndrome to an individual.	



		Consequence					
Consequence Type	Very Low	Low	Moderate	High	Very High		
Communities & Social Performance	2 - Short term loss of trust with communities. Damage to cultural heritage of low significance.	3 - Loss of trust with communities taking weeks to resolve. Non-disruptive organised opposition.	4 - Loss of trust with communities that cannot be resolved through routine procedures.	5 - Widespread, sustained opposition from communities.	6 - Systemic opposition from communities that impacts community trust at other Rio Tinto assets.		
Legal & Regulatory Compliance	2 - Non-compliance with agreements or laws that can be resolved via informal discussion or direct engagement.	3 - Breaches of agreements or laws resulting in formal notices or written warnings.	4 - Breaches of agreements or laws resulting in low-level fines or payments.	5 - Breaches of agreements or laws or legal action resulting in fines, settlements or payments that are material at the Site level, or short term suspension of operations.	6 - Breaches of agreements or laws or legal action resulting in fines, settlements or payments that are material at the Business Unit level, long term suspension of operations or sanctions against responsible managers.		
Closure and Legacy Management	2 - Changes to closure scope which have limited impact.	3 - Changes to scope with a noticeable increase in complexity and/or degree of difficulty of closure.	4 - Change to scope with a moderate increase in complexity and/or degree of difficulty of closure.	5 - Changes to scope with a significant increase in complexity and/or degree of difficulty of closure.	6 - Material changes to scope with a major increase in complexity and/or degree of difficulty of closure.		
Schedule (Time)	3–6 weeks	6 weeks-3 months	3–6 months	6–12 months	1–2 years		



Control Rank	Description	Guidance
C1	Good	Substantially effective/adequate design Controls are considered adequately designed <b>and</b> are operating effectively on almost all occasions.
C2	Satisfactory	Mostly effective/adequate design. Controls are considered adequately designed <u>and</u> are operating effectively on most occasions.
C3	Marginal	Inadequate design/partially effective. Controls are considered inadequately designed <u>or</u> are only operating to partial effectiveness on most occasions.
C4	Weak	No controls/ineffective. There are no controls designed <u>or</u> the existing controls are operating ineffectively on all occasions.

#### Table 7-5: Control and Overall Control Effectiveness

Further to this, the Ranger Mine Closure portfolio captures 'Overall Control' effectiveness and 'Overall Action Status' as an indicator of the overall health of the mine closure risk portfolio.

### 7.3.7 Communication and Consultation

All closure project personnel are actively encouraged to identify and discuss potential risks as a normal part of daily work, regardless of their role. The full closure risk portfolio is available to all project personnel through the internal ERA intranet, promoting project team members to actively incorporate risk management into their daily discussions and promotes continual review of risks as a part of normal project activities.

Communication is also supported by a formal project risk reporting process, as outlined in Figure 7-2. Beyond the routine risk reviews and updates shown in Figure 7-2, material changes to planned activities (e.g. directional drilling from the wall of Pit 3 for brine disposal) trigger a review and update of relevant risks.





#### Figure 7-2: Risk Reporting Structure

Consultation on risk related matters occurs regularly through the following channels:

- Monthly notifications are sent to action owners on overdue actions, regular reminders are sent to risk and action owners to ensure data is complete and current.
- Fortnightly risk meetings are conducted to review and report on risk movement, review overdue actions, discuss trending, capture emerging risk and highlight concerns.
- Quarterly reviews are conducted with the aim to ensure that the information remains current, including risk trend update, control effectiveness, overall control effectiveness, action status and overall action status.
- Annual reviews are conducted with the aim to challenge the risk profile and provide confidence the most material risks to achieving the strategic objectives and targets are understood. The risk threshold is reviewed against the business' objectives and targets, the risk profile is challenged due to external or internal influences/decisions, the control effectiveness is reviewed based on assurance outcomes and implemented actions, new risks are captured and existing risks are closed or tolerated.
- Ad hoc workshops are determined by business need, risk owner or other with the aim to ensure that information is current and material risks are being actively managed, meaning new risks can be identified or existing risks are reviewed. These ad hoc workshops may be triggered by material changes to planned closure activities.
- A monthly summary of material risk is provided in the Closure Steering Committee for further monitoring and action, as necessary.



- A monthly reporting on the overall status and health of the risk register.
- Bi-annual risk portfolio health checks are undertaken (i.e. missing fields, querying data and providing overall summary).

### 7.4 Current risk profile

There are 45 environmental and technical risks related to mine closure at the time of writing this 2022 MCP.

The risks within each class are listed below, with additional information provided for the Class IV (Critical) risks: including causes, consequences, existing controls, control effectiveness, how the risk has been trending over time, and when the risk was last updated. This information is provided for all risk events within Appendix 7.1.

The number of risk events per class are:

- 5 Class IV (Critical) risks;
- 21 Class III (High) risks;
- 14 Class II (Moderate) risks; and
- 5 Class I (Low) risks.

### 7.4.1 Class IV (Critical) risks

There are five (5) Class IV (Critical) risks in the current risk register (see Appendix 7.1 for details). These are:

- Extraction of process water from Pit 3 takes longer than planned (ID No. 797894):
  - there are numerous potential causes for this risk event including: longer than modelled tailings consolidation, poor installation/performance of wick drains and/or under drain pump, delay in backfilling Pit 3, and inability to validate the modelling to stakeholder acceptance;
  - the consequences relate largely to additional cost and time for process water treatment;
  - the existing controls relate to specialist consultants being engaged to undertake the modelling and for this modelling to be independently reviewed;
  - the control effectiveness is rated 'Satisfactory' and the risk trend is 'Stable';
  - the risk was last updated on 7 July 2022.
- Failure to contain and/or eradicate Spigelia weed from the operations area causing infestation in Kakadu National Park (ID No. 597589):
  - potential causes for this risk event revolve largely around insufficient controls being implemented for vehicle hygiene (e.g. wash downs) and insufficient monitoring;



- the consequences relate to the environmental and biodiversity impacts in the surrounding Kakadu National Park, and reputational and cost impacts to ERA;
- the existing controls relate to clear vehicle hygiene procedures in place and successfully implemented, and dedicated resources managing the monitoring and treatment of the weed;
- the control effectiveness is rated 'Marginal' and the risk trend is 'Decreasing';
- the risk was last updated on 8 March 2022.
- Inadequate pond water storage availability (ID No. 597532):
  - potential causes for this risk event relate to extreme rainfall events, premature closure or management of water storage ponds;
  - the consequences relate to the unauthorised release of water to the environment, delay in closure activities due to flooding, reputational and cost impacts to ERA;
  - the existing controls relate to sound planning for water storages and the contingency plan to construct retention pond 7;
  - the control effectiveness is rated 'Marginal' and the risk trend is 'Stable';
  - the risk was last updated on 8 March 2022.
- Unable to inject brine into the Pit 3 underfill (ID No. 504876):
  - there are numerous potential causes for this risk event but they materially relate to blocked injection wells, and brine not filling the void spaces as expected;
  - the consequences relate to the need for additional injection wells, temporary storage of brine in RWD prior to injection increasing the total dissolved solids load in process water resulting in increased cost of treatment, increased cost and schedule;
  - the existing controls relate to the use of proven technologies by experienced practitioners in the form of directional drilling, the ability to access and clean-out injection wells drilled from the Pit 3 wall, and modelling of the underfill voids;
  - the control effectiveness is rated 'Marginal' and the risk trend is 'Stable';
  - the risk was last updated on 8 March 2022.
- Rainfall is greater than planned in the Water Model (P50) increasing the process water inventory to manage/treat, leading to later completion of process water treatment than planned (ID No. 504166):
  - potential causes for this risk event are extreme one-off rainfall events, particularly towards the later stages of closure;
  - the consequences relate to the need for additional storage and treatment of process water, increased cost and schedule;



- the existing controls relate to sensitivity analysis included in the modelling and planning, sound planning for water storages and the contingency plan to construct retention pond 7;
- the control effectiveness is rated 'Satisfactory' and the risk trend is 'Stable';
- the risk was last updated on 8 March 2022.

### 7.4.2 Class III (High) risks

There are twenty-one (21) Class III (High) risks in the current risk register (see Appendix 7.1 for details). These are:

- Damage occurs to cultural heritage site during rehabilitation works;
- Perception amongst local community of downstream contamination from Ranger closure impacting ability to engage in traditional activities;
- Over time, climate change causes a significant shift to the expected environmental baseline of the RPA restricting ERA in meeting its environmental requirements;
- Large scale fire or natural disaster (e.g. cyclone) destroys immature vegetation;
- Planned active process water treatment tactics (i.e. plant capacity) do not meet the assumed productivities modelled for site inventory reduction;
- Solutes and sediments from surface runoff from final rehabilitated site enters off-site water bodies at greater than closure criteria;
- Groundwater solute transport outcomes are not as expected;
- Inaccuracies or simplifications in the water model, excluding rainfall and water treatment rates (managed in other risks), leads to inadequate water treatment tactics;
- Process water exceeds MOL in Pit 3;
- Tailings consolidation is slower than expected;
- Slope failure in Pit 3 or stockpiles;
- Tailings Storage Facility wall breached during deconstruction works or while still in use;
- Elevated levels of contaminants (metals) in bush tucker;
- Unplanned contaminated materials found on RPA;
- Requirement for more extensive remediation / removal of contaminated plumes than planned;
- Insufficient volume or quality of trees from nursery for revegetation;
- Insufficient volume or quality of viable seed stock available for whole of site revegetation;
- Excessive erosion impacts landform stability and revegetation success;
- Uncertain terms of access to RPA from 9th January 2026, including Traditional Owner Access to significant areas;



- Closure of Ranger Mine impacts on local economics causing reputational damage; and
- Site condition does not meet Stakeholder expectations resulting in rework.

### 7.4.3 Class II (Moderate) risks

There are sixteen (16) Class II (Moderate) risks in the current risk register (see Appendix 7.1 for details). These are:

- Direct and indirect impact to cultural heritage sites during post closure especially if signage/demarcation is decommissioned;
- Unable to extract expressed tailings pore water;
- Larger scale failure of the capping surface;
- Localised failure of the geotextile or capping surface;
- Erosion and gully formation across landform surface exposes contained tailings;
- Insufficient infrastructure and capability to manage offsite discharge of release water;
- Dust from rehabilitation works enters environment;
- Total above baseline radiation dose to plants and animals exceed UNSCEAR values;
- Radiation doses from the final landform exceeds dose constraint and annual dosage limit to the public, post closure;
- Sediment from surface water from rehabilitated landform impacts billabongs resulting in the need for subsequent remediation;
- Major native fauna does not return to landform;
- Feral (introduced) animals occur at higher densities than in surrounding Kakadu National Park;
- Low plant survival rates in the field during establishment and vegetation decline after/at establishment;
- Failure to consider closure impacts on downstream customers, hauliers or other communities.

### 7.4.4 Class I (Low) risks

There are five (5) Class I (Low) risks in the current risk register (see Appendix 7.1 for details). These are:

- Remnant mineralized material discovered in stockpiles after Pit 3 bulk backfill completed;
- Spillage of hazardous material during rehabilitation works in Pit 3;
- Loss of process water containment during Pit 3 activities;
- Disposal location for contaminated material not available following backfill of Pit 3;
- Increased aquatic weed establishment in RPA billabongs impacts Kakadu National Park.



### 7.5 Risk management

Considerable attention and work have been placed on the identification and management of closure risks for the Ranger Mine since 2008. ERA acknowledges that this work is not complete. It is continuing and subject to ongoing reviews and updates as more information becomes available from the KKN studies and from monitoring activities. ERA also plan to undertake another significant review of the environmental risks (including controls, planned activities and contingency measures) in 2023.

With specific regard to risk management, the current risk register provided in Appendix 7.1 shows that for the 45 risks:

- 351 existing controls are in place;
- the effectiveness of the control currently in place is identified for one (1) risk as 'weak', twelve (12) risks as 'marginal', nineteen (19) risks as 'satisfactory', ten (10) risks as 'good', and three (3) risks are currently unrated;
- two (2) risks have an 'increasing' risk trend (i.e. have worsened), thirty-nine (39) risks have a 'stable' trend (i.e. have not worsened or improved), and four (4) risks has a 'decreasing' trend (i.e. have improved);
- with regards to those risk events that are in a class that requires further management action (i.e. Class IV and Class III risks):
  - o for the five (5) Class IV risks, 9 actions are currently being implemented;
  - o for the twenty-one (21) Class III risks, 65 actions are currently being implemented.



#### REFERENCES

- Bartolo, R, Parker, S, van Dam, R, Bollhöfer, A, Kai-Nielsen, K, Erskine, W, Humphrey, C & Jones, D 2013. *Conceptual models of stressor pathways for the operational phase of Ranger Uranium Mine.* Supervising Scientist, Darwin, January.
- Energy Resources of Australia Ltd (ERA) 2018. *HSEC Hazard Identification and Risk Management. ERA Standard ERS003.* Energy Resources of Australia Ltd, 12 July 2018.
- Energy Resources of Australia (ERA), 2020. *Ranger Closure: Risk Management Plan.* Energy Resources of Australia Ltd, Darwin, Doc ID CDM.03-0000-MR-PLN-00001, 11 September 2020.

Rio Tinto 2019. Risk Management Standard. RIS-B-001

2022 RANGER MINE CLOSURE PLAN



# APPENDIX 7.1: RANGER CLOSURE RISK ASSESSMENT

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
<u>797894</u>	Extraction of process water from pit 3 takes longer than planned	Tailings consolidation takes longer than modelled. dr>Poor installation of wick drains. Poor performance of under drain pump. 	Increased cost from additional process water treatment through the BC. kRequirement for another process water treatment process to treat water post-BC. 	Assurance of consolidation model being completed by stakeholders (2 independent reviews). [504190] Continued stakeholder engagement via ongoing presentations to stakeholders through MTC and RCCF. [1083233] CPT Testing to inform consolidation model and wick design. [504194] Ongoing monitoring and modelling of tailings during deposition phase. [602110] Pit 1 actual consolidation rates known and model adjusted to suit; ongoing monitoring. [504193] Pit 3 design is based on the learning of Pit 1. [602105] Placement of bulk backfill will be undertaken to lead to timely completion of consolidation. [602107] Prefabricated vertical drains (wicks) installed to maximise consolidation. [602106]	Satisfactory	Majority of controls are good but risk still critical, more actions and controls may be required. Actions will be revisited when Pit 3 capping works commence.	Stable	Class IV	Monitoring the success of existing decant towers, pumping systems, and the number and distribution of the settlement towers, which may also be equipped with pumps. Beyond the use of the settlement towers, risk contingency is installation of additional extraction and/or monitoring bores, following completion of capping and backfill works.	7/07/2022
<u>597589</u>	Failure to contain and/or eradicate Spigelia weed from the operations area causing infestation in Kakadu National Park	Weed has spread without ERA detection. <br /&gt;Insufficient monitoring of area surrounding operational area. Insufficient controls in place around vehicle hygiene. Insufficient staff knowledge of weed / transmittance of weed.</br></br 	Potential to impact close out certificate. br/>Weed may be listed as a declared weed species, creating an increased obligation to manage. br/>lmpacts ERA's ability to demonstrate ability to manage rehabilitation. br />Loss of containment of the Spigelia weed to the operational area. br/>Senvironmental and biodiversity impacts in surrounding areas. br/>Peradication/ remediation of Spigelia detracts from other BAU tasks (i.e. other weeds).	Clear procedures around vehicle hygiene (e.g. washdowns) Dedicated resources to manage treatment [616678] External Stakeholder monitoring, managing and regular consultation [616681] Mini ipads for weed monitoring [936385] Monthly reporting to weeds Branch of Gov [597593] Polaris ATV used for weed management [607791] Regular monitoring and surveys of Spigela weed [597592] Weed Management Plan [597591] Weed specific training (exclusive to Spigela) [597594]	Marginal	Marginal until we know more from season change and what impact that may have on additional controls.	Decreasing	Class IV	Investigate the opportunity for partial coverage of Spigelia through final landform development.	8/03/2022
<u>597532</u>	Inadequate pond water storage availability.	Rehabilitation of catchment areas without direct release approval.  kop>Removing retention ponds. >belays in civil works. 	(Prior to 2023) RP2 spill into pit 3 converting pond water to process water. Post 2023) RP2 spill into pit 3 delaying back fill (1-2 months, volume dependent). -br>Unauthorized discharge of pond water to environment. 	Continuous monitoring of pond water level and volumes [700068] Developing catchment conversion plan for BMM operations [1047332] OPSIM Water Balance model and forecast. [597533] RWMP001 Ranger Water Management Plan. [700052] Water model validated throughout operations [1047331] Weekly water treatment plant operational coordination meeting [104732]	Marginal	Controls are not fully mitigating the threat until actions are complete.	Stable	Class IV	Develop detailed plan for catchment management (inc. catchment conversion). Develop a water management plan for bulked and final landform construction, and a post closure sediment management plan. Plan and execute wet season preparation activities for 2022-2023 wet season.	8/03/2022
<u>504876</u>	Unable to inject brine into underfill.	Scaling in pipelines associated with wells causes sufficient back pressure to prevent well operating (caused by scale and brine TSS). <pre>  </pre> <pre>  </pre> <pre>comes blocked from detached scale.</pre> <pre>  block.</pre> <pre>Stroked from detached scale.</pre> <pre>  </pre> <pre>  Brine injection pipeline is kinked and stops/slows flow</pre> <pre>or is otherwise damaged.</pre> <pre>  </pre> <pre>stroked from detached scale.</pre> <pre>  </pre> <pre>  Brine injection pipeline is kinked and stops/slows flow</pre> <pre>or is otherwise damaged.</pre> <pre>  </pre> <pre>  </pre> <pre>  </pre> <pre>stroked scale.</pre> <pre>  </pre> <pre>  </pre> <pre>  </pre> <pre>distribution bore or inability to  <pre>reinstate bore.</pre> <pre>  </pre> <pre>  </pre> <pre>  </pre> <pre>distribution bore or inability to  <pre>reinstate bore.</pre> <pre>  </pre> <pre>  </pre> <pre>  </pre> <pre>distribution bore.</pre> <pre>  </pre> <pre> </pre> <pre>  </pre> <pre>  </pre> <pre>  </pre> <pre> <td>Brine recycling leads to increased Total Dissolved Solids (TDS) in process water, causing increased cost of treatment. br&gt;Requirement for additional wells to be drilled. br&gt;Significant additional maintenance costs. br&gt;Additional cost for replacement under-drain pumping infrastructure. br&gt;Significant capital cost associated with contingent brine disposal. br&gt;Extended process water treatment duration (with risk of additional process water from rainfall). brInstallation of additional bores required to replace failed bores. br&gt;Increased cost from alternative salt storage system. brIncreased schedule for alternate salt storage.</br></br></br></br></br></br></br></br></br></br></td><td>Ability to directionally drill additional steel-cased bores, with accessible headworks and positive-displacement pump injection capability. [504877] Ability to directionally drill additional steel-cased bores, with accessible headworks and positive-displacement pump injection capability. [1047292] Additional pipe available on-site to allow faster installation of replacement. [504880] Assurance Plan with production metrics developed. [504878] Conductivity meter on the under-drain water flow. [602390] Contingency plan for blocked well head [936477] Data gathering plan for performance of brine injection. [504882] Delivery lines (to manifold with original system, to headworks with replacement bores) able to be pigged and flushed. [1047291] Full pump replacement held on-site as critical spare. [504881] HDS plant incorporated into water model, removes salt from circuit. [602389] Once Pit 3 capping and backfill is complete, ability to vertically drill additional bores through capping and tailings into underfill [1047293] Pigging strategy. [504883] Underfill engineered with a 20% contingency for brine storage (based on 100% of process water treated via BC) [602387] Underfill volume review of as-built undertaken (Mark Goghill Nov. 2016) and determined contingency of 20% [602388] Water model capable of forecasting TDS. [504879]</td><td>Marginal</td><td>The replacement directionally drilled bores include several features, such as the ability to access the bore headworks for downhole cleaning and descaling, and the ability to deliver fluid to the bore under high pressure, which are expected to improve their lifetime relative to the original bores. A 'marginal' effectiveness of controls is in place because the controls will not ensure that each specific injection well is successful and additional bores are likely.</td><td>Stable</td><td>Class IV</td><td>Brine storage options study. Contingency plan for brine injection system development.</td><td>8/03/2022</td></pre></pre></pre>	Brine recycling leads to increased Total Dissolved Solids (TDS) in process water, causing increased cost of treatment. br>Requirement for additional 	Ability to directionally drill additional steel-cased bores, with accessible headworks and positive-displacement pump injection capability. [504877] Ability to directionally drill additional steel-cased bores, with accessible headworks and positive-displacement pump injection capability. [1047292] Additional pipe available on-site to allow faster installation of replacement. [504880] Assurance Plan with production metrics developed. [504878] Conductivity meter on the under-drain water flow. [602390] Contingency plan for blocked well head [936477] Data gathering plan for performance of brine injection. [504882] Delivery lines (to manifold with original system, to headworks with replacement bores) able to be pigged and flushed. [1047291] Full pump replacement held on-site as critical spare. [504881] HDS plant incorporated into water model, removes salt from circuit. [602389] Once Pit 3 capping and backfill is complete, ability to vertically drill additional bores through capping and tailings into underfill [1047293] Pigging strategy. [504883] Underfill engineered with a 20% contingency for brine storage (based on 100% of process water treated via BC) [602387] Underfill volume review of as-built undertaken (Mark Goghill Nov. 2016) and determined contingency of 20% [602388] Water model capable of forecasting TDS. [504879]	Marginal	The replacement directionally drilled bores include several features, such as the ability to access the bore headworks for downhole cleaning and descaling, and the ability to deliver fluid to the bore under high pressure, which are expected to improve their lifetime relative to the original bores. A 'marginal' effectiveness of controls is in place because the controls will not ensure that each specific injection well is successful and additional bores are likely.	Stable	Class IV	Brine storage options study. Contingency plan for brine injection system development.	8/03/2022

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
<u>504166</u>	Rainfall is greater than planned in the Water Model (P50) increasing the process water inventory to manage/treat leading to later completion of process water treatment than planned.	Rainfall exceeds the P50 as modelled. br />Extreme "one off" rainfall event (particularly later in the closure schedule).	Additional process water treatment increases schedule beyond closure date - cost + legal/regulatory & reputational impacts. <br /&gt;Increased cost from additional process water treatment through the BC.<br /&gt;Increased cost from requirement to implement process water contingency (large scale HDS). br /&gt;Delay in rehabilitating the TSF/RP6 due to need to use for process water storage for longer. br /&gt;High water inventory in 2020-21 prevents TSF being cleaned as process water cannot all fit in Pit 3.</br></br </br 	Industry established tool used (water model) with model assured. [504167] OBS upgrade for process water treatmenmt [936453] Process water volume tracked against water model prediction [602101] Regular Water Model update. [504171] Scenario of extreme weather event late in the closure schedule assessed during feasibility study and included in water management plans. [504174] Water inventory sensitivity to rainfall is well understood via model based on significant data base (>100 years of data). [504168] Water Model uses significant historical data records from local monitoring location. [504169]	Satisfactory	Controls are considered appropriate at this time - as rainfall has not exceeded average in the last two wet seasons.	Stable	Class IV	Complete a concept level study to determine a suitable location and design for RP7, including in TSF options as contingency. Confirm the P50 values that are to be taken into the Feasibility Reforecast.	8/03/2022
<u>936478</u>	Over time, climate change causes a significant shift to the expected environmental baseline of the RPA restricting ERA in meeting its environmental requirements.	Changing climate results in conditions unfavorable for target revegetation speciesbr />Temperature and excessive dry weather affects early survival of revegetationbr />Increase in burning season and severity of firesbr />Increase in weed encroachment from the mine site into KNP as invasive species have a higher competitive advantage in changing climatesbr />Increase in pests or diseases, such as myrtle rust, affecting vegetation on the rehabilitated sitebr />Increase in number and intensity of storms/cyclonesbr />Nutrient cycling changes due to impacts on soil biotabr />Higher temperatures coupled with longer drier periodsbr />Increased evaporation leads to an increase in contaminants washed into onsite and receiving water during the first flushbr />Longer hotter dry periods could dry out billabongs and expose previously unexposed acid sulfate soils (ASS)br />Toxicity of contaminants will increase in higher temperature waterbr />Increased erosion during storm eventsbr />Lack of information and knowledge regarding these subjects.	Selected vegetation communities to become unviable. hr/sDamage to vegetation. hr/shcreased hot fires, leading to increased tree mortality. hrceased long term management and monitoring requirements. hr/shcreased cost associated with rectification works. hr/sDelay in Mine Close Out Certification. hr/sDelayed relinquishment of areas. hr/sDuable to meet Environmental Requirements. hr/sFaunal decline due to fires and tree mortality impacts.	Current groundwater modelling incorporates considerations for climate change [936484] Early understorey growth and survival will be monitored and remediated as required during the management period. [936483] Irrigation strategy creates cyclone resistance (encourage deep root development). [1069939] Landform Evolution Model (LEM) has climate change scenarios and a synthetic rainfall data set for 10,000 years. [1092045] Monitor climate projections and ensure that new information is accounted for when selecting plant species for revegetation. [936482] Monitor performance of revegetation actions and make adjustments as required. [936481] Ongoing liaison with KNP regarding fire, weed and feral animal management strategies [1092052] Ongoing review of climate risk assessment following IPCC updates. [1047337] Revegetation Adaptive Management Plan [1047336] Revegetation strategy designed to meet closure criteria for resilience (e.g. species mix, irrigation, weed monitoring) [1092069] State and Transition model for revegetation [1047335] Weed management plan [1092077] YFM001 Fire Management Plan [1092080]	Weak	There are still unknowns in climate change projections. Controls rely heavily on modelling.	Stable	Class III	Develop agreed scenario for climate change, with Stakeholders, so unknowns or reduced and appropriately considered. Revegetation Adaptive Management Plan to improve Revegetation Management Plan. Review climate risk assessment for Ranger in light of the 2022 IPCC report.	8/03/2022
<u>694650</u>	Elevated levels of contaminants (metals) in bush tucker.	Bioaccumulation of contaminants from surface water/sediments, and/or soils. br />Localised areas of higher uptake coinciding with higher harvesting rates. 	Non-compliance with ER 3.1. Increased uptake of metals.	Alligator Rivers Region Technical Committee (ARRTC) process and key knowledge needs developed. [500616] Bush food consumption restrictions to particular areas of the RPA may apply post closure. [694655] Bush food monitoring program [1047356] Closure criteria working group [507828] Diet confirmed through consultation [1047354] Singular RP1 additional sediments investigation. [988328] Site specific concentrations factors (BRUCE database) [1047355] Site specific research undertaken against identified knowledge gaps. [499956] Stakeholder communication strategy and management e.g. Traditional Owners (TOs), Minesite Technical Committee (MTC), Alligator Rivers Region Advisory Committee (ARRAC), Alligators Rivers Region Technical Committee (ARRAC), technical working groups, community engagement. [693662] Stakeholder engagement. [518282] Water Pathways Risk Assessment to inform additional contamination knowledge gaps [988327]	Marginal	Further work ongoing.	Stable	Class III	Review diet assumptions and concentration factors for manganese - consider peer assessment. Determine an appropriate uranium environmental investigation level (EIL). Undertake additional sediment sampling at RP1 and Coonjimba billabong. Undertake aquatic vegetation investigation as a part of the Bushtucker Investigation & Assessment study. Undertake faunal bushtucker investigation as a part of the Bushtucker Investigation & Assessment study. Undertake flora assessment of on-site fruit as a part of the Bushtucker Investigation & Assessment study.	8/03/2022

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
<u>505863</u>	Damage occurs to cultural heritage site during rehabilitation works.	Vehicle movement in restricted areas. Non- conformance with the land disturbance permit process. Breach to the cultural heritage management system. shor all sites identified. Indirect impact from closure activities 	Breach of NT Heritage Act 2011 and Sacred Sites Act 1989br>Reputation impacted. Cost of remediation. Enssbr>Civil/criminal actionbr>Loss of trust. Solute and sedimentation affects cultural site of significance. Delay in schedule for final landform completion. Enson between the cultural site.	Aboriginal Areas Protection Authority (AAPA) certificate. [505865] Access restricted to sites through signage and / or fencing. [505868] Cultural Heritage Management Plan includes corrective actions for unplanned solute or sediment load at sacred site. [1045954] Cultural Heritage Management system including general induction and heritage induction, mitigation measures, incident process and additional security of sensitive sites [505864] Database of cultural heritage sites. [505867] Land Disturbance Permit system. [505866] Maintain multiple ERA representatives with relationships to specific stakeholders i.e. GAC [696045] Solute transport modelling to understand issue and design controls. [1045956]	Satisfactory	Controls are considered appropriate at this time.	Stable	Class III	Complete all actions from 2019 CH audit. Develop sediment and water quality control plan. Ensure that Feasibility Reforecast reflects the final landform design to address stakeholder recommendations. Land disturbance process to be reviewed against CH requirements and rehabilitation process. Undertake role review for the Cultural Heritage training matrix.	8/03/2022
<u>505718</u>	Slope failure in Pit 3 or stockpiles.	Unknown latent geotechnical conditions. Vehicle enters area of known instability. Rapid drawdown of water. dr>Flood event over walls. Pressurization of existing weakness from 	Engulfment, bogging, or rollover causing vehicle damage and/or injury. Schedule delay during investigation and rectification. Impact to additional works/ critical path.	Bi-annual geotechnical inspection, assessment and review of the slope stability in Pit 3 and stockpiles. [592105] Prism monitoring of Pit 3. [927855] Slope dump management plan updated annually through geotechnical consultant. [505719] Vehicle standards. [505721]	Satisfactory	New plan in place, control improving.	Stable	Class III	Conduct risk assessment for upcoming wicking works. Geotechnical investigation, assessment and review of the slope stability in Pit 3 and stockpiles.	8/03/2022
<u>505249</u>	Insufficient volume or quality of trees from nursery for revegetation.	Higher than expected mortality in the nursery due to disease, fire, theft. br />Under skilled and/or inexperienced propagators. br />Lack of viable 	Delay to revegetation. Unable to get stakeholder acceptance. Reduced in 	20% allowance for infill. [505250] Alternative off site nursery available if required. [602401] CDM.03-0000-NH-PLN-00002 Ranger Closure Revegetation Plan (Final Landform). [694601] Disease control activities in nursery. [505254] Expert propagation knowledge and implementation provided by existing contractor. [602399] Interative allowances for unviable seeds per species is factored into seed collection requirements. [505251] Learnings from Pit 1 will be taken into remaining work - lead time for additional seeds & seedlings. [505256] Management of combustables in nursery area. [505253] Nursery secured. [505252] Planting and propogation trials successfully completed. [505255] Primary nursery (expansion) [829839] Primary nursery (fit for purpose). [693556] Primary nursery constructed on site [602400] Pavagetation bandover checklist [1092063]	Marginal	Margin for error has been addressed, iterative processes continually updating knowledge source.	Stable	Class III	Consider accelerating revegetation packages for LAAs and final landform. Ensure planting requirements are levelled as a part of the Feasibility Reforecast (FR). Incorporate stage 13 results into revegetaton plan. Investigate opportunity to open an offsite nursery within the Kakadu National Park. Consider recommencing the use of the old nursery.	8/03/2022
<u>505238</u>	Large scale fire or natural disaster (e.g. cyclone) destroys immature vegetation.	Wild fires from external sources. Wild fires from ongoing operational management practices. <br /&gt;Lightning strikes. Inadequate weed management. Inadequate response capability. Extreme weather event - flood, wind, drought. Resilience factors are dependent on vegetation type and time (e.g. 5-15 years).</br></br></br></br></br 	Reduction in floristic diversity and density. />Re-sprouting from lignotubers post fire, delays the maturation of the final landform revegetation. br />Increased active management of revegetation. br />Low representation of fauna taxa. br />Increased erosion due to lower revegetation success across landform. br />Potential water quality impact from increased erosion. br />Large scale damage to new vegetation.	Deep rooting of trees [607821] Delayed introduction of high biomass grasses, reduces fire risk. [602392]	Satisfactory	Controls are considered appropriate at this time and studies are continuing to be progressed.	Stable	Class III	Develop weed hygiene package to address prevention and management of weed spread on the RPA. Integration of weed management plan.	8/03/2022
<u>504648</u>	Planned active process water treatment tactics (i.e. plant capacity) do not meet the assumed productivities modelled for site inventory reduction.	BC does not achieve planned production profile. br>Higher TDS impacts BC productivity. Implementation of Brine Squeezer 	Additional process water treatment increases schedule beyond closure date - cost + legal/regulatory & reputational impactsbr-Delay in rehabilitating the TSF/RP6 due to need to use for process wate storage for longer.	BC evaporator vessel scaling issue understood and addressed. [504649] BC fan upgrade completed. [504652] BC operation reached a sustained rate of 115% with no fan upgrade. [504651] BC seed cyclones upgraded. [504650] Regular review and update of the water model [1092057] Brine squeezer being implemented - schedule in Water Model. [504653] Performance guarantees from vendor for BC upgrade. [1093480] Sensitivity analysis on current water model complete. [504658]	Marginal	Further work ongoing.	Stable	Class III	Develop a compendium of past water treatment plans and current status. Develop Brine Concentrator Recovery Execution Plan. Develop/revise Asset Management Plan. Feasibility Reforecast to review planned performance of water treatment tactics. Installation of the Brine Squeezer upgrade.	8/03/2022

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
<u>504641</u>	Process water exceeds Maximum Operating Limit (MOL) in Pit 3.	Very high rainfall event. Additional tailings/material transferred from TSF to Pit 3. Additional tailings from mill. Notching of TSF reduces volume that can be stored in TSF. rorsSeepage of process water from Pit 3 into the environment	Overflow of process water from Pit 3br>Seepage of process water from Pit 3into the environment. Requirement to store water in TSF stops dredging operations.	Approved MOL based on surrounding head data to ensure Pit 3 remains a sink. [504642] Monitoring of water levels in Pit 3 [1047327] Pumps in pit 3 maintained through the wet season to allow pump back. [973177] Regular bathymetric surveys to determine process water inventory. [504644] Tailings quantities well understood - production data and Fugro survey. [504643] Significant capacity in the Ranger Water Dam (converted from TSF)	Marginal	Dependent on future rainfall.	Stable	Class III	Continue to monitor (risk trending down now RWD operational)	8/03/2022
<u>504622</u>	Solutes and sediments from surface runoff from final rehabilitated site enters off-site water bodies at greater than closure criteria. (surface water)	Poor quality water shedding from waste rock is released offsite. br/>Uncontrolled erosion on the final landform (e.g. gullying). br />Water management 	Sediments and/or solutes entering offsite environment at greater than closure criteria. br/sBillabong sedimentation. />Ecosystem damage. colosure criteria not met; no lease relinquishment. colosure/>Levels of contamination in offsite drinking water exceed health guidelines. br />Elevated levels of contaminants (metals) in bush tucker.	Bathymetry and I-site scanning of billabongs [936473] Characterisation of LAA and billabong sediments (partially complete). [504627] Historic and ongoing studies into erosion. [504625] Landform flood study informs sedimentation controls design. [504624] Post-closure Management Plan. [504628] Ranger Conceptual Model (RCM) and solute transport modelling completed. [504623] Source term review. [936474] Surface water pathways risk assessment [936475] TSF solute transfer study completed by Intera. [504626] Closure oregonation and post closure aroundwater monitoring to	Unrated	Controls are considered appropriate at this	Increasing	Class III	Conduct study to review the confidence and suitability of TSS sensors. Consider reactive transport for Manganese, Ammonia, Uranium and Radium in Solute Transport Model.	29/04/2022
<u>504602</u>	Groundwater solute transport outcomes are not as expected.	Higher than estimated solute load from interred tailings in Pit 1 and Pit 3. br/Higher than estimated solute load from Brine injection into Pit 3 underfill. br/Higher 	Downstream environmental impactbr />Additional scope and cost required to address solute transferbr />Ongoing long term water treatment requiredbr />Prosecution due to lack of Compliancebr />Reputation impactsbr />Impact to cultural heritage sitesbr />Non-compliance with ER 3.1 & 11.3 (ii)-br />(e.g. KNP values are compromised; Ramsar status is compromised, aquatic biodiversity of ARR is compromised)br />Water quality closure criteria isn't metbr />Potential toxicity to downstream aquatic biotabr />Bioaccumulation in bush tucker rendering it unfit for consumption.	Closure execution and post closure groundwater monitoring to inform model validation and updates. [1105980] Detailed assessment via Water Pathway Receptors Risk Assessment and Vulnerability Assessment Framework (VAF). [1105968] Groundwater and Surface Water interaction Study. [1105972] Monitoring of bores / site groundwater during closure to to track the performance of the model. [1105967] Non conservative assessments available for certain Constituents of Potential Concern (COPCs), including reactive transport and bioavailability modelling. [1105976] Ongoing engagement/peer review with stakeholders through presentation of water studies at RCCF and ARRTC forums. [1105979] Review source term for magnesium, manganese, ammonia, uranium and radium. [1105977] Short term deviations (approx. 5 years) can be handled by decant operations. [1105966] Significant database of site hydrogeological characteristics. [1105961] Tailings consolidation model updates to improve predictive capability of the model. [1105962] Uncertainty analysis of Intera Model. [1105960] Update of Solute Source Terms Conceptual Models. [1105981] Validation of ground water model through monitored real data informing the update of Ranger Conceptual Model and Groundwater Uncertainty Analysis. [1105978] Verified the tailings consolidation model from geotechnical and geophysical investigations. [1105963]	Satisfactory	Controls are considered appropriate at this time, however further contingency will be considered.	Stable	Class	Review and verify tailings consolidation model. Consider reactive transport for Manganese, Ammonia, Uranium and Radium in Solute Transport Model.	19/08/2022
	Insufficient volume or quality of viable seed stock available for whole of site revegetation.	Changes in seasonality - e.g. dryer wet season leads to less flowering and fruitingbr />Size of areas to be revegetated concurrently, exceed stock capacitybr />Late seasonal fires impacts seed collectionbr />Predation (birds)br />Local provenance area may still be too restrictivebr />Availability of contractor/labor force to meet demandbr />Limited seed harvesting capacitybr />Loss of seed in storage (fire, theft, disease, vermin, fungus, failure of air- conditioned)-br />Loss of license to collect seedbr />Variable seed viability after collectionbr />Inadequate land accessbr />Inadequate resources for seed collectionbr />Single contractor with seed collection permitbr />Direct seeding (if progressed) requires more seedbr />Stakeholder approvals not formally agreed (requirements may change in future)br />Non woodland domain species not in plan or considered by FSbr />Revegetation plan focused on seed not vecetative propagation.	Reduction in floristic diversity and density. />Delay in revegetation schedule. />Revegetation does not support fauna diversity. PReputation damage. 	Backup airconditioning in seed storage room. [504584] Current seed collection permit with Kakadu National Park with KNPS (expires 2023). [504576] Dedicated equipment for collecting grass seed [557230] Dedicated equipment for collection of seed i.e. EWP, brush harvester. [693553] ERA conducts annual and opportunistic seed collection on the Ranger Project Area (RPA). [504585] Main planting for shrubs and trees will be planted via tube-stock rather than direct seeding (significantly less seed required) [602122] MTO and schedule of seed requirements complete (including by species). [504586]		Overall effectiveness considered marginal. Stakeholder relationships are positive.			Ongoing review and update of Species Establishment and Research Plan to inform seed requirements.	

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
				Nursery expansion including seed storage facility. [504583]						
<u>504574</u>				Ongoing collection and storage of seed stock by third party. [504575]	Marginal		Stable	Class III		8/03/2022
				Ongoing review and update of seed collection and propagation plan regarding seed viability (including storage, handling, duration of viability). [797817] Primary fit for purpose seed storage facility including climate control, security etc. [693557] Quality assurance process applied to see management (viability testing regime). [693559]						-
				Emergency management / security plans and fire protection in place for seed storage						-
				Seed collection and management procedures						-
				Secondary fit for purpose seed storage facility. [726843] Secure Contract in place with third party seed and plant provider						-
				[936388] Seed management database, collection schedule and metric to manage performance. [504578]						-
				Stakeholder agreed tree and shrub species list. [504580]						_
	Excessive erosion impacts landform stability and revegetation success.	Final landform not matched to rainfall characteristics. Insufficient sedimentation controls. Insufficient erosion controls. <br /&gt;Tailings not fully consolidated. Rainfall is greater than anticipated (eg. Climate Change</br></br 	Revegetation requires ongoing management. Extensive cracking and subsidence occurs over the landform leading to an increased maintenance regime. <br /&gt;Stability issues occur along the developing</br 	Access tracks designed to minimise erosion and/or not cause erosion. [602120]		Number of controls in place, contingency addressed in ongoing monitoring and ongoing rectification works during post closure.			Develop detailed plan for catchment management (inc. catchment conversion). Develop a water management plan for bulked and final landform construction, and a post closure sediment management plan.	
		scenarios). br />Revegetation insufficient or ineffective in minimizing erosion.	/>Tailings or Low 2 material becomes	Compaction of waste rock on Pit 1/Stage 13 results incorporated					Ensure components are in line with BMM	-
			exposea.	Contour ripping in high erosion areas. [602119]					Ensure revegetation strategy tailored to	
				Controls on Material Movement to ensure built landform matches					Incorporate stage 13 results into revegetation	
				Final designed landform does not contain slopes > 4%. [504480]					Update final landform to include concave slopes and first order drainage lines.	5
				Flood study informs erosion control design. [504482]					Update MNP126 Specification for Design and Construction of Mine Roads Procedure to	
<u>504475</u>				Landform Evolution Model (LEM) has climate change scenarios and a synthetic rainfall data set for 10,000 years. [504477]	Good		Stable	Class	Update scarification/ripping plan to incorporate contour ripping in high erosion areas and pit 1 learnings	8/03/2022
				Landform Evolution Model (LEM) model has informed both landform design, erosion controls and sediment traps. [504476]					iourinigo.	
				Monitoring of backfill during landform construction [1047338] Revegetation handover checklist [1092062] Revegetation plan updated with outcomes of Pit 1 and Stage 13 trails [1047339]						-
				Revegetation strategy tailored to landform elements (e.g slopes, gullies, etc). [602118] Ripping Management Plan. [971917] Scheduling of landform to decrease erosion output and landform design includes no gully formation over tailings. [971915]						-
				Traffic and logistics management plan [1047340] Updated consolidated model with Pit 1 validation from monitoring data and CPT testing. Ongoing updates. [504481] Validation of consolidation models. [504479]						-
	Requirement for more extensive remediation	TSF plume management plan to leave in situ not accepted by stakeholders. (Legacy commitment) str	Additional unplanned cost to treat plumes. Inability to meet closure schedule. <br< td=""><td>Application of BPT processes [602095]</td><td></td><td>Controls are considered appropriate at this time. Pending outcomes of the solute</td><td></td><td></td><td>Characterise contamination of wetland filters and billabongs.</td><td></td></br<>	Application of BPT processes [602095]		Controls are considered appropriate at this time. Pending outcomes of the solute			Characterise contamination of wetland filters and billabongs.	
	/ removal of contaminated plumes than planned.	/>Fuel farm plume mobility not fully understood. <br /&gt;Stakeholders have not accepted no plume remediation as of yet. Inaccuracies in modelling.</br 	/>Loss of trust with stakeholders.	Closure Contaminated sites management plan. [504381] Engagement underway with regulator on remediation plan.		transport modelling.			Conduct an Independent Assurance Audit on TSF deconstruction methodology (post-FR). Conduct stakeholder engagement and obtain stakeholder acceptions on pluma considering	-
				Existing audits of LAA wetland filters provide an accurate					plan.	-
<u>504409</u>				indication of potential scope and contamination level. [504420]	Good		Stable	Class III	methodology/plan.	8/03/2022
				Ground water monitoring program for mill and fuel farm has provided specific information. [504410]					Ensure this risk is reviewed in detail under the Feasibility Reforecast.	-
				completed (Intera). [504412]					ronowing a risk based approach determine remediation required for PFAS contamination.	

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
				Ranger conceptual model developed and accepted by stakeholders. (Confirms Mill plume can stay in situ, TSF plume needs further investigation) [504411] Surface water pathway risk assessment [936463]						
<u>504385</u>	Tailings Storage Facility wall breached during deconstruction works or while still in use.	Draw down rates within the facility cause instability and slumping of the walls. Wall demolition sequencing causes uncontrolled release of material. Seepage of water occurs through or under wall during water storage; potential for piping erosion leading to failure. Damage to wall rock armouring during tailings removal (dredge/machinery). Excessive erosion on dam walls. Over topping of dam leading to failure. Seismic event.	Significant compliance impact and legal prosecution. br />Reputation severely impacted. br />Clean up and remediation 	Additional monitoring and instrumentation for drawdown [602112] Advanced notice through bore monitoring. [504392] Compliance and auditing against compliance to RT D5 Standard. [504391] Dedicated dam engineer oversiting and approving all plans (Coffey). [504386] Downstream raise dam constructed with clay core [602113] Engineering supervision of construction works. [1092028] Independent review of all engineering. [504387] Interception trenches installed around west wall of the TSF. [504390] Maintain appropriate MOL. [504395] Modelling to understand impact [602114] Process safety CCMP's include TSF failure which references drawdown rates on facility. [504389] Process safety controls for dredging. [504393] Successful completion of Eastern wall notch. [504394] Technical review complete for use of TSF as a water storage facility. [504396]	Good	Risk decreasing in line with inventory. Technical oversite under D5 standard.	Decreasing	Class	Conduct an Independent Assurance Audit on TSF deconstruction methodology (post-FR). Develop the TSF deconstruction methodology/plan.	18/05/2022
<u>504373</u>	Unplanned contaminated materials found on RPA.	Unknown asbestos materials. br />Unknown radioactive material. br />Unknown hydro-carbons plume. br />Unknown PCBs. br />Use of PFAS	Additional closure scope required to manage material, may impact achieving 2026 closure date. Cost overrun to manage contaminated materials. Reputational 	Asbestos Register available for consultation. [1101007] FS generated Contaminated Sites Management Plan. [989604] PFAS is no longer used on the RPA. [989600] Resources available to manage circumstance. [989602] RT PFAS specific E15 Guidance note. [989601]	Satisfactory	Controls are weighted towards PFAS.	Stable	Class III	Consultant undertaking PFAS Assessment.	8/03/2022
<u>504367</u>	Inaccuracies or simplifications in the water model, excluding rainfall and water treatment rates (managed in other risks), leads to inadequate water treatment tactics.	Water Model does not directly duplicate real-world scenarios. Water Model assumptions are inaccurate (only includes assumptions not included in other risks). 	Process water inventory reduction does not meet the closure schedule. br />Longer than planned process water treatment increases schedule beyond closure date - cost + legal/regulatory & reputational impacts. br />Increased cost from additional process water treatment through the BC. br />Increased cost from requirement to implement process water contingency (large scale HDS). br />Delay in rehabilitating the TSF/RP6 due to need to use for process wate storage for longer.	Consolidation model. [506949] Regular bathymetric surveys of free process water inventory used to validate model. [504368] Water Model validation (external assurance). [504369]	Satisfactory	Controls are considered appropriate at this time.	Decreasing	Class III	Assurance plan to be developed for water model for FR. Complete a concept level study to determine a suitable location and design for RP7, including in TSF options for contingency. FR to document, in an auditable form, the basis of water model, setting out the inputs, constraints and assumptions for water model. Stage and/or phasing plans to better detail catchments and simplifications for input into the water model.	29/04/2022
<u>504188</u>	Tailings consolidation is slower than expected.	Poor management of deposition of tailings causes segregation effects. Poor installation of wick drains. Poor performance of under drain pump. br>Delay in back-filling Pit 3. trailings consolidation outcomes do not match modelling behavior. br>Inadequate characterisation of tailings properties. Delays to tailings transfer from the tailings dam. tor>Stakeholders do not agree that 97% consolidation has been achieved and dewatering is required for longer. Stakeholders do not accept groundwater modelling. lnability to validate consolidation model to required confidence. lnaccurate consolidation model.	Process water treatment required beyond closure date to achieve 97% consolidation. Landform subsidence causes delays and impacts to the success of revegetation. Olifferential settlement of final landform. Solute transport different to predicted. Changes to waste rock volumes in Pit, resulting in changes to landform design. lorerased cost from additional process water treatment through the BC. 	Assurance of completion of consolidation model to stakeholders (2 independent reviews). [1105989] CPTu, sampling and test work to inform consolidation model and wick design. [1105992] Norwegian Geotechnical Institute separate 2D consolidation model. [1105990] Ongoing presentations to stakeholders through MTC and RCCF platforms. [1105993] Pit 1 actual consolidation rates understood with adjustment to model ; ongoing monitoring. [1105991] Specialist consultant employed for consolidation modelling. [1105988]	Marginal	Further work ongoing.	Stable	Class III	Continue to monitor and update model as required.	19/08/2022
	Uncertain terms of access to RPA from 9th January 2026, including Traditional Owner Access to significant areas	ERA's current tenure of the Ranger Project Area expires in 2026 Atomic Energy Act amendment not passed New section 44 is not agreed beyond 2026. Terms of associated instruments is not yet agreed.	Disruption to the rehabilitation schedule. Varying rehabilitation requirements ERA forced to concede ground on the environmental obligations Stakeholders seek to impose access arrangements on onerous terms.	General agreement to proposed amendment (i.e. GAC, Traditional Owners, cross government, DISER) [1046045] Multiple mechanisms for stakeholder discussion (i.e. MTC, ARRTC, ARRAC, Relationship Committee). [1046048] Supportive letter from Minister received [1046046]		Conditions of access are determined by external parties.			Continued engagement with Commonwealth, GAC and NLC on term sheets for section 41, section 44 and mining agreement.	

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<u>504069</u>			Impact to community confidence in ERA and associated reputational impact Negative media attention. Adverse impact to shareholders due to increase in schedule or forecasted costs Amendments to act and associated instruments could go beyond the existing legislative framework and impose new requirements on ERA and do not provide the necessary flexibility to meet future requirements.	Atomic Energy Eact amendment bill	Marginal		Stable	Class III		8/03/2022
<u>504047</u>	Closure of Ranger Mine impacts on local economics causing reputational damage.	Removal of subsidies. Removal of services. Cessation of royalties. Lack of consultation. Lack of understanding of timeline of closure. Lack of understanding of impact on population of Ranger closure. No future plan for the region by government.	Businesses become unviable. br />Social dislocation. br />Loss of leasehold to operate business. br />GAC reduced income. br />Reputational impact.	Engagement with stakeholders on future state. [504049] SIA (social impact assessment) [504048] Stakeholder Engagement and Communications Plan [1033370]	Satisfactory	Controls adequate at this time.	Stable	Class III	Complete SIA review and communicate any changes to the relevant stakeholders. Continue local employment programs to build a future employable workforce.	8/03/2022
<u>503403</u>	Perception amongst local community of downstream contamination from Ranger closure impacting ability to engage in traditional activities. Includes radiation, contamination.	Poor/lack of communication with stakeholders. Historical incidents and lack of trust.	Traditional Owners not able to collect bush foods and/or interact with country for cultural practicesbr>Damage to relationship with key stakeholdersdr>Loss of community trust.	ARRAC meeting discussed and presented by DITT and SSB. [1101057] Community and Stakeholder Engagement plan. [1092018] Cultural reconnection steering committee [1046097] Management Actions included in the Communities and Stakeholder Engagement Plan. [1069955] Relationship committee meetings. [503405] Water monitoring program. External Relations team is on mailing list for enviro water monitoring to proactively manage media. [503404]	Good	Controls adequate at this time.	Stable	Class III	Develop and implement internal communications to address perceptions on Ranger Mine's potential impact to the environment. Include water quality model in 3D landform model. Undertake aquatic vegetation investigation as a part of the Bushtucker Investigation & Assessment study. Undertake faunal bushtucker investigation as a part of the Bushtucker Investigation & Assessment study. Undertake flora assessment of on-site fruit as a part of the Bushtucker Investigation & Assessment study.	8/03/2022
<u>500614</u>	Site condition does not meet Stakeholder expectations resulting in rework.	Previous commitments made are not embedded within scopebr>Insufficient stakeholder engagement or consultationbr>Insufficient scientific basis to support closure criteriabr>Inconsistent expectations from different stakeholdersbr>Misalignment SSB closure elements viewed as not meeting "Best Practicable Technology" (BPT)br>Poor environment performance onsitebr>Closure Studies and the outcomes presented in reports, undertaken by relevant experts are complex and difficult to communicate to stakeholdersbr>Significant changes to pre- communicated/approved closure strategybr>The communicated/approved closure strategybr>The communicate or lost as a result of the closurebr>Community expectations for the retained infrastructure is retained or lost as a result of the closurebr>Community expectations for the retained infrastructure are different to that remainingbr>Nisunderstanding of the Authorisation by the communitybr>RPA perceived to be contaminatedbr>Perception of ERA failing to comply with UN conventions, for instance those relating to Tradition Owners/ World Heritage Sitesbr>Broad definition in the legislation interpreted differently by authoritiesbr>Landform may block the view of Mt Brockman.	Traditional owners do not return to country. ty-Landform does not meet the values (e.g. land uses) that are expected from the Traditional Owners. to obtain final closeout. *br />Regulator agrees with stakeholders causing additional unplanned scope and cost to meet uncertain or changing closure criteria. *br />Additional scope added late in schedule leads to inability to meet closure schedule milestones. *br />Extended care and maintenance phase (possibly in perpetuity). *br />Inability to gain closure certificate and relinquish RPA. *br />May result in prosecution action from not adhering to requirements of Authorisation. *br />Increased liability post-2026. *br />ERA is not be released from the legal responsibilities.	Site specific recognised scientific research undertaken against identified knowledge gaps. [500615] 3D printed physical model of final landform used to demonstrate final landform topography. [693665] Alligator Rivers Region Technical Committee (ARRTC) process and Key Knowledge Needs developed. [1092006] Application of BPT processes [1092007] BPT and approvals process. [500625] Agreed closure criteria Closure Plan updates to incorporate stakeholder recommendations [500630] Communication fora (e.g. ARRTC, ARRAC,MTC,stakeholder workshops). [1092016] Continued stakeholder engagement via ongoing presentations to stakeholders through MTC and RCCF. [504195] Early engagement with stakeholders. [602094] GIS study undertaken to model the potential view lines which has been approved by stakeholders. [602100, 693666] Iterations of the Mine Closure Plan with updated closure criteria are submitted to Minister for approval annually. [936465] Landform design cultural closure criteria. [693663] Physical site visits undertaken by stakeholders i.e. Pit 1, Trial landform [936464] Rehabilitation Animation [608175] Socio-economic impact assessment [602098] Stakeholder communication strategy and management e.g. Traditional Owners (TOs), Minesite Technical Committee (MTC), Alligator Rivers Region Advisory Committee (ARRAC), Alligators Rivers Region Technical Committee (ARRAC), technical working groups, community engagement. [1092073] Stakeholder engagement Plan developed. [500621] Tiered assessment framework. [500628] Trial landform established and results transparent to TO's. Jabiluka rehabilitation provides precedent. [500622]	Satisfactory	Overall progress across raft of controls is reasonable.	Stable	Class	Continue to engage with TOs on site conditions post closure. Investigate opportunities to demonstrate the construction of a stable landform to stakeholders.	13/05/2022

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<u>1106000</u>	Dust from rehabilitation works enters environment.	Dry surface plus prevailing winds transports dust from surface (TSF learnings). Trucking and dumping of waste rock during BMM.	Dust deposition into Magela Creek. Breaches of license conditions. Reputational impact.	Significant corporate knowledge and experience. [1106005] Water carts for dust suppression. [1106004] Air quality assessment completed [604171]	Unrated	Not officially rated but well understood	Stable	Class II		19/08/2022
<u>1064162</u>	Sediment from surface water from rehabilitated landform impacts billabongs resulting in the need for subsequent remediation.	Inappropriate release of water. Downstream closure criteria do not protect upstream billabongs on RPA.	Additional cost and schedule delay associated with billabong remediation. Stakeholder concerns should smothering of aquatic plant species occur due to sediment (cultural bush tucker aspect).	RWMP001 Ranger Water Management Plan includes release water quality monitoring and is approved by external stakeholders . [1064178] Stakeholder approved Closure Criteria. [1064174] Turbidity monitoring in onsite billabongs for early indication. [1064176]	Satisfactory	On site and offsite monitoring in place that should provide an early indication of the need for potential remediation (if necessary).	Stable	Class II	Catchment conversion planning to incorporate modelling of sediment leaving the landform to sediment found in the creek. Develop detailed plan for catchment management (inc. catchment conversion). Develop a water management plan for bulked and final landform construction, and a post closure sediment management plan.	8/03/2022
<u>1049198</u>	Unable to extract expressed tailings pore water.	Decant towers not located in the lowest point of the tailings. br>Decant towers collapse or otherwise fail.	Increased solute load to environment. Solute transport outcomes are not as expected and unable to attain license.	Ability to drill bores post capping completion to target new areas/replace failed towers. [1049209] Ability to monitor tailings surface using settlement towers. [1049205] Ability to monitor water quality across the pit using settlement towers. [1049204] Ability to use settlement towers for decanting. [1049208] Multiple decant towers. [1049203]	Good	Design in place. Contingency known. Monitoring controls not yet embedded.	Stable	Class II		13/05/2022
<u>868244</u>	Larger scale failure of the capping surface.	Areas of large differential settlement.	Tailings heave, potentially resulting in tailing being above maximum level. Delays to installation of secondary capping.	Factors of safety in capping design. [1049190] Settlement column monitoring of tailings surface. [1049193] Surveys of top of capping surface. [1049191]	Marginal	Continued monitoring of Pit 1 surface will increase comfort in control effectiveness	Stable	Class II		8/03/2022
<u>868243</u>	Localised failure of the geotextile or capping surface.	Uneven tailings surface. Areas of large differential settlement. bettlement. bettlement. capping material choice or quality. Weaker tailings than expected. bettle/capping material choice or the structure of t	Health and Safety impacts (e.g. heavy equipment sinking, injury to personnel). Delays to subsequent capping activities. Localised tailings boils.	Access to the initial capping to be restricted and addressed in the traffic management plan for implementation. [1049176] Comprehensive geotechnical testing regime to determine timing of placement of secondary capping over initial capping. [1049179] Comprehensive geotechnical testing undertaken before placement of secondary capping. [1049177] CPT testing during and after tailings deposition to provide tailings properties. [1049178] Engagement of a design consultant. [1049180] Field supervision. [1049181] Peer review by geotechnical expert on geotechnical design. [1049182] Review and verification of tailings consolidation model. [1106635] Technical assurance of final Geotech design. [1049183]	Satisfactory	Controls considered suitable	Stable	Class II		8/03/2022
<u>730288</u>	Failure to consider closure impacts on downstream customers, hauliers or other communities	The transition from operations to closure combined with the peaking demand in individual closure packages results in varying demand on ERA suppliersbr />Lack of transparency with suppliers leads to poor business planning.	Financial instability for businesses. <br /&gt;Reputational impact.  </br 	CDM.03-0000-PL-PLN-00003 Procurement and Contracts Management Plan [508037] CDM.03-0000-PL-SCH-00001 Ranger Closure Contract and Procurement Schedule [1092013]	Satisfactory	Controls considered suitable	Stable	Class II		8/03/2022
<u>694661</u>	Total above baseline radiation dose to plants and animals exceed UNSCEAR values.	Dust transported to local soils (terrestrial). bwaste rock on final landform (terrestrial). br/>Land application area (terrestrial). br/>Run-off from the landform to creeks (aquatic). br/>Controlled water releases to creeks (aquatic) during stabilisation phase. br/>Groundwater contaminants expressed to surface water (aquatic).	Increase in radionuclide concentrations in soil affecting terrestrial biotacbr />Increase in radionuclide concentrations in water and/or billabong sediments affecting aquatic biota.	Dust control during decommissioning. [1092025] Erosion structures are incorporated into landform design - e.g. ripping and armouring where required. [1092029] Establishment of vegetative surfaces to reduce erosion. [1092031] Iterative/adaptive landform design based on landform stability modelling. [1092043] Material movement planning and stockpile resource model to identify location of 1s and 2s rock. [1047361] Only 1s waste rock used for final landform [1092054] Radiological dose assessment [1046061] Stormwater and erosion control, design and management structures. [1092076]	Satisfactory	Controls are considered satisfactory at this time.	Stable	Class II		8/03/2022
<u>694625</u>	Feral animals occur at higher densities than in surrounding KNP.	Lack of management. Open disturbed area. Weed infestation.	RPA becomes a source of feral animals to KNP. br>Impacts natural recruitment of fauna. br>Impacts revegetation 	Active feral animal management aligned with current operational practices. [694626] Ongoing liaison with KNP regarding fire, weed and feral animal management strategies [602396]	Satisfactory	Solid management practices are in place.	Stable	Class II		8/03/2022
<u>694597</u>	Major native fauna does not return to landform.	Fire damage to habitat. Competition from feral animals and weeds. Acutely toxic onsite waterbodies. No appropriate habitat types preventing adequate shelter food and/or breeding opportunity. tor>Insufficient diversity and abundance of flora and fauna to meet defined trajectories. Changes in biodiversity survey techniques. techniques. kor>Lack of artificial habitat to encourage fauna. chr>Natural disturbance events i.e. pests,	Reduced representation in functional groups. Unable to meet cultural criteria for a sustainable food and medicinal source. No fertilization of some animal pollinated flora groups. Lack of sustainability of established ecosystems. Breach of authorization conditions leading to significant reputation damage (social license to operate). Additional cost of rehabilitation	CDM.03-0000-NH-PLN-00002 Ranger Closure Revegetation Plan (Final Landform). [1092010] Creation of faunal habitats on the landform, including nesting boxes [694620] Eventual removal of site fence (physical barriers) allowing egress on to site. [694619] Implementation of rocky habitat areas. [694617] Ongoing discussion held through Cultural Reconnection Steering Committee. [1049167]	Satisfactory	Controls are effective at this time.	Stable	Class II	Complete fauna, habitat nestbox trials and undertake fauna monitoring trials.	8/03/2022

Risk ID	Risk Description	Causes	Consequences	Existing Controls	Overall Control Effectiveness	Overall Control Effectiveness Rationale	Risk Trend	Risk Class	Actions (beyond the ongoing and successful implementation of existing controls)	Risk Last Updated
		cyclones. Poor recruitment of key flora species.	of deviated states and maintaining artificial habitats for up to 200 years.	Specific cultural closure criteria agreed with stakeholders. [1049165] Specific fauna closure criteria agreed with stakeholders [936400] Weed Management Plan [1092079] YEM001 Fire Management Plan [694615]						-
<u>693671</u>	Erosion and gully formation across landform surface exposes contained tailings.	Rainfall is greater than anticipated (eg Climate Change scenarios) Failure of proposed erosion controls. Erosion rates do not match modelled <br /&gt;Final landform not constructed to design</br 	Non-compliance with ER 2.1, ER 5 and ER 11.3(i)br />Potentially increases solute transport on/off sitebr />Potentially increases radiation dose to members of the public. <br /&gt;Limits access by traditional owners to post decommissioning site.</br 	Design of Pit backfill has tailings low in the Pit with thick waste rock cap. [693681] Erosion structures are incorporated into landform design. [693677] Establishment of vegetative surfaces to reduce erosion. [693676] Implementation of a QA program for landform construction and erosion controls. [693679] Iterative/adaptive landform design based on landform stability modelling. [693675] Landform designed with drainage channels diverted away from in Pit tailings. [693683] Ongoing maintenance of erosion structures and mitigation of gully formation, post decommissioning. [693678]	Satisfactory	Controls are considered satisfactory at this time.	Stable	Class II		8/03/2022
	Incutticiant	Lock of maintanance and colorement of sumples	Dreach of outhorization conditions loading to	Hazardous Materials Management Plan. [505828]		Controle ore meture				ļ
<u>597545</u>	Insumicient infrastructure and capability to manage offsite discharge of release water.	Lack of maintenance and replacement of pumping infrastructure (pumps, generators etc). dsr>Loss of LAA's. dsr-Inability to build and commission 	significant reputation damage (social license to operate). br>Cost of replacement if maintenance is not continued. br>Localised erosion and flooding. br>Increased pond water inventory due to mismanagement of wetland filter.	Completion and submission of the annual groundwater         management plan [1057828]         Water management inspections [597551]         Engineering assessment of new catchments [597550]         Regular assessment of groundwater conditions [597548]         Turbomisters [597549]         Water Infrastructure Maintenance Plan [597547]	Satisfactory	Controis are mature.	Stable	Class II		8/03/2022
<u>506028</u>	Direct and indirect impact to cultural heritage sites during post closure - especially if signage /demarcation is decommissioned.	Inappropriate access on RPA by contractors <br /&gt;Remediation works carried out without consideration of cultural heritage (process not followed)</br 	Breach of NT Heritage Act and Sacred Sites Act. Reputation impacted. Cost of remediation. Fines. 	AAPA certificate [506030] Land disturbance process [506031]	Marginal	Could include further stakeholder engagement to finalise handover expectations post closure.	Stable	Class II	Continue to build cultural heritage capacity with Djurrubu Rangers. Triannual Cultural Heritage audit. Identify protection measures to remain in place based on post-rehab monitoring plan. Update the management plan with information from Triannual Cultural Heritage audit outcomes.	8/03/2022
<u>506000</u>	Radiation doses from the final landform exceeds dose constraint and annual dosage limit to the public, post closure.	Mineralised material left on surface (gamma, dust and radon). Exposed tailings. Solutes expressed to surface water and mobilised. Elevated levels of contaminants (metals) in bush tucker.	Non-compliance with ER 5. Increased dose to public.	Air quality assessment completed [604171] Data from trial landform studies has informed the landform design and LEM. [506007] Dust control during decommissioning. [506002] Engineering dose constraint of 300 µSv per year will be applied. [1046078] Final landform thickness reduces the likelihood of exposing tailings and radon emanation from tailings. [506003] Only 1s waste rock used for final landform [506001] Stormwater and erosion control, design and management structures. [506005] Surface Water Model [1046079]	Satisfactory	Controls are considered adequate at this time.	Increasing	Class II	Bush tucker monitoring assessment. Radiological dose assessment. Undertake aquatic vegetation investigation as a part of the Bushtucker Investigation & Assessment study. Undertake faunal bushtucker investigation as a part of the Bushtucker Investigation & Assessment study. Undertake flora assessment of on-site fruit as a part of the Bushtucker Investigation & Assessment study.	8/03/2022
<u>504500</u>	Low plant survival rates in the field during establishment and vegetation decline after/at establishment.	<div>Low plant available water in waste rock substrate. Low plant availability of landform is not optimum for planting. br /&gt;Plant disease or poor health in nursery stock e.g. disease or root:shoot ratio. br /&gt;Lack of nutrient cycling. br /&gt;Lack of local accumulation of litters and fines (sediments). br /&gt;Flauna grazing on tube stock/seedlings. br /&gt;Elevated magnesium sulfate concentrations in groundwater. br /&gt;Inadequate irrigation during first few days and weeks following planting.</div>	Species composition, abundance and richness does not meet closure criteria. <br /&gt;Delay in revegetation schedule or resources taken from primary planting to support additional infill planting requirements.<br /&gt;Revegetation does not support fauna diversity. tor /&gt;Unable to meet cultural criteria for a sustainable food and medicinal source.  Increased mortality rate.</br></br </br 	Compliance with National Standard for Nursery Management [504510] Construction of landform using various techniques to make sure particle size distribution is to design and paddock dumping to get better compaction. [504504] Criteria established with stakeholders on species and seed gathering area. [1092021] Future studies to close out KKN's scoped. [499996] Irrigation for first 6 months post-planting. [504508] NESP study into magnesium sulfate concentration in ground water impacting vegetation. [936399] Nutrient Cycling Study [936394] Ongoing improvement of nursery practices including seed preparation, potting mix, irrigation, fertilizing and other treatments. [971911] Optimize seedling age and root-shoot ratio at time of planting to reduce water stress. [971912] Plant available water modeling predictions indicate sufficient walter holding capacity of wase rock to support vegetation [504503] Revegetation handover checklist [1092064] Revegetation management plan. [1092065] Stockpile drilling to inform perched water table [936398]	Good	Recent survival rates for Stage 13 were very high (90-95%), indicating current controls good.	Decreasing	Class II	Complete study / trial on understorey development on waste rock (CDU and ERA studies). Incorporate stage 13 results into revegetaton plan. Update revegetation plan following experience from Pit 1.	13/05/2022

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				Sub-surface compaction layers increase water holding capacity of waste rock [504513] Trial landforms completed to demonstrate viability of vegetation in waste rock. [504501] Understanding mortality rates contributing factors [936397] Use of biodegradable pots. [504507] Water crystal use for seedlings planted during monsoon without irrigation. [971913] Watering of plants (irrigation) in early stages but not long term. [504505]						
<u>1106647</u>	Remnant mineralised material discovered in stockpiles after Pit 3 bulk backfill completed.	Mineralised material not identified by previous stockpile drilling/assessment. Material movement plan not followed.	Mineralised material ends up in shallower part of final landform.	Availability of RP2 for mineralised material. [1106652] Material movement plan based on available stockpile grade information. [1106649]	Good		Stable	Class I		19/08/2022
<u>1106596</u>	Spillage of hazardous material during rehabilitation works in Pit 3.	Transportation of hazardous material. Deconstruction works. Failure of storage vessel.	Local environmental impact.	Existing operational environmental and hazardous substances management controls. [1106599]	Good	Mature controls in place.	Stable	Class I		19/08/2022
<u>1106578</u>	Loss of process water containment during Pit 3 activities.	Ruptures of pipelines. General spillages from vehicles/equipment. Hydrocarbon spill. Tank and/or bund overflow. Mechanical damage to pipeline by contact by vehicle or other object.	Local (environmental) impact. Offsite impact not envisaged.	Existing hydrocarbon spill response. [1106580] Process safety system. [1106581] Termite spraying program. [1106582] Testing and inspection of pipelines. [1106579]	Good		Stable	Class I		19/08/2022
<u>1106008</u>	Disposal location for contaminated material not available following backfill of Pit 3.	Pit 3 no longer available for disposal of contaminated material (water treatment plants, heavy mobile equipment (HME), construction facilities). Inability to agree upon location with stakeholders. Water treatment infrastructure is required post backfill of Pit 3.	Schedule overruns. Cost overruns. Potential offsite disposal (higher cost).	Closure schedule. [1106011] Decontaminate and transport materials off-site. [1106012] Retention Pond 2 (RP2) planned for Phase 2 demolition material. [1106013]	Good	Contingency planned and available.	Stable	Class I		19/08/2022
<u>694628</u>	Increased aquatic weed establishment in RPA billabongs impacts KNP	Transfer from surrounding environment, vehicles, transient fauna. Transport of weeds from surrounding KNP.	Decrease in downstream aquatic biodiversity / habitat leading to Ramsar status and aquatic biodiversity of ARR being compromised.	Early warning monitoring and subsequent adaptive management. [694635] Weed Management Plan [1092078]	Unrated		Stable	Class I		8/03/2022