Hamersley HMS Pty Limited

Baby Hope

Mine Closure Plan

Mineral Field 47 – West Pilbara

FDMS No. RTIO-HSE-0245210

17 August 2015

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EXECUTIVE SUMMARY

Overview

Hope Downs 1 South West Marra Mamba deposit (**Baby Hope**) comprises a series of open cut iron ore pits located immediately to the south of the existing Hope Downs 1 mining operations (**HD1**). The deposit is located in the eastern Pilbara region of Western Australia, approximately 75 km north-west of Newman and will be developed using conventional drill-and-blast and load-and-haul mining methods. Ore will be processed at HD1. HD1 and Baby Hope are managed by Hamersley HMS Pty Limited (**Hamersley HMS**), which is a member of the Rio Tinto group (Rio Tinto).

Scope

This closure plan has been prepared to support the Baby Hope Area referral under Part IV of the *Environmental Protection Act* 1986 (**EP Act**). This closure plan is designed to address the closure requirements for the Baby Hope deposit and associated infrastructure. Closure is assumed to include progressive rehabilitation that will occur throughout the life of the mine. The goal of mine closure is to relinquish the site to the Government.

This closure plan has been developed to meet the requirements of the joint Office of the Environmental Protection Authority / Department of Mines and Petroleum Guidelines for Preparing Mine Closure Plans (2015) [1] (**Closure Guidelines**).

Primary obligations and commitments

Development of Baby Hope will be subject to proposals to be approved by the Minister for State Development pursuant to the *Iron Ore (Hope Downs) Agreement Act 1992*. This will occur following approval by the Minister for the Environment under Part IV of the EP Act.

Post-mining land use

Options for post-mining land use are limited, with mining and pastoralism the only industries that have historically proven viable. Land use options under consideration include a change to pastoralism or return to a native ecosystem.

Closure objectives and completion criteria

The following closure objectives are proposed for Baby Hope:

- Rehabilitated landforms are stable,
- Vegetation on rehabilitated land is native and self-sustaining,
- Mineral waste is appropriately managed to prevent contamination of surface and groundwater, and
- Measures to mitigate public health and safety hazards have been agreed with stakeholders and implemented.

Note that these objectives do not represent the full range of closure issues that may be present at the site. Rather the objectives reflect key issues against which closure performance will be assessed by government regulators.

[1] Department of Mines & Petroleum and Office of the Environmental Protection Authority (2015) Guidelines for Preparing Mine Closure Plans, June 2015.

Indicative completion criteria have been proposed within this closure plan, however further work is required to clarify and quantify the completion criteria.

Anticipated closure outcome

On closure, infrastructure utilised for the development of the Baby Hope deposit and no longer required for other mining purposes will be removed. Three mine voids, developed just outside the Pebble Mouse Creek flood plain, will remain on closure.

The majority of the mineral waste will be transported to the exhausted HD1 South SE pit. The mineral waste is expected to fill the southern portion of the HD1 South SE pit to surface, and then extend above the lowest natural elevation of the pit crest, merging into the adjacent topography. Mineral waste will also be returned to the Baby Hope pits opportunistically during the life of the mine. Two additional external waste dumps will also be required during operations, and are expected to remain on closure.

Waste dumps will be rehabilitated to be internally draining; as such, it may not be possible to reinstate local drainage lines and runoff from the hills to the north of the deposit. Surface water flow along Pebble Mouse Creek will not be disturbed by the development of Baby Hope, and will continue to flow past the Baby Hope deposit without disruption.

Revegetation will be undertaken across all disturbance areas and rehabilitated landforms. Selected species from vegetation communities within the surrounding area will be used for the revegetation of the waste dumps, backfill and other disturbance areas. Small areas within the pre-mining riparian vegetation corridor may be disturbed during mining to facilitate mine access. These areas will be rehabilitated to re-establish riparian ecosystem function. Rock surfaces associated with the mine voids, such as pit walls, will not be rehabilitated.

CLOSURE GUIDELINES CHECKLIST

Q	Mine Closure Plan (MCP) Checklist	Y/N /NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
1	Has the Checklist been endorsed by a senior representative within the operating company?	Y	vii				
2	Are you aware that from 2015 all MCPs will be made publically available?	Y					
3	Is there any information in this MCP that should not be publicly available?	N					
4	If "Yes" to Q3, has confidential information been submitted in a separate document / section?	NA					
5	Does the MCP cover page include: Project Title, Company Name, Contact Details (including telephone numbers and email address) Document ID and version number, Date of submission (needs to match the date of this checklist)	Y					
6	State why the MCP is submitted (e.g. as part of a Mining Proposal, a reviewed MCP or to fulfil other legal requirement)			Referral under Part IV EP Act	Y		
7	Does the project summary include land ownership details, location of the project, comprehensive site plans and background information on the history and status of the project?	Y					
8	Does the MCP include a consolidated summary or register of closure obligations and commitments been included?	Y					
9	Have all stakeholders involved in closure been identified?	Y	20				

10	Does the MCP included a summary or register of historic stakeholder engagement been provided, with details on who has been consulted and the outcomes?	Y	21				
11	Does the MCP include a stakeholder consultation strategy to be implemented in the future?	Y	20				
12	Does the MCP include agreed post-mining land use, closure objectives and conceptual landform design diagram?	Y	25, & 40				
13	Does the MCP identify all potential (or pre-existing) environmental legacies which may restrict the post mining land use (including contaminated sites)?	Y	34				
14	Has any soil or groundwater contamination that occurred, or is suspected to have occurred, during the operation of the mine, been reported to DER as required under the Contaminated Sites Act 2003?	NA					
15	Does the MCP include an appropriate set of specific completion criteria and closure performance indicators?	Y	26				
16	Does the MCP include baseline data (including pre-mining studies and environmental data)	Y	28				
17	Has materials characterisation been carried out consistent with applicable standards and guidelines (e.g. GARD Guide)?	Y	31				
18	Does the MCP identify applicable closure learnings from benchmarking against other comparable mine sites?	Y		See Appendix B Knowledge shared across Rio Tinto managed Pilbara mines			
19	Does the MCP identify all key issues impacting mine closure objectives and outcomes (including potential contamination impacts)?	Y	50				

20	Does the MCP include information relevant to mine closure for each domain or feature?	Y	58				
21	Does the MCP include a gap analysis / risk assessment to determine if further information is required in relation to closure of each domain or feature?	Y	55				
22	Does the MCP include the process, methodology and has the rationale been provided to justify identification and management of the issues?	Y	57				
23	Does the MCP include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	57				
24	Does the MCP include a closure work program for each domain or feature?	N		To be developed prior to closure			
25	Does the MCP contain site layout plans to clearly show each type of disturbance as defined in Schedule 1 of the MRF Regulations?	N		State agreement site not subject to MRF			
26	Does the MCP contain a schedule of research and trial activities?	Y	55				
27	Does the MCP contain a schedule of progressive rehabilitation activities?	N		Indicative closure schedule provided. Opportunities for rehab assessed annually			
28	Does the MCP include details of how unexpected closure and care and maintenance will be handled?	Y	60				
29	Does the MCP contain a schedule of decommissioning activities?	N		To be developed prior to closure			
30	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	N		To be developed prior to closure			

31	Does the MCP contain a framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance?	Y	61				
32	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	64	Financial provision not included			
33	Does the MCP include a process for regular review of the financial provision?	Y	64				
34	Does the MCP contain a description of management strategies including systems and processes for the retention of mine records?	Y	65				

Corporate endorsement:

I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan is true and correct and addresses the relevant requirements of the *Guidelines for Preparing Mine Closure Plans* approved by the Director General of Mines and Petroleum.

David Bloor

General Manager - Health, Safety and Environment

Date: 17 August 2015

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FIGURES

INTRODUCTION TO CLOSURE PLANNING

1 WHAT IS A CLOSURE PLAN

A closure plan documents strategies to achieve the desired post-closure landform and avoid or mitigate potential social and environmental impacts associated with site closure, to an extent that is fiscally appropriate. As such, closure plans provide the framework for planning and implementing mine closure. Closure plans also document tasks Hamersley HMS has committed to undertake to improve closure outcomes.

Closure plans are intended to be used by all personnel to inform on-going planning decisions, and to ensure closure is integrated into operational activities. Closure plans are also one of the methods used by the business to communicate its closure strategy to stakeholders, including regulators.

2 THE CLOSURE PLANNING PROCESS

Closure plans are regularly reviewed and updated to account for changes resulting from:

- amendments to the mine plan;
- improvements of the site closure knowledge base (e.g. through daily activities, technical studies and research actions, progressive rehabilitation);
- new or amended regulation;
- changes to surrounding land uses; and
- evolving stakeholder expectations.

Review processes bring experts together to discuss current performance, proposed mine changes and opportunities to improve closure outcomes. At the end of the review process, improvement actions are assigned and the closure plan is updated.

A key output of closure planning is the development of a closure cost estimate. Closure provisions are subsequently integrated into our business planning processes to ensure funds will be available to close the site effectively.

The detail of each closure plan increases as the knowledge base develops. When the site approaches scheduled closure, studies will be completed to define how infrastructure, decontamination, rehabilitation, the workforce and communications will be managed throughout the mine closure period (and beyond), specific to the site conditions at the end of mining. Stakeholder engagement and endorsement of the final completion criteria is facilitated at this time.

In the final closure plan update, location specific management plans are provided for each closure domain. These detailed plans cover the physical closure, dismantling and subsequent rehabilitation implementation requirements. The supporting technical reports that have been used within the closure plan to predict the post-closure outcomes are also appended to the final closure plan.

3 CLOSURE TERMINOLOGY

This closure plan is accessed by various groups within Rio Tinto as well as external stakeholders, including Western Australian State Government regulator and advisory departments and Traditional Owner groups. The following clarification is provided to define how the following terms are used within this closure plan:

- A mine void refers to the cavity created in the natural geology in order to mine ore, which extends below the natural surface.
- A pit refers to total area from which material was removed. A pit may include shallow depressions, where material is removed for construction purposes e.g. a borrow pit, and / or quarries where no surface depression is created, but instead part of a rock outcrop is removed.
- Post-mining landform refers to the shape of the land that would be generated as a result of implementation of the current operational mine plan and standard operating practice. Issues that could potentially arise from this scenario, and strategies to manage them, are the focus of this closure plan.
- Final landform designs refer to the individual feature or domain-based landform shaping requirements required to achieve the closure objectives.
- Closure landform refers to the overall shape of all the land disturbed by mining activities after rehabilitation earthworks are complete.
- Post-closure landform encompasses the closure landform and the surrounding undisturbed land, to describe the wider catchment conditions.

PURPOSE AND SCOPE

4 PURPOSE

Planning for closure of a site is a critical business process that demonstrates Hamersley HMS's commitment to sustainable development. This closure plan follows the format and content requirements for mine closure plans as recommended in the Closure Guidelines

This closure plan has been produced to:

- define the closure requirements for the Baby Hope above water table (**AWT**) deposit; and
- support the Baby Hope Area referral under Part IV of the EP Act.

Due to the close proximity and interrelationships between Baby Hope and HD1, it is anticipated that this closure plan will be merged with the HD1 Closure Plan, to form an integrated Greater HD1 closure plan in future iterations.

5 SCOPE

This plan covers the closure, rehabilitation and decommissioning of facilities and disturbed areas associated with mining activities at Baby Hope, including:

- open cut pits at deposits;
- mineral waste dumps; and
- haul roads and associated infrastructure.

The scope of this closure plan excludes any disturbance, landforms, infrastructure etc. associated with the existing mining activities at HD1.

This closure plan has been prepared for external review.

6 CLOSURE PLAN REVIEW HISTORY

This closure plan is the first to be developed for the Baby Hope area and has been developed using information current as at July 2015.

PROJECT SUMMARY

7 DESCRIPTION OF OPERATION

7.1 OVERVIEW

Baby Hope is a Marra Mamba Iron Formation ore deposit located approximately 60 km north-west of Newman (Figure 7-1) in the Pilbara region of Western Australia. Ore from Baby Hope will be processed at HD1, located 1 km to the northwest of Baby Hope. Baby Hope and HD1 are managed by Hamersley HMS.

Baby Hope is situated adjacent to Pebble Mouse Creek, within the Weeli Wolli Creek catchment and 20km upstream of Weeli Wolli Springs. A number of iron ore mining developments are located in the vicinity of Baby Hope, including the BHP Billiton Iron Ore MAC and Jinidi operations.

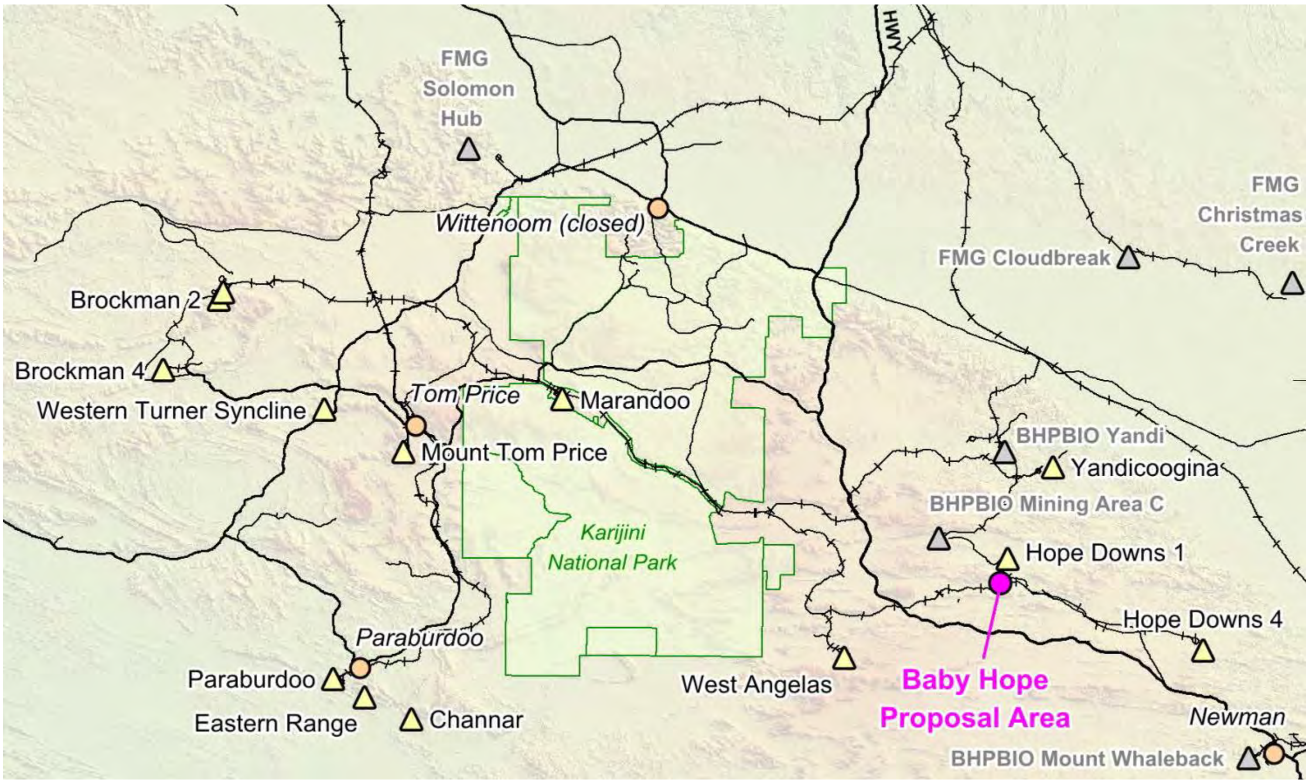

Figure 7-1: Regional location of Baby Hope

7.2 MINING LAYOUT

Baby Hope will utilise standard truck and shovel methods to develop open pit iron ore deposits. The proposed mine layout is shown in Figure 7-2. Baby Hope will include:

- open cut pits that mine above the natural groundwater table;
- mineral waste that is directed to surface waste dumps and in pit areas;
- sealed and unsealed access tracks and haul roads; and
- supporting infrastructure as required (administration buildings and facilities).

Note, a full site inventory is included in closure cost estimate reports for the site and is not reproduced in this closure plan.

7.3 MINING SCHEDULE

Based on the current mine plan, mining of the AWT ore at Baby Hope is expected to commence in 2016 and finish in 2026.

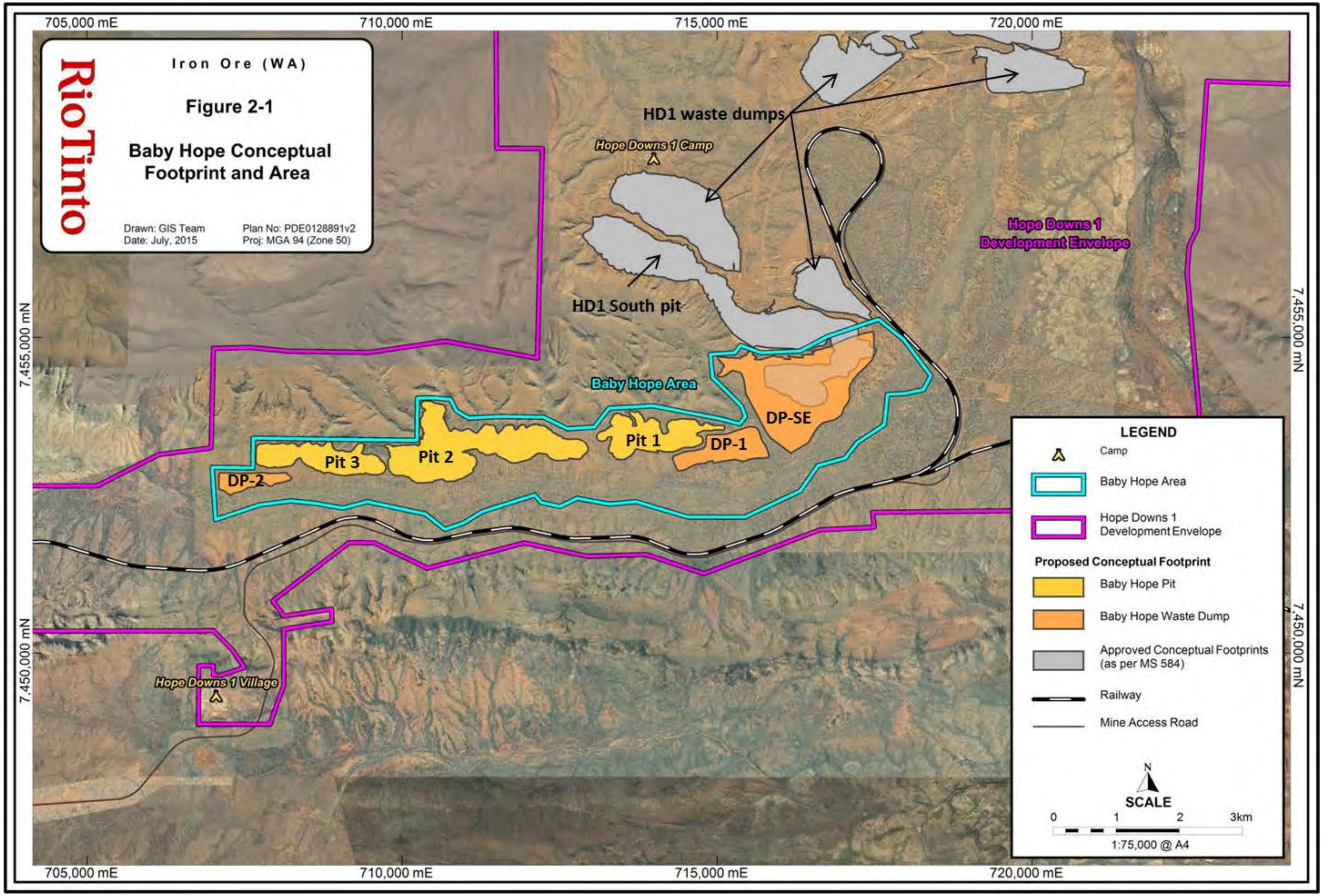

Figure 7-2: Baby Hope proposed mine layout

CLOSURE OBLIGATIONS AND COMMITMENTS

A closure obligations register is presented as Appendix A, in accordance with the format prescribed in the Closure Guidelines. It contains a list of obligations from the following instruments:

- *Iron Ore (Hope Downs) Agreement Act 1992*;
- Ministerial Statement 584 (Hope Downs Iron Ore Mine); and
- Ministerial Statement 893 (Hope Downs Iron Ore Mine).

The register also identifies legislation, standards and guidelines that may not apply to Baby Hope specifically, but that may be relevant to closure of mine sites generally.

This closure plan has been prepared to support the Baby Hope referral under Part IV of the EPA Act, and additional specific obligations may arise through these processes. These will be documented in the next update of this closure plan.

STAKEHOLDER CONSULTATION

8 STAKEHOLDER CONSULTATION

8.1 CONSULTATION PROCESS

Stakeholder consultation is undertaken to ensure all stakeholders have their interests considered during closure planning. Hamersley HMS has established processes and protocols for consultation with each of its key stakeholders. This work expands on the principles established by Hamersley HMS's approach to communities and social performance. Most closure consultation is conducted within this existing framework.

Consultation is commenced in the early stages of the closure planning process, and continues through to site relinquishment. The consultation strategy proposed is designed to:

- identify stakeholders and interested parties;
- develop a targeted consultation plan to reflect the needs of the stakeholder groups and interested parties;
- integrate the consultation plan into the mine planning/closure planning process; and
- where practicable, work with communities to manage the potential impacts of mine closure.

Closure consultation is usually conducted within a broader consultation framework, as a component of on-going consultation forums. For example, consultation with State and Local Government stakeholders occurs as part of regular meetings held with individual agencies. Consultation on specific issues is also undertaken outside of these regular meetings as the need arises. Consultation with other stakeholders is conducted in a manner that is appropriate to the stakeholder and the specific issues requiring discussion.

The timing of discussions and discussion focus will change as the project matures or new deposits are discovered and developed. The focal areas for discussion are illustrated in Table 8-1.

Table 8-1: Closure discussion framework

Stage	Discussion focus
Prior to the commencement of operations	Stakeholder identification and stakeholder mapping. Commence closure-specific discussions with key stakeholders. Agree key environmental, cultural and social values and closure objectives.
During operations	Ensure closure objectives and indicative closure criteria remain relevant and appropriate. Communicate outcomes of studies undertaken to improve the closure knowledge base, reduce closure risks or improve closure strategies. Communicate proposed changes to the closure plan.
In the lead up to closure	Final completion criteria consensus. Discussion future use of infrastructure post-closure. Commence workforce communication strategy.
Post-closure	Process to meet commitments. Progress against completion criteria.

8.2 COMMUNICATION REGISTER

Key stakeholders in the closure of Baby Hope are listed in Table 8-2 below. This list is dynamic and is expected to evolve over time. The communications register (Table 8-3) summarises aspects of site closure that have been discussed with, resolved or otherwise communicated by key stakeholders.

Given the early stage of the Baby Hope proposal, consultation on the closure strategies and outcomes for the Baby Hope proposal has been limited.

Table 8-2: Key stakeholders

Category	Stakeholder
State Government	Department of State Development (**DSD**) Department of Aboriginal Affairs (**DAA**) Department of Mines and Petroleum (**DMP**) Environmental Protection Authority (**EPA**) Office of the EPA (**OEPA**) Department of Environmental Regulation (**DER**) Department of Parks and Wildlife (**Parks and Wildlife**) Department of Water (**DoW**) Department of Regional Development and Lands (**RDL**) Department of Health (**DoH**) Department of Agriculture and Food WA (**DAFWA**) Main Roads WA Pastoral Lands Board (**PLB**)
Local Government	Shire of East Pilbara
Community	Nyiyaparli people Ngarlawangga people Banjima people Weeli Wolli Co-management Board

Table 8-3: Communications register

Stakeholders	Summary of discussion relevant to closure	Response
Part IV environmental approval		
2014	Baby Hope referral	
DMP	Hamersley HMS provided a general overview of Baby Hope above water table mining project. Characteristics related to closure included: • All activities located outside Pebble Mouse Creek 100 year flood plain. Landforms to be stabilised to prevent impact to Pebble Mouse Creek floodplain. • Mineral waste initially directed to surface waste dumps and, thereafter, used in progressive backfilling of the eastern and western sections of the mine pit where practicable. • No PAF expected to be excavated.	Proposal accepted by stakeholders. Postscript, some activities are now proposed to occur within the 100 year flood plain, although waste dumps and mine voids remain outside 100 year flood plain. Postscript, backfill strategy discussed is no longer proposed to be implemented.
2015	Baby Hope referral	
OEPA	Hamersley HMS and OEPA discussed the Part IV Approval approach for Baby Hope. Agreed assessment under s46B will result in a new Ministerial Statement as second amendment to MS 584, with new conditions expected for rehabilitation and decommissioning.	Hamersley HMS submitted Baby Hope referral to OEPA
DMP	DMP Environment branch provided written feedback on the draft 2014 Mine Closure Plan – Baby Hope Project DMP Comments as follows:	 Hamersley HMS response as follows:
	It is noted that the MCP has been developed as a one off document and that it is planned for the HD1 and Baby Hope MCPs to be merged in future iterations. Given the close proximity and interrelationship of these two projects, this approach is both supported and encouraged by DMP. The Baby Hope MCP is a very broad and general document and it is expected that, once merged with the HD1 MCP, future revisions will contain greater detail.	Commitment to merge with HD1 MCP included in 2015 Baby Hope MCP
	A large amount of highly erodible material (approximately 86% of total waste) is likely to be produced as a result of this project. Based on information provided within section 11, it appears as though the management of this material through waste scheduling and waste dump designs are yet to be investigated. Information such as the anticipated final height of the dumps, final slope angles and potential capping material requirements and availability should be included at this stage. It is important to commence these investigations prior to mining to mitigate the risk of inadequate landform design or sterilising competent materials in the centre of a waste dump	Waste dump designs provided in 2015 Baby Hope MCP. No mineral waste material segregation required to achieve landform.
	Information gathered for soils and presented in section 11.3 does not detail the characteristics of the topsoil within the proposal area. It is important to define the topsoil characteristics at an early stage to ensure the material is suitable for future rehabilitation. Early identification of any	Soil texture, dispersion and pH updated in 2015 Baby Hope MCP. Knowledge base references to technical reports updated in 2015 Baby Hope MCP. No problematic

	problematic or limiting materials will allow for alternative solutions to be developed during operations rather than having to remediate failed rehabilitation post closure. Guidance on relevant information to obtain can be found in section 4.7 of the Mine Closure Guidelines (2011) and in section 4.3.3 of the Mining Proposal Guidelines (2006).	materials expected to be encountered.
	Section 13.3.1 discusses a number of conservation significant flora species and their relationship to the Hope Downs mine lease. It is noted that three of the species identified in the ER document (*Eremophila* sp. Hamersley Range, *Hibiscus* sp. Gurinbiddy Range and *Goodenia lyrata*) have not been discussed in this section. Given these species have been identified within the Baby Hope proposal area it is important to investigate the potential for utilising these species in rehabilitation.	Significant flora species list updated in 2015 Baby Hope MCP. *Eremophila* sp. Hamersley Range, *Hibiscus* sp. Gurinbiddy Range and *Goodenia lyrata* not considered suitable for inclusion in rehabilitation seed mix.
	It is noted that fibrous material is expected to be encountered however little information has been provided as to how this will be managed both during operations and at closure. Section 17 of the MCP states that fibrous material will be encapsulated in demarcated areas that are not likely to be disturbed as part of rehabilitation. Table 21-4 advises that management will be in accordance with an existing Management Plan. Relevant information from this Management Plan should be extracted and included in the MCP.	Closure management aspects from existing Fibrous Management Plan included in 2015 Baby Hope MCP. 2015 Baby Hope MCP recognises further definition of fibrous materials will be developed during mine life.
	Section 18.2.1 advises that topsoil will be spread to a depth of 200 mm however, there is likely to be a topsoil deficit. It is understood that subsoil is planned to be used to address any shortfall in topsoil however, it should be noted that spreading topsoil to a depth of 100 – 200 mm is generally accepted. While the subsoil may be an adequate growth medium, it is likely to lack the seed bank and potentially the nutrients that are available in topsoil. The potential for spreading a thinner layer of topsoil to cover a larger surface area may therefore be worth investigating.	2015 Baby Hope MCP updated to reflect topsoil contribution to growth media will be between 100 mm and 200 mm.
	Many of the indicative completion criteria presented are not measurable. For example, some of the completion criteria presented include: -Investigate alternative strategies that will achieve the same objective (regarding phreatophytic vegetation and flow in Weeli Wolli Creek) -Aquifer recharge will be undertaken for a period of 20 years (relating to Weeli Wolli flow and groundwater quality) Indicative completion criteria should be re-visited to ensure that they relate to targets to be achieved. Section 4.9 and Appendix K of the Mine Closure Plan Guidelines (2015) provide guidance on the development of completion criteria.	Completion criteria in 2015 Baby Hope MCP reviewed and updated. Further refinement and review will be undertaken as part of merge with HD1 MCP.
	The Closure Implementation strategies listed in table 28-1 are very broad. While not ideal, these will be adequate for this stage of mine life. It is expected that this will contain much greater detail within the next iteration of the MCP.	Comments noted.

8.3 ONGOING CONSULTATION SYNOPSIS

8.3.1 ABORIGINAL TRADITIONAL OWNER GROUPS

Baby Hope is situated is situated within the Nyiyaparli People's Native Title Claim application area. Consultation with the Nyiyaparli People is undertaken through the Local Implementation Committee process. This committee is a joint forum of Hamersley HMS senior leaders and Karlka Nyiyaparli Aboriginal Corporation who represent the interests of the Nyiyaparli People. This committee process is used to convey key information, undertake consultation and, where required, seek Traditional Owner feedback on mine related activities, including closure; although no consultation on closure of Baby Hope has been undertaken with the Nyiyaparli People to date. Closure aspects may also be raised and discussed, when appropriate, during ethnographic surveys. The outcomes of these sessions inform the development of closure strategies. Where appropriate, this engagement is also documented as part of the Cultural Heritage Management System.

Some of the cultural values from the wider mine lease that may be applicable to Baby Hope include:

- Access to rock shelters post-closure. Rock shelters have been identified in the hills above (north) of Baby Hope. Safe access to these sites could be influenced by the Baby Hope closure landform.
- Repatriation of artefacts to the rehabilitated site.
- Inclusion of Snappy gum trees in rehabilitation. These trees, usually located on hilly topography, provide habitat for the native honey-bee. Existing honey-bearing trees are linked to the honey-bee dreaming, or song-line, referred to as the "Jundaru Jibalba". Further work is required to understand if there is potential for these trees to be included in rehabilitation seed mixes.

Weeli Wolli Spring, located 20 km downstream from Baby Hope, is an area of significant ecological and cultural value. The current mining and closure strategies for Baby Hope are not expected to impact or further alter conditions in Weeli Wolli Creek or at Weeli Wolli Spring. Consequently no actions are proposed as part of this closure plan to address aspects of Weeli Wolli Creek or Weeli Wolli Spring.

8.3.2 REGIONAL COMMUNITY

The area surrounding the Baby Hope deposit is unallocated crown land with no homesteads or Aboriginal communities in close proximity. The nearest town, Newman, is located approximately 60 km south-east.

The Baby Hope will be operated by the existing HD1 workforce. HD1 operates solely as a Fly-In Fly-Out (**FIFO**) operation with flights in and out of the privately owned airstrip adjacent to the mine village.

Consequently, there is negligible direct interaction between Baby Hope and any Pilbara community.

POST-MINING LAND USE AND CLOSURE OBJECTIVES

9 POST-MINING LAND USE

The Pilbara is classified as an Extensive Land Use Zone. Baby Hope ground disturbance will be undertaken on land tenure historically classified as unallocated vacant crown land.

The Nyiyaparli People, the Traditional Owners of the land in the vicinity of Baby Hope, regularly access culturally significant areas to maintain traditional law and connection to country. This connection to land is the basis for the formal recognition of Traditional Owner native title rights and interests.

Options for post-mining land use are limited in the Pilbara region, with mining and pastoralism the only industries that have historically proven viable. Beneficial uses for the mining area (e.g. recreation) that might have potential in areas supported with a higher population base are unlikely to be viable.

Until an alternate land use is identified and agreed, and to ensure the system remains compatible with general Pilbara land uses, the closure and rehabilitation strategy for Baby Hope will focus on establishing stable landforms that support native vegetation of local provenance.

10 CLOSURE OBJECTIVES

The ultimate goal of mine closure at Baby Hope is to relinquish the site to the Government. This goal will be achieved once the key stakeholders (State Government, Local Government and Community) agree that the condition of the site is compatible with an agreed post-mining land use. In consideration of the key stakeholder expectations for mine closure, Table 10-1 lists the closure objectives proposed for Baby Hope.

Table 10-1: Baby Hope closure objectives

Number	Objective
1	Rehabilitated landforms are stable
2	Vegetation on rehabilitated land is native and self-sustaining.
3	Mineral waste is appropriately managed to prevent contamination of surface and groundwater
4	Measures to mitigate public health and safety hazards have been agreed with stakeholders and implemented.

COMPLETION CRITERIA

11 COMPLETION CRITERIA

Completion criteria can be defined as the indicators used to determine whether closure objectives have been met. They are used to measure the success of closure implementation against objectives, and to facilitate relinquishment of mining tenure.

Table 11-1 lists the indicative completion criteria proposed for each site closure objective. To support the development and communication of the final completion criteria, indicative measurement processes and supporting data (evidence and/or metrics) lists are included in Table 11-1. The evidence and metrics column includes a range of information types that will be collected during the mine life or post-closure (as appropriate) and may be required to demonstrate, through the measurement process, that the completion criterion has been achieved.

These criteria are subject to ongoing review and update, and due to the early stage of the project, have yet to be extensively discussed with stakeholders. The final, agreed completion criteria are expected to contain greater detail than the indicative completion criteria.

Table 11-1: Indicative Completion Criteria

	Objective	Indicative completion criteria	Indicative process and/or monitoring methods	Indicative evidence / metrics
1	Rehabilitated landforms are stable	a. Gully width or depth development on waste dumps does not increase by more than 10 percent in the five year period prior to relinquishment. b. Landforms located within the Pebble Mouse Creek Peak Maximum Flood event area are appropriately stabilised.	• Passive monitoring of rehabilitation slopes to identify potential erosional structures (e.g. aerial photography). • Field validation of erosional structure size. • Use of stabilizing materials such as rock armour, where appropriate • Monitoring assessment of stability for erosional structures to demonstrate completion criteria achieved.	• Annual aerial photography • Field records of gully depth and width • Definition of the Pebble Mouse Creek Peak Maximum Flood event area • Hydraulic assessment of erosional forces • Records that correct rock armour sizing requirements have been utilised
2	Vegetation on rehabilitated land is native and self-sustaining.	a. Mean density of plants within rehabilitated areas is within the range demonstrated by reference sites. b. Percentage of perennial cover within rehabilitated areas is comparable to reference sites. c. Weed distribution and abundance within rehabilitated areas is comparable to or lower than adjacent undisturbed	• Identification of key species for rehabilitation habitats / domains. • Comparison of key species density on rehabilitation areas with reference site statistics. • Establishment of long term rehabilitation (monitoring) areas. • Comparison of key species density variability with reference sites.	• Field vegetation monitoring of key species in reference sites to determine natural density range. • Measurement of key species density in rehabilitation areas. • Field vegetation monitoring of key species in reference sites to determine natural density range. • Field vegetation

	Objective	Indicative completion criteria	Indicative process and/or monitoring methods	Indicative evidence / metrics
		areas.	• Comparison of weed density on rehabilitation areas with reference site statistics.	monitoring of key species over 10 year period to determine density variation over time. • Field vegetation monitoring of reference sites to determine natural weed species and density range. • Measurement of weed species and density in rehabilitation areas.
3	Mineral waste is appropriately managed to prevent contamination of surface and groundwater	a. Confirmation mineral waste does not generate AMD.	• Independent expert evaluation that long term AMD risks have been appropriately identified and have been effectively managed.	• Review by independent expert to confirm that outcomes are reasonable and appropriate. • Groundwater monitoring.
4	Measures to mitigate public health and safety hazards have been agreed with stakeholders and implemented.	a. Key stakeholders are engaged in the process to define the management approach for potential hazards. b. Abandonment structures are erected to inhibit vehicles access to mine voids. c. Safe access to sites of cultural significance is implemented as agreed with key stakeholders. d. Hazardous fibrous materials have been adequately encapsulated. e. Abandonment signage is erected to describe potential hazards.	• Identification of potential hazards to the public in the decommissioned area. • Identification of cultural heritage sites that require access post-closure • Records of stakeholder engagement • Independent audit(s) to confirm that hazard mitigation measures have been implemented.	• Communications register • Geotechnical evaluation • Fibrous materials audit • Contaminated sites audit • Electrical safety inspection • Public access evaluation • Traditional Owner cultural access consultative report

COLLECTION AND ANAYLSIS OF BASELINE DATA

The closure knowledge base (Appendix B) is a collection of baseline studies, models and interpretations, which are used to inform the closure planning process presented in this closure plan. The knowledge may be specific to the site or generally applicable to the Pilbara region; and includes information on the performance of closure-related trials completed at other Pilbara mining operations (when appropriate). At this stage of the closure plan development, only summaries of these reports are provided and the relevant information is summarised below. The relevant knowledge base reports will be included in the final closure plan.

12 CLIMATE

The HD1 weather monitoring station has been recording data since 2009, with intermittent data collection undertaken during the initial exploration phases, between 1993 and 2000. The Bureau of Meteorology (**BOM**) maintains a station at Newman Aerodrome (BOM station number: 007176), which has been operational since 1971. This station provides a longer term climate record for the local region. The Wonmunna rainfall station, just 15 km away, has been operated by the DoW since 1984 and is suitable for providing local rainfall context. There are also several short term weather and rainfall gauges located with a 50 km radius of the site that are employed as part of various mining, surface and vegetation monitoring activities.

Information provided in this section is based on information analysed from the Wonmunna and Newman Aero monitoring stations.

12.1 WEATHER

The general climate of the Pilbara can be described as semi-arid, and is characterised by a hot, wet summer (October to April) and a mild winter (May to September).

The north/north-western (Pilbara) coastline of Australia has experienced more tropical cyclones than anywhere else on mainland Australia. Most tropical cyclones are observed during the late summer, occurring between November and May. Tropical cyclones can produce damaging wind gusts in excess of 150 km per hour, with heavy rains resulting in regional flooding. Five tropical cyclones are expected off the Pilbara coast each year, with two expected to make landfall.

Precipitation is driven by summer cyclonic activity; the months of August, September and October have the lowest average rainfall, and December, January and February the highest average rainfall. Annual rainfall is also highly variable. Rainfall from the Wonmunna gauge suggests the local annual average rainfall is around 370 mm, slightly higher than experienced at Newman Aerodrome, with significant inter-annual variability ranging from 170 mm to 770 mm.

Temperatures in the east Pilbara range from an average maximum temperature of 44^{o}C in January to an average minimum of 3^{o}C in August[2].

Average temperatures during the day are typically between 36^{o}C to 39^{o}C over summer and drop to 23^{o}C to 26^{o}C over winter. Average minimum temperatures are between 23^{o}C to 24^{o}C over summer and 6^{o}C to 7^{o}C over winter. Monthly average temperatures recorded at Newman Aero between 1996 and 2013 are presented in Figure 12-1.

[2] Bureau of Meteorology, Newman Aerodrome dataset, Accessed: 20 March 2014

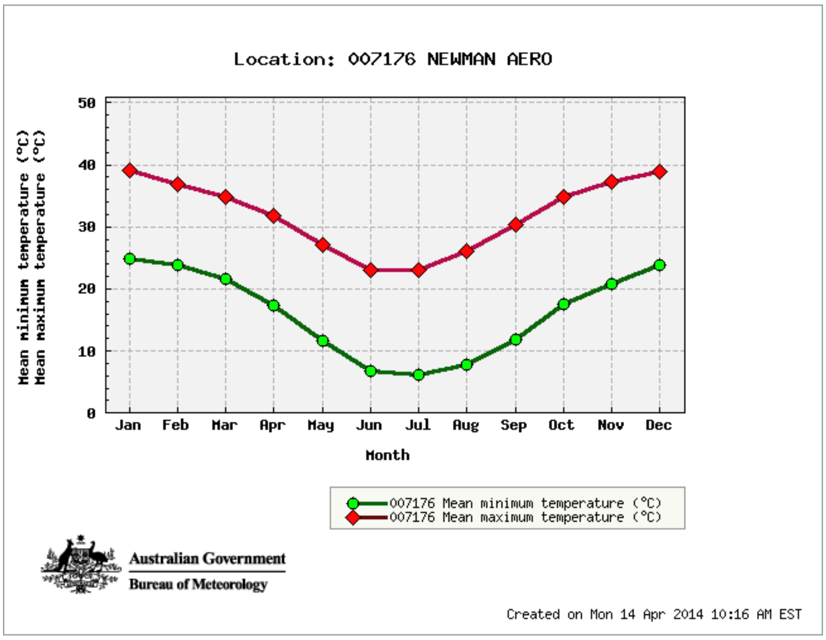

Figure 12-1: Mean maximum and minimum monthly temperature data (1996 to 2013) at Newman Aerodrome

Evaporation rates in the region greatly exceed rainfall. Evaporation in the east Pilbara ranges between 2500 to 3400 mm per annum while average humidity has been recorded as 37%, with higher humidity corresponding to higher annual rainfall.

12.2 IMPACT OF CLIMATE CHANGE

The understanding of how, in the future, climate will change in the Pilbara is guided by the outcomes of climate modelling, commissioned privately by Rio Tinto and other Australian government agencies. The main climate drivers for the Pilbara are the El Niño Southern Oscillation (**ENSO**) and Indian Ocean Dipole (**IOD**) ocean currents. However, these ocean currents are not well represented in most global climate models, and as a result climate predictions for the northwest of Western Australia vary significantly. Consequently, the impact of climate change, and more importantly the change in water availability and the influence on Pilbara ecosystems, is still unclear.

The ENSO and IOD ocean currents are currently being researched by CSIRO. At the same time, modelling is being progressively improved by various Australian Government agencies to expand our understanding of the climate drivers in the southern hemisphere, to understand the associated impacts on water availability and to predict changes to existing ecosystems.

From the modelling completed to date, our understanding of Pilbara climate change suggests the region will experience the following climate trends:

- A shift in the historical tropical cyclone season, with an earlier start and potentially later finish.
- Continuation of the highly variable multi-decadal scale rainfall trends.
- A significant warming trend, influencing maximum temperatures, with the largest changes during the January to March period.

13 LAND AND WATER

13.1 SETTING

Baby Hope is located on the northern boundary of a local U-shape valley, north of Pebble Mouse Creek. The southern and northern boundaries of the valley rise to elevations of approximately 890 m RL, 250 m above the valley floor. At the widest point, the valley spans a distance of 6 km.

Two land systems dominate the valley, as listed in Table 13-1, the Platform land system associated with the valley floor and Newman land system on the flanking range. The northern range is dominated by Marra Mamba Iron Formation, the primary host for the iron ore mineralisation.

Table 13-1: Baby Hope land systems and land units

Land System	Description
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands

The valley floor is dominated by the floodplain of Pebble Mouse Creek, which ranges in width from 300 m to 500 m. Pebble Mouse Creek is a meandering, flood dominated system, characterised by intermittent flow and infrequent flooding, resulting from high rainfall events in the upper catchment.

The flow regime of Pebble Mouse Creek adjacent to Baby Hope has already been altered by the construction of the HD1 rail crossing, immediately downstream of Baby Hope, which causes water to back up behind the rail, artificially increasing the floodplain width, during large (greater than 20 year annual recurrence interval) flood events. There are no permanent water bodies or water sensitive areas in the local area.

Groundwater is hosted within the regional karstic dolomite aquifer, within the Paraburdoo Member of the Wittenoom Formation. The groundwater is fresh to slightly alkaline with low total dissolved solids, ranging between 260 mg/L and 540 mg/L, and pH varying between 6.7 and 8.1.

The groundwater table beneath Baby Hope rises from 585 m RL in the east to 595 m RL in the west, roughly 50 m below the valley floor. Dewatering of HD1 South pit has already lowered the groundwater level at the eastern end of Baby Hope by an additional 5 m (approximately 580 m RL).

13.2 SOIL

13.2.1 LOCAL SOILS

The dominant soil types covering Baby Hope are shallow coherent and porous loamy soils of a non-cracking nature. Field tests carried out on the soils determined that they slake rather than disperse. The soils are non-sodic and typically acid to neutral in the upper 20 cm (defined as the topsoil) of the profile with the subsoils being neutral to alkaline. Trace element analysis does not indicate any potential deficiencies or toxicities.

Subsoil has physical properties suitable for plant growth and generally has chemical properties amenable to plant growth, although it does lack the high nutrient content, organic matter, soil seed back and mychorrihizal fungi properties of topsoil.

In the northern hills and rock ridges, extensive areas without soil cover occur. The Marra Mamba Iron Formation weathers very slowly, and those soils that do occur are shallow and skeletal. As a consequence of the sparse vegetation cover and erosion force of heavy rains, associated with Pilbara thunderstorms, soil that forms on the northern range tends to be transported into the valley below.

The soils on slopes, although having had more time to develop than the soils of the adjacent ridges, are still influenced by the parent rock and may be shallow and stony sands or loams. These colluvium dominated soils are generally unfavourable for plant growth due to low moisture holding capacity and poor nutrient status.

On the alluvial plain, hard alkaline red loamy soils tend to be dominant, and may be considered as the regional mature soil type. These soils may contain layers of small gravel, derived from the more resistant rocks in the area, that have been deposited as part of flood activities.

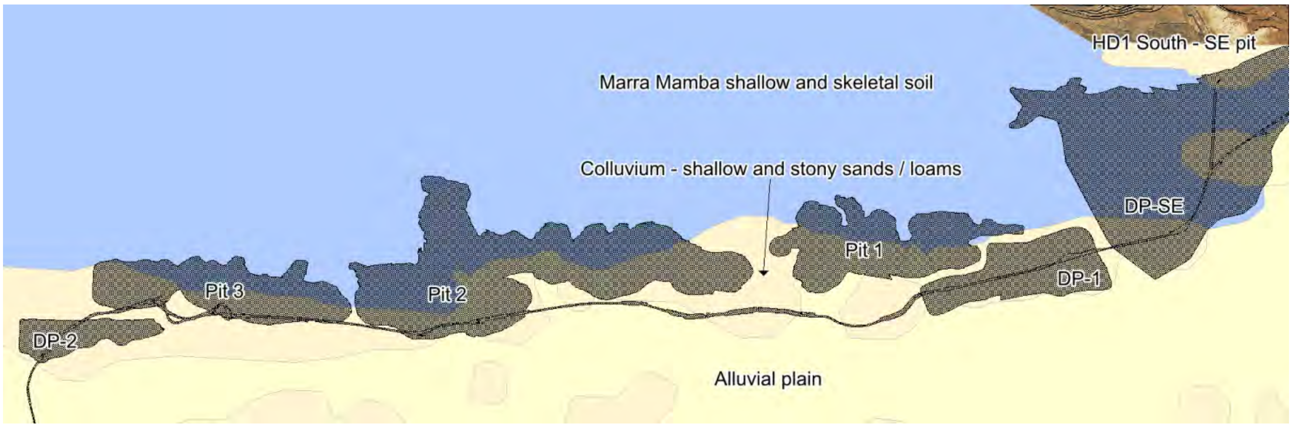

Figure 13-1: Pre-disturbance soil distribution with respect to proposed Baby Hope footprint.

13.2.2 SOIL INVENTORY

During operation of the mine, topsoil recovery and soil viability will be maximised by:

- stockpiling grubbed surface vegetation to provide a supply of additional seeds and organic matter for the soil;
- collecting more than the minimum 200mm mandated quantity of topsoil where available;
- storage of topsoil in stockpiles no more than 2m high (or one truck paddock dumped tip height, when using larger trucks) in sign posted, restricted access areas;
- collection of subsoil up to 600mm where available;
- collecting additional subsoil where practicable / available;
- maintaining a soil inventory; and
- regularly reconciling the available and project soil requirements to the projected life of mine disturbance areas.

A soil inventory for Baby Hope will be developed at the commencement of operations, and will be maintained throughout the life of the operation, to ensure that there is sufficient soil available to achieve successful rehabilitation.

13.3 MINERAL WASTE CHARACTERISATION

13.3.1 PHYSICAL CHARACTERISTICS

Mineral waste expected to be generated at Baby Hope includes:

- detritals, including colluvial and alluvial deposits of sand, gravel and a high proportion of clay, canga, limonite or bedded goethite, pisolite and red ochre detritals;
- Nammuldi Member, characterised by cherty Banded Iron Formation (**BIF**) and thin shale beds, including a silica-enriched hydrated or hardcap zone;
- MacLeod Member, comprised of BIF, chert, carbonates and inter-bedded shales, including a silica-enriched hydrated or hardcap zone;
- Mt Newman Member, also comprised of BIF, chert, carbonates and inter-bedded shales; and
- West Angela Member, characterised by laminated pink, khaki and grey shales with minor chert and BIF bands.

The erodibility potential of the mineral waste was assessed using a combination of site-specific geophysical test work and extrapolation from equivalent material found at similar Pilbara sites. Table 13-2 lists the mineral waste types by erodibility class and percentage of total mineral waste predicted to be generated by closure.

Table 13-2: Mineral waste erodibility characterisation

Mineral waste type	Erodibility	Percent total waste
Detritals	High	72%
West Angela Member	High	14%
Mt Newman Member	Low	10%
Hydrated - Nammuldi Member and MacLeod Member	Low	4%

13.3.2 GEOCHEMISTRY

Ore and waste samples have been submitted for Acid Base Accounting (**ABA**) and geochemical characterisation. The geochemical characterisation process has established that sulphur content is an indicator of acid generation potential. When appropriate, further kinetic testing of materials has been undertaken to improve the geochemical characterisation. Results from the geochemical characterisation are applied to the geological block model and subsequent mining model, to ensure materials with potential geochemical issues are identified prior to mining and managed.

For lithologies such as banded iron formation (**BIF**) and detrital rock types, a value of 0.3% total sulphur concentration has been adopted as the boundary value to differentiate potentially acid forming (**PAF**) material from inert / non-acid forming (**NAF**) material. Samples associated with elevated-sulphate (where sulphur values may range from 0.1% to greater than 1%) have been classified as Potentially Acid Forming - Low Capacity (**PAF-LC**). The volume of mineral waste with sulphur values above 0.1% and 0.3% are used to evaluate geochemical risk.

To date, most of the samples submitted for ABA were classified as NAF. Only three samples, from lignite and siderite geologies, had sulphur levels greater than 0.1%, two samples with sulphur values of 0.48% and 0.33% were classified as PAF, while the third had a sulphur level of 0.15% and was classified as NAF and had a measured acid neutralising capacity of 105 kg H_2SO_4/t.

Further analysis of sulphur values was undertaken on those rock types identified with acid-forming potential (and any related metalliferous drainage). The risk posed by the high sulphur values is determined by comparing the occurrence of sulphur levels greater than 0.1% and 0.3% against the total number of recorded drill samples for all in-pit (waste and ore) samples. These results, summarised in Table 13-3, suggest the risk of acid drainage being generated during the operation and / or from mineral waste is low.

Table 13-3: Acid-forming potential risk based on sulphur values.

Deposit	Sulphur levels greater than 0.1%	Sulphur levels greater than 0.3 %	AMD Risk
HD1 SWMM	2.3 %	0.3 %	Low

A multi-element analysis was also undertaken for all drillhole samples. Results showed that most rock types are either enriched or elevated in Fe, as correlated with the iron mineralisation associated with the ore body. Arsenic is enriched in most rock types while tin is generally elevated. Manganese is enriched in lignite, siderite, Wittenoom Dolomite and West Angelas Shale waste and tends to be elevated in the rock types close to the surface. Sulphur is enriched or elevated in lignite and siderite. (Note, drillhole samples include materials outside of the pit shell and, as a consequence, these materials will not necessarily contribute to the mineral waste.)

In general, whilst concentrations of some trace elements of potential environmental concern (e.g. arsenic, lead) were enriched or elevated in some of the sampled ore and waste materials, these elements will not necessarily mobilise into groundwater. Arsenic, in particular, is commonly enriched in iron ore and mineral waste for many Hamersley Group deposits, including the Marra Mamba Iron Formation. Iron oxy-hydroxides such as hematite and magnetite have high sorption capacities for arsenic.

These results suggest groundwater monitoring should initially include the following elements: Fe, As, Mn, Sn, S and Zn (based on elevated Geochemical Abundance Index triggers) and Mn, V, S, Pb, Zn and Co (based on potential for elevated levels in elements of environmental significance).

13.3.3 FIBROUS MINERALS

Naturally occurring silicate minerals can have fibrous habits. Fibrous minerals pose a risk when fibres of a respirable size become airborne and are inhaled. Respirable fibres are defined as being less than 3 microns wide, more than 5 microns in length and with a width to length ratio of greater than 3:1, and are classified as hazardous fibrous material.

In the HD1 region, the most commonly identified silicate minerals are the non-fibrous (massive) riebeckite and the asbestiform mineral crocidolite. Riebeckite is an indicator to the likely presence of crocidolite. Both minerals are usually associated with fresh, unweathered BIF.

Crocidolite has been encountered during geological sampling at Baby Hope, and there is potential for this material to be in excavated during mining.

When fibrous materials are encountered, management of the material will be guided by health and safety requirements. With respect to closure, actions that are undertaken include:

- establishing the fibrous material risk;
- completing risk assessments prior to entering or disturbing areas with potential fibrous risk, to ensure appropriate personal protection equipment is worn; and
- encapsulating intersected / identified fibrous mineral waste in 2 m thickness of non-fibrous mineral waste, in a location where the material will not be disturbed on closure.

13.4 SITE CONTAMINATION

There is no contamination present at Baby Hope. An internal contaminated sites register will be established for Baby Hope, once construction activities commence, and maintained throughout the life of the mine.

14 BIODIVERSITY

Baseline surveys of terrestrial flora and vegetation, terrestrial fauna and subterranean fauna have been undertaken at Baby Hope and in the surrounding environment (Appendix C). This information has been used to identify biodiversity / ecosystem values of relevance to the closure of Baby Hope and to inform the rehabilitation process.

14.1 FLORA

Table 14-1 describes the significant flora that has been identified in the surrounding environment and their habitat relationships. Activities associated with Baby Hope are not expected to disturb any species listed in Table 14-1. This includes changes to abundance, species diversity, geographic distribution and / or productivity of flora at species or ecosystem levels.

Table 14-1: Significant flora and its relationship to habitat in the wider environment.

Flora taxon	Conservation status WA	Habitat comments
Lepidium catapycnon	Threatened	Skeletal soils. Hillsides. Not recorded at Baby Hope.
Eremophila sp. Hamersley Range	1	Rocky gullies and gorges. Not recorded at Baby Hope.
Hibiscus sp. Gurinbiddy Range	2	Gullies and steep, rocky hill slopes. Not recorded at Baby Hope.
Goodenia lyrata	3	Red sandy loam, near claypan (terminal basin). Not recorded at Baby Hope.
Acacia aff. *subtiliformis*	3	Rocky calcrete plateaus. Not recorded at Baby Hope.
Eremophila magnifica subsp. *velutina*	3	Skeletal soils over ironstone. Recorded adjacent to the Baby Hope development.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	3	Red brown clay soil, calcrete pebbles. Low undulating plain, swampy plains. Not recorded at Baby Hope.
Eremophila forrestii subsp. *viridis*	3	Flat to undulating plains. Not recorded at Baby Hope.
Eremophila youngii subsp. *lepidota*	3	Stony red sandy loam on flats, plains and floodplains. Not recorded at Baby Hope.
Acacia bromilowiana	4	High in landscape, summit of hill and on steep slope, skeletal red gritty soil over massive basalt type rock. Not recorded at Baby Hope.
Eremophila magnifica subsp. *magnifica*	4	Stony red sandy loam on flats, plains and floodplains. Recorded at numerous locations within and immediately outside of the Baby Hope Development Envelope.

14.2 TERRESTRIAL FAUNA

Significant fauna species that have been identified as present, or as potentially present, in the surrounding environment are listed in Table 14-2. A short-range endemic mygalomorph spider, *Aname* sp. 37, was also identified in the surrounding environment.. Activities associated with Baby Hope are not expected to impact the conservation status of any fauna species, populations or fauna habitat. This includes changes to abundance, species diversity, geographic distribution and / or productivity of flora at species or ecosystem levels.

Table 14-2: Significant fauna and its relationship to habitat in the wider environment.

Fauna species	Conservation status WA	EPBC Act status	Habitat occurrence	Comments
Dasyurus hallucatus (northern quoll)	Schedule 1	Endangered	Gullies Disturbed	Not recorded at baby Hope. Prefers rocky gorge / gullies near water.
Liasis olivaceus barroni (olive python)	Schedule 1	Vulnerable	All hill habitats	Not recorded at Baby Hope. Widespread in rocky areas, showing a preference for rocky habitats near water, particularly rock pools. Unlikely to reside in area, but may transit.
Falco peregrinus (peregrine falcon)	Schedule 4	-	All habitats	Recorded in greater HD1 area. Ranges across habitats in search of food
Falco hypoleucos (grey falcon)	Priority 4	-	All drainage habitats	Not recorded at Baby Hope. Ranges across habitats in search of food. Prefers lightly wooded coastal and riverine plains.
Pseudomys chapmani (western pebblemound mouse)	Priority 4	-	All hill habitats	Recorded in Greater HD1 area and Baby Hope. Prefers rocky, hummock grasslands, with little or no soil. The western pebble-mound mouse occupies burrows beneath mounds of pebbles. Mounds are most common on the spurs and lower slopes of ridges
Ardeotis australis (Australian bustard)	Priority 4	-	Plains	Recorded in Baby Hope and Greater HD1 area. Prefers lightly wooded country next to daytime shelter of thickets or long grass.
Burhinus grallariuss (bush stone-curlew)	Priority 4	-	All valley habitat	Not recorded at Baby Hope. Prefers tussock grassland, Triodia hummock grassland, grassy woodland and low shrublands
Merops ornatus (rainbow bee eater)		Migratory	All valley habitats	Recorded in Greater HD1 area. Found within open forests, woodlands and shrublands, and cleared areas. Open pit walls may be utilised to build nesting tunnels

14.3 SUBTERRANEAN FAUNA

Troglofauna that have been identified at Baby Hope include species from the Palpigradi, Pseudoscorpiones, Diplura and Schizomida orders. Habitat mapping suggests troglofauna inhabit the surface geological units of colluvium, Marra Mamba Iron Formation and Brockman Iron Formation. These geological units dominate the surrounding environment; such that troglofauna habitat will be present outside of the Baby Hope area.

14.4 TERRESTRIAL HABITAT

A habitat is made up of physical factors such as soil, moisture, range of temperature, shelter and availability of light as well as biotic factors such as vegetation, availability of food and the presence of predators. Habitats provide a simple method of dividing the land into areas with common characteristics. The biodiversity significance of a habitat may subsequently be measured in terms of the range of habitat types, habitat coverage or with respect to the diversity or rarity of species within the individual habitats.

The habitat units (Figure 14-1) identified at Baby Hope are described in Table 14-3 and include:

- Hill habitats, set in Marra Mamba Iron Formation geology, including:
  - hilltop, which includes rugged top, slope, ridge and cliff features; and
  - gullies, including scree slopes.
- Valley habitat, specifically:
  - plains, including colluvium and foot slope hills.
- Drainage habitats, specifically:
  - creek, dominated by Pebble Mouse Creek.

Creek habitat is considered to have high biodiversity value, due to the diversity of microhabitats. Hilltop and gully habitats are considered to have moderate biodiversity value due to the specialty habitat and / or number of fauna that may utilise the area, while plains habitat has the lowest value.

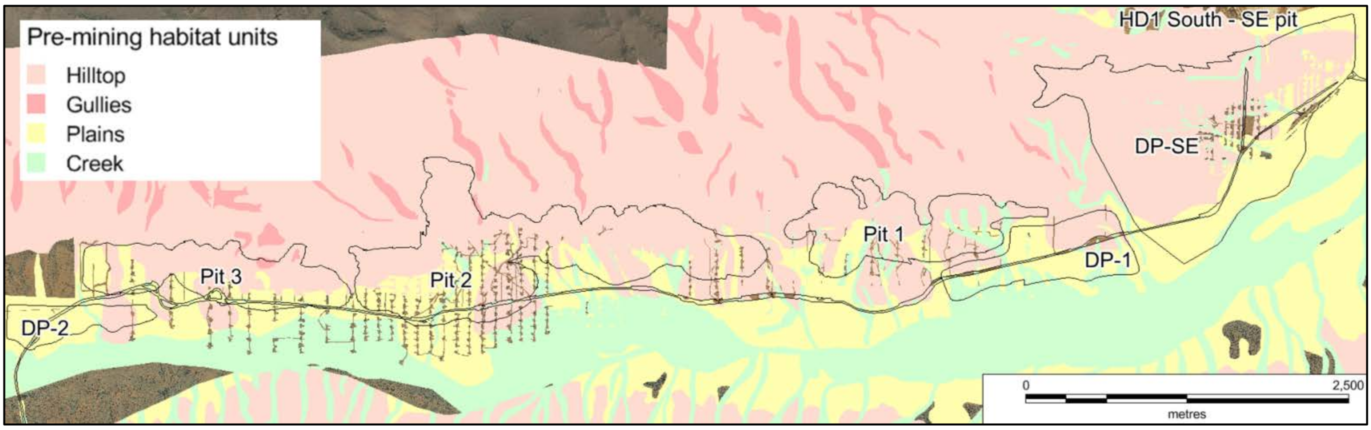

Figure 14-1: Baby Hope existing habitat units.

Table 14-3: Habitats at Baby Hope

Type	Basic description	
Hill habitats		
Hilltop		Hills, ridges, plateaux remnants, gorges and breakaways of varied geological origin. Soil is generally skeletal sandy clay loams with greater than 80% stony detrital material. Under natural conditions this habitat zone is characterised by a scattered overstorey of Snappy gum *Eucalyptus leucophloia* and mulga (*Acacia aneura* complex) isolated trees over sparse shrubland of a combination or selection of *Senna artemisioides* subsp. *artemisioides, S. artemisioides* subsp. *filifolia, Ptilotus rotundifolius, Tribulus suberosus, Eremophila fraseri* and *Acacia ancistrocarpa* sparse shrubland to isolated shrubs over *Triodia pungens* hummock grassland. Rocky, sheltered ridges and breakaways provide a suite of specialist plants or species more typical of lowlands. This habitat creates a diverse array of microhabitats and refugia. The habitat often contains rock shelters in the form of overhangs, cracks, crevices, caves and areas for water to pool during the wet season. Vegetation provides microhabitats in the form of logs, debris and hollows. This habitat zone will be present in undisturbed areas of the mine and may evolve around the edge of the disturbed mine area especially where the pit shell intersects local hills after erosion processes occur. However the characteristics of this habitat are not compatible with the closure landform is unlikely to be restored or introduced as part of the rehabilitation activities.
Gullies		Very steep topography with an irregular surface with little exposed soil. The soil, when available, is sandy to sandy-clay. Under natural conditions gully habitats are only marginally different from the community that happened to surround them (i.e. other hill habitats). Usually species poor, with occasional eucalypts over *Triodia* species. This habitat creates a diverse array of microhabitats and refugia. The habitat often contains rock shelters in the form of overhangs, cracks, crevices, caves and areas for water to pool during the wet season. Vegetation provides microhabitats in the form of logs, debris and hollows. This habitat zone will be present in undisturbed areas of the mine, although the habitat is unlikely to be restored or rehabilitated as part of rehabilitation activities.

Type	Basic description	
Valley habitats		
Plains		Low and undulating alluvial plains including outwash areas and broad drainage basins. Under natural conditions soils often consisting of sandy-clay soils covered by rocky lag gravel. The habitat is characterised by open woodland of *Eucalyptus gamophylla* and other eucalypts and acacia species over *Triodia* spp. open hummock grassland. This habitat type contains limited microhabitats with the dominant Acacia species providing no tree hollows, few logs, limited leaf litter and sparse vegetation. SRE invertebrate species usually comprise mygalomorph (trapdoor) spiders, scorpions, pseudoscorpions and isopods. Most SRE invertebrates prefer the southern footslopes where sun exposure is reduced and the level of moisture under shrubs and trees is increased. This habitat zone will be present in undisturbed areas of the lease. Characteristics of this habitat may be suitable for rehabilitation planning and could be considered where there is the opportunity for deep soils to develop, i.e. on waste dumps.
Drainage habitats		
Creek		A linear habitat characterised by regular surface water flows, defined banks and associated riparian vegetation corridor. The creek habitat includes areas that are periodically flooded due to high surface water flow volumes (floodplains). Vegetation is characterised by open woodland of *Eucalypts victrix, E. camaldulensis*, *Acacia citrinoviridis* and *A. coriacea* subsp. *pendens*, over shrubland and sparse tussock and/or hummock grasses. Creek habitats act as wildlife corridors that help flora and fauna disperse across the landscape. There is a high diversity of microhabitats including logs, debris, tree hollows and soft soils, as well as temporary and permanent pools. This habitat zone will be present in undisturbed areas outside of the mine. Disturbed creek habitat, i.e. access roads that cross creeks will be rehabilitated with the aim of returning the land to functional creek habitat.

14.5 WEEDS

Table 14-4 lists the weed species identified in the environment at or surrounding Baby Hope. Although the land is designated as unallocated vacant crown land, stray cattle were observed to graze in the vicinity of Baby Hope, in the creek and plains habitats, prior to the development of HD1. The presence of cattle is linked to higher numbers and diversity of weed species in these habitats.

Weed management will be undertaken during operations, and on closure, in accordance with the Parks and Wildlife 2013 Pilbara weed species ranking action response recommendations:

- Very high - objective is eradication;

- High - objective is eradication or control to reduce;
- Medium - objective is control to reduce or containment;
- Low - objective is containment at key sites only; and
- Negligible - no action to be undertaken but may include monitoring only.

Table 14-4: Weed species identified at and in the environment surrounding Baby Hope.

Scientific name	Common name	Pilbara weed species ranking
Acetosa vesicaria (L.) A.Love	Ruby Dock	Medium
Aerva javanica	Kapok	Low
Alternanthera pungens	Khaki weed	Low
Argemone ochroleuca	Mexican Poppy	Low
Bidens bipinnata	Beggars Tick	Low
Cenchrus ciliaris	Buffel grass	Low
Cenchrus setiger Vahl	Birdwood Grass	Low
Citrullous colocynth	Pig mellon	Low
Cynodon dactylon	Counch grass	Low
Datura leichhardtii	Native Thornapple	Low
Setaria verticillata	Whorled Pigeon grass	Low
Sigesbeckia orientalis	Indian Weed	Low
Solanum nigrum	Black Berry Nightshade	Low
Malvastrum americanum	Spiked Malvastrum	Negligible
Sonchus oleraceus	Common Sowthistle	Negligible
Chloris virgata	Feathertop Rhodes Grass	To be advised

CLOSURE RELATED DATA AND ANALYSIS

15 LANDFORM DESIGN

15.1 MINERAL WASTE MANAGEMENT

Mineral waste dumps, DP-1, DP-2 and DP-SE, are proposed to be established outside the Baby Hope pits (Figure 15-1).

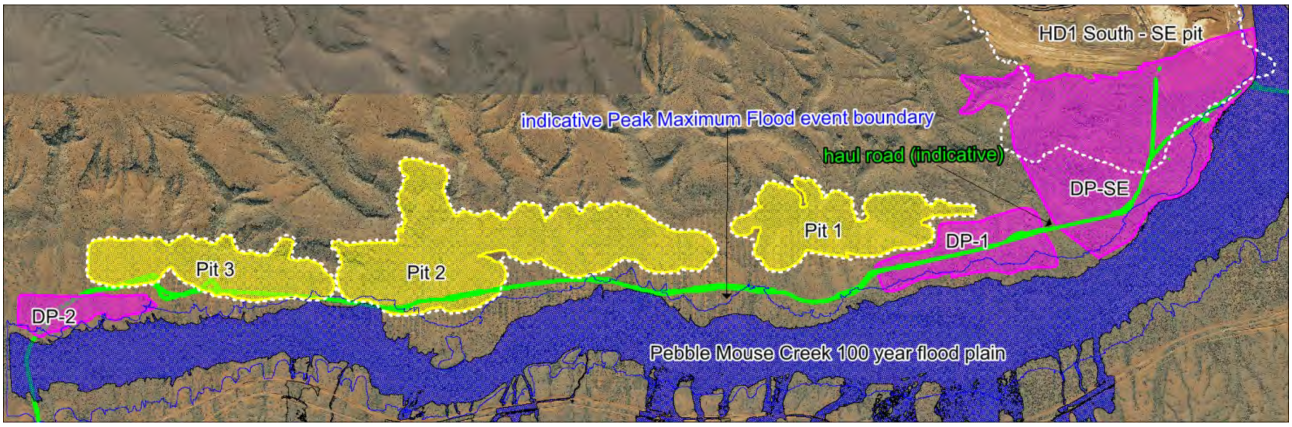

Figure 15-1: Baby Hope pits (mine voids) and waste dumps

Siting and design of the waste dumps has considered:

- climatic conditions present at the site;
- location, including in pit disposal / backfill and surface water considerations;
- maximum dump height and footprint constraints;
- shape of waste dump, preferably to minimise surface area to volume ratio;
- expected presentation sequence of different material types;
- shaping and flood protection options for the top of the waste dump.

Siting of the waste dumps has also considered the estimated geotechnical zone of instability, to ensure waste dumps located external to the mine voids are not compromised by pit wall subsidence and / or collapse.

Waste dump rill erosion, and subsequent gully development, is minimised by controlling the size of surface water catchment areas on waste dump slopes. Mineral waste erodibility properties have been used to define the lift heights, berm widths and (batter) slope angles (Table 15-1) required to shape suitably stable slopes given local rainfall conditions. These parameters are based on test work, which suggests that an average erosion rate of <5 t/ha/y, averaged over the entire slope length, together with a predicted maximum erosion rate at any point on the slope of <10 t/ha/y, will minimise rill erosion. Erosion rates on the final landforms may differ from these values, however, due to waste dump specific variations in final surface mineral waste types, surface treatments, plant growth and drainage controls.

Mineral waste characteristics will be periodically reviewed during the mine life. If the mineral waste proves to be more competent than expected, opportunities to optimise the waste dump design will be explored, e.g. to reduce the waste dump footprint.

The waste dumps will be constructed in two stages. Initially, waste dumps will be constructed in 7 m lifts with 19 m berms with slopes at the natural angle of repose (slope formed as it is tipped off the back of the haul truck). The waste dump slopes will be flattened or battered during rehabilitation, to create the landforms described by Table 15-1.

Table 15-1: Waste dump inventory and rehabilitation design information

Waste dump	Predicted erodibility	Lift height (m)	Rehab berm width (m)	Batter slope angle (degrees)	Indicative max height (m)	Comment
DP-1	High / soft	7	10	20	60	
DP-2	High / soft	7	10	20	40	
DP-SE	High / soft	7	10	20	90	Height 90m above pit crest

DP-SE will be constructed in the southern portion of the HD1 South SE pit, once the ore in HD1 South SE pit is exhausted. The resulting waste dump will extend from the floor of the pit to the pit crest, and will then be extended above and over the pit crest, to merge with eastern range and land to the south of the HD1 South SE pit.

As mining is progressed in the Baby Hope pits, and the ore in the Baby Hope pits is exhausted, mineral waste is expected to be progressively returned to the mine void in the form of in pit backfill and / or as internal waste dumps (Figure 15-2).

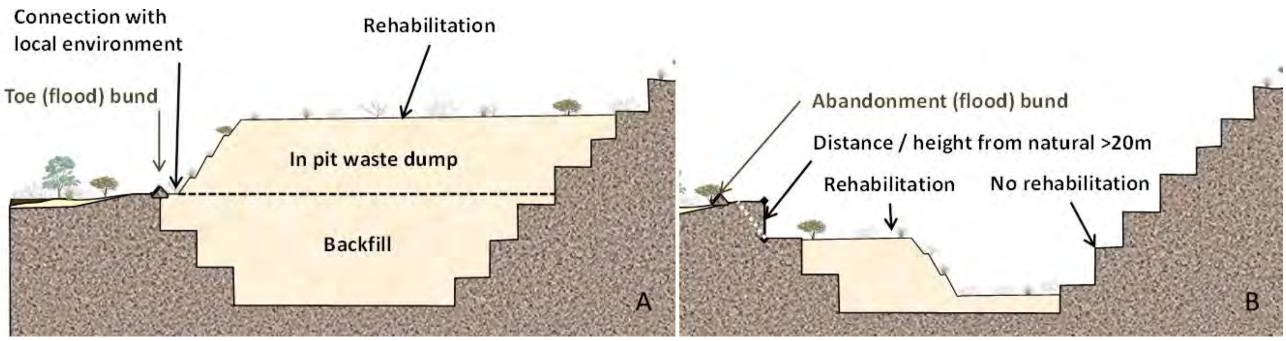

Figure 15-2: All waste dumps and backfill will be rehabilitated. Bare rock areas, such as the pit walls, will not be rehabilitated.

Prior to the commencement of rehabilitation activities, the final landform design will be reviewed by a multi-disciplinary team to resolve final design details including drainage management. As illustrated in Figure 15-2, all waste dumps and backfill will be rehabilitated. Where portions of the waste dumps are located within the Peak Maximum Flood event area, a toe bund (shown in Figure 15-2 A) or similar flood protection structure will be constructed to prevent erosion.

15.2 VOID MANAGEMENT

Mining at Baby Hope will occur above the water table. Three pits are planned to be developed. As illustrated in Figure 15-3, the pits will extend below the natural surface and into the adjacent hills. All three mine voids are expected to be present at closure.

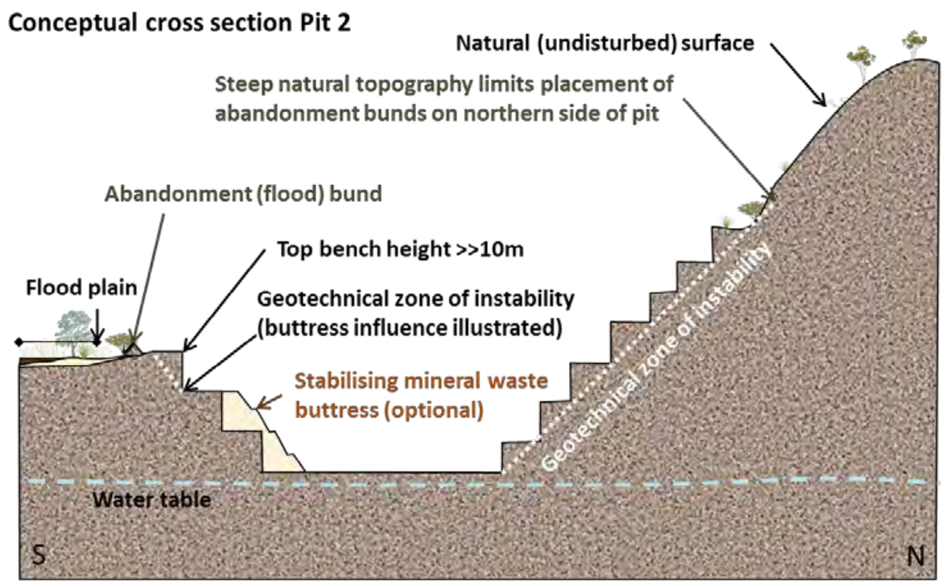

Figure 15-3: Conceptual cross section (south to north) through the centre of Baby Hope Pit 2.

Surface water runoff from the small, rocky hills immediately above (north) of the mine voids will be left to flow over the pit wall, to be captured in the pit. This water is expected to create temporary pools that dissipate via evaporation and infiltration after the rainfall ceases.

Structures will be erected to prevent inadvertent public access to areas where the ground may be unstable, due to erosion and /or mass movement in the pit wall, the geotechnical zone of instability. The geotechnical zones of instability are presented in Figure 15-4 to Figure 15-6.

The geotechnical zone of instability adjacent to Pebble Mouse Creek is difficult to establish prior to mining, due to the uncertain occurrence of infiltration groundwater and varying wall rock properties (dominance of detrital materials in upper benches). Geotechnical assessment of the pit wall is proposed to be undertaken once the pit is developed. Results from this assessment will be used to refine the geotechnical zone of instability. If the geotechnical zone of instability extends into the Pebble Mouse Creek floodplain, additional management, such as partial backfill or the construction of a stabilising buttress (as illustrated in Figure 15-3), will be undertaken to limit the zone of collapse and prevent impacts to Pebble Mouse Creek floodplain.

On the southern side of the mine voids, in the low foothills and plains, abandonment bunds will be constructed 10m outside the geotechnical zone of instability to prevent inadvertent public access.

Abandonment bunds would be difficult to install on the northern side of the mine voids, which is dominated by steep, inaccessible topography; and installation of abandonment bunds in the gullies could dam surface water runoff and impact gully ecosystems. Consequently, alternative solutions to prevent inadvertent access to the mine void from the north will be investigated and discussed with the relevant stakeholders, prior to closure.

Exposed rock surfaces, such as those areas that are generated in the pit walls, will not be revegetated on closure.

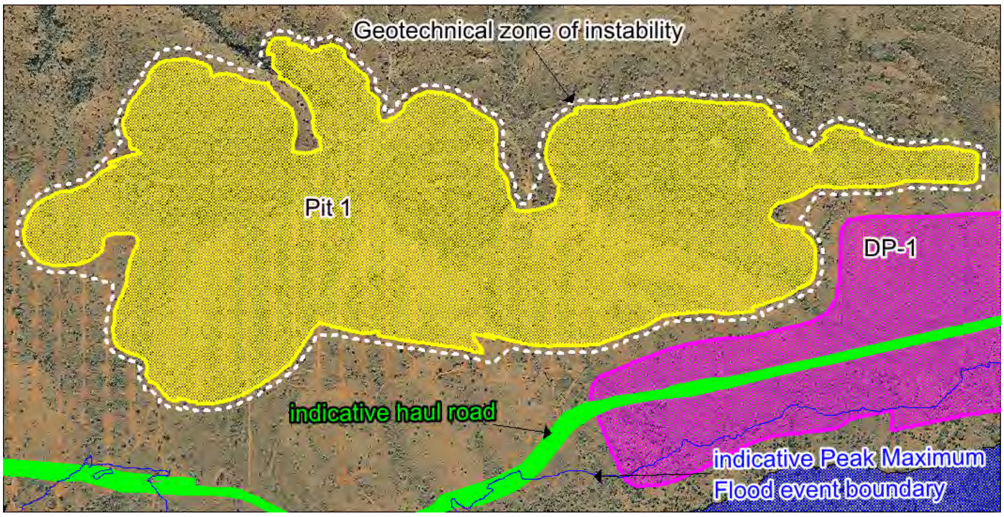

Figure 15-4: Baby Hope Pit 1 with geotechnical zone of instability and estimated extent of a peak maximum precipitation flood event.

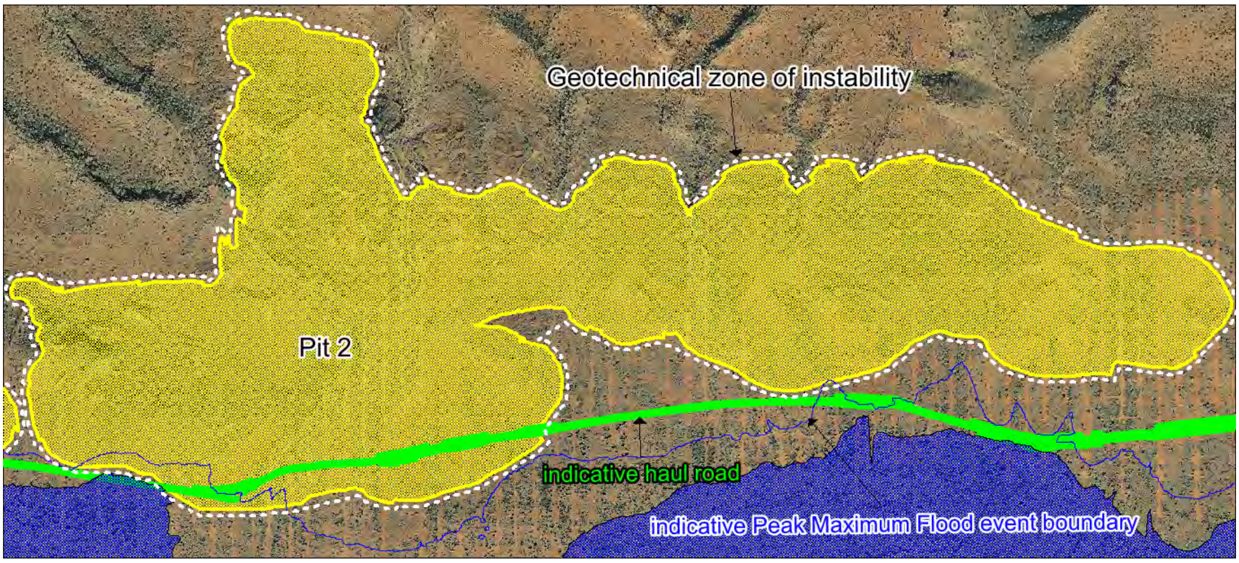

Figure 15-5: Baby Hope Pit 2 with geotechnical zone of instability and estimated extent of a peak maximum precipitation flood event.

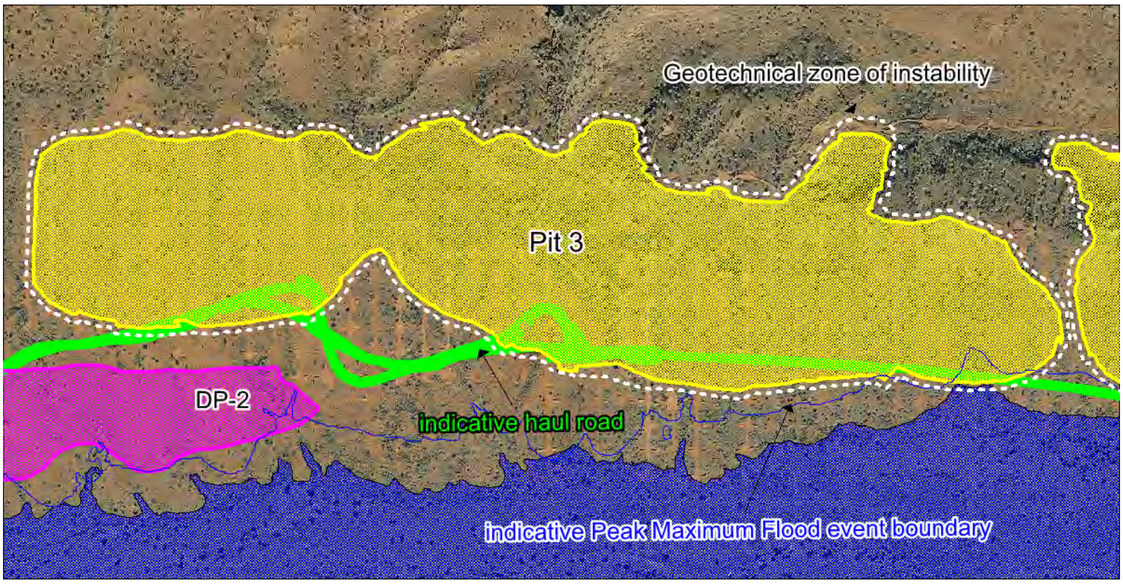

Figure 15-6: Baby Hope Pit 3 with geotechnical zone of instability and estimated extent of a peak maximum precipitation flood event.

15.3 FLAT AND UNDULATING AREAS

The majority of the infrastructure areas can be described as flat or undulating areas. This includes areas such as laydown areas, haul roads and minor buildings. Rehabilitation of these areas is subject to detailed design, expected to be undertaken immediately prior to rehabilitation, in accordance with the following guidelines:

- Any steep slopes that have been artificially constructed will be dozed or shaped to less than 20 degrees or rock armoured to prevent erosion, unless it can be demonstrated that the structures are stable in the long term. (High disturbance areas)
- Areas with less than 1m relief will be re-contoured, to control runoff and so that the landform blends in with the surrounding landscape. If the area is large with a slight slope, then shallow windrows may be constructed on the contour approximately every 50m to prevent erosion from large sheet water flows. (Moderate disturbance)
- Where practical, areas will be ripped or scarified to remove compaction and encourage water infiltration and plant growth. On slopes, areas will be ripped parallel to the topographic contours. Roads are usually ripped along their length if they are not wide enough for contour ripping. Compacted areas such as haul roads require deep ripping (e.g. dozer Tyne at depth of ~1 m).

15.4 MINOR DRAINAGE

Drainage management at closure is expected to be limited to:

- removing roads, culverts and floodways across creeks and minor drainage lines;
- following the removal of infrastructure, reinstating minor drainage lines / surface water flow systems and repairing creek beds, banks and associated vegetation;
- implementing localised surface water controls on / around waste dumps, e.g. runoff from ridge lines onto waste dumps; and
- ensuring adequate flood erosion protection for landforms located adjacent to the Pebble Mouse Creek floodplain, e.g. rock armouring of abandonment bunds within the peak maximum flood area.

These minor drainage works will aim to:

- ensure the long term safety and stability of engineered landforms e.g. considering local climate and climate change;
- reinstate local drainage in such a way that impacts on local hydrology is limited e.g. maintain flows, minimise erosion and sedimentation; and to
- use the latest waterway design practice and monitoring evidence to guide design.

Minor drainage design works require a comprehensive understanding of the local long-term landforms. As a result, closure drainage designs cannot be effectively generated until the future landform is known and no further land disturbance is proposed. Consequently, drainage design activities for these minor drainage works will only be undertaken as part of progressive rehabilitation activities or immediately prior to closure.

In general, re-instated and constructed drainage will be designed in accordance with the following guidelines:

- The final profile of the constructed drainage line will consist of a flat base and sloped banks to allow for free drainage. Depth should not exceed 0.5m.
- The channel width will be determined based on the estimated volume of water that is anticipated to flow down the channel. In areas where friable, easily erodible material exists, or where there is the potential for high flow velocities, it may be necessary to cover the base of the constructed channel with BIF rock material or available equivalent.
- Where possible, the channel will be designed to meander such that the constructed channels have characteristics similar to the surrounding region, e.g. are not all linear features.
- The constructed channel will be blended in with any natural drainage lines.

16 PLANT AND SOIL DEVELOPMENT

16.1 HABITAT PLANNING

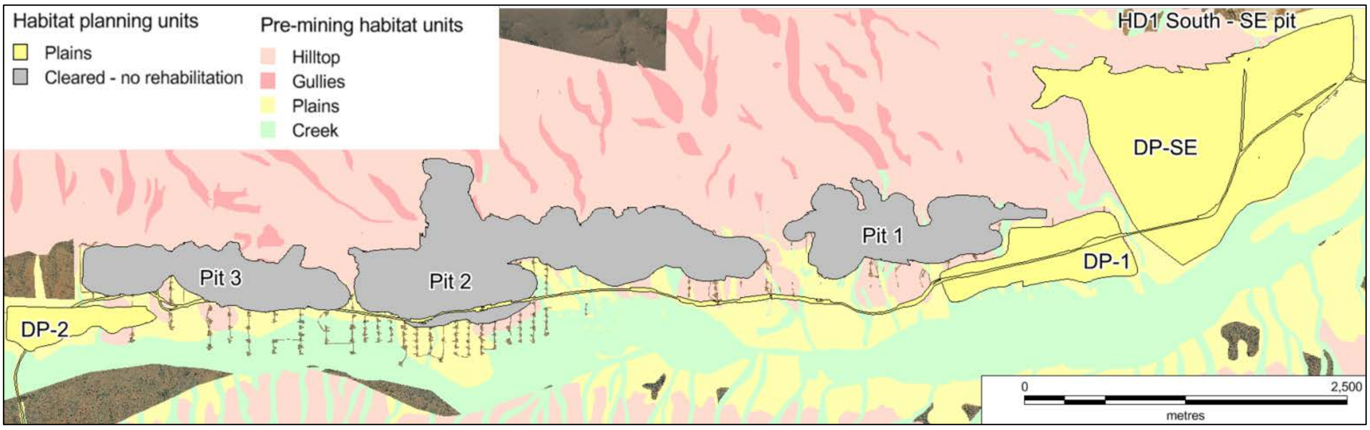

Figure 16-1: Baby Hope habitat plan.

The habitat plan (Figure 16-1) integrates mine related landscape changes with the habitat properties of the pre-mining and adjacent environment (Table 14-3), to illustrate how the land is expected to function in the longer-term, post-closure. Mine related landscape changes that are considered as part of habitat planning include:

- introduction of new topographical features, e.g. waste dumps, mine voids etc.;
- change in surface water flow direction, volume or loss (infiltration) rates;
- increased soil profile depth;
- change to groundwater depth; and
- topographical aspect and solar radiation.

As a strategic vision for the site, the habitat plan is used to facilitate discussions with stakeholders, to align expectations, identify alternate land uses and biodiversity opportunities, and to guide progressive rehabilitation planning. The habitat plan includes revegetating:

- backfill and waste dumps, whether located outside or within mine voids, to reflect the characteristics of a plains habitat ecosystem, due to the deep substrate associated with these structures;
- disturbance within the Pebble Mouse Creek floodplain to reflect the characteristics of creek habitat, appropriate to the surrounding vegetation; and

- all other disturbance areas, outside the geotechnical zones of instability, to reflect the most appropriate habitat unit, to ensure the rehabilitation is sympathetic to the surrounding environment.

Descriptions of the habitats are provided in Table 14-3.

Natural migration of flora and fauna species into rehabilitated land will be encouraged by re-establishing connectivity with undisturbed areas of similar habitat at closure, and by maintaining the quality of these undisturbed habitats during operations. Natural migration will also be encouraged by integrating fauna habitat improvement opportunities into the habitat and subsequent rehabilitation plans, where appropriate. This includes using:

- plant species known to provide a food or shelter preference (e.g. significant fauna habitat preferences listed in Table 14-2);
- retained woody debris, to create fauna refuge and microhabitats;
- rocky features, i.e. oversized waste burden or scree slopes;
- small-scale topography litter (e.g. furrows created from ripping) to trap and retain leaf litter;
- short lived plant species to rapid generate leaf litter and increase soil carbon; and
- subsoil or inert mineral waste to create habitat for burrowing fauna.

These opportunities will be reviewed throughout the life of the mine and as part of rehabilitation activities.

16.2 REHABILITATION

16.2.1 REHABILITATION DESIGN

Rehabilitation management will be undertaken in conjunction with operational planning to ensure that land with no further mine use is progressively rehabilitated. Rehabilitation designs will be developed in consultation with internal stakeholders and in accordance with existing environmental commitments (including this closure plan). The rehabilitation designs consider (and integrate):

- Construction method and equipment, including appropriate vehicle access.
- Topographic and landscape limitations, such as waste dump height limits.
- Operation and other land user infrastructure, e.g. power lines.
- Final surface material types and associated design requirements / modifications.
- Surface water, including management of run-on, ponding, erosion, sedimentation and the resulting drainage network.
- Surface treatment, including soil requirements, rock armour, habitat improvement opportunities etc.
- Vegetation, including seed selection, availability of seed / seedlings, external stakeholder vegetation preference.
- Monitoring, i.e. access to rehabilitated areas, monitoring technique, record keeping etc.

16.2.2 SOIL APPLICATION

The availability of topsoil significantly improves the potential for rehabilitation success. At Baby Hope, like many sites in the Pilbara, the naturally shallow and rocky soil make it difficult to recover and replace the preferred quantities of topsoil (200 mm) across all disturbed areas. Consequently, it will be necessary to prioritise topsoil application.

Topsoil and subsoil application requirements will be developed as part of rehabilitation activities, at which time the age of the topsoil and other local factors will be considered, e.g. topsoil will be prioritised if plant growth is required to assist with landform stability. Topsoil depth at Baby Hope is expected to range between 100 mm and 200 mm. Subsoil will be applied, where required, to ensure at least 200 mm of good quality growth media is returned to all disturbed areas.

Topsoil will be spread over reconstructed landforms and ripped into the underlying substrate. Stockpiled vegetation is then returned to the area.

16.2.3 SEED SELECTION

Monitoring has shown that in small disturbed areas adjacent to existing vegetation or in areas where fresh topsoil can be utilised (e.g. borrow pits) appropriate species generally re-establish without the need for additional seed. This is because the seed bank in the fresh topsoil remains viable, resulting in good germination and growth, and in some areas seeds can ingress from surrounding vegetation.

In most cases, however, locally collected seed is needed to assist in revegetation and the creation of a self-sustaining ecosystem. Over time the viability of seeds in stockpiled topsoil decreases, and thus the quality of the topsoil deteriorates. In addition the topsoil that was salvaged prior to disturbance may not contain seeds of all the target species of its new location / habitat.

Seeds will be purchased from commercial seed suppliers immediately prior to rehabilitation. Seed mixes will, preferentially, be sourced for local provenance and will be selected to provide a range of species appropriate to the desired habitat, taking into consideration landscape position and slope. In areas where erosion risks are identified, seed mixes may be modified to include or increase the portion of species that provide rapid cover.

Seed mixes may also include species of cultural significance to Traditional Owners, such as bush tucker and medicinal plants, if and when identified through ongoing consultation with Traditional Owners.

The inclusion of rare and threatened flora species in rehabilitation programs is limited by:

- habitat preference, e.g. preference for drainage lines, gullies, calcretes or other habitat not suitable or similar to those likely to be present in the rehabilitated landscapes;
- seed abundance, dormancy and / or availability, e.g. very few populations or small populations from which to source seed; and
- propagation and growth form, e.g. short lived annual species with preference for growth under woodland canopies are unlikely to survive in new rehabilitation areas.

In consideration of these issues, three significant flora species from the Greater HD1 area (refer to Table 14-1) have been identified with the potential for considered in future rehabilitation programs. These species include:

- *Acacia bromilowiana*;
- *Acacia subtiliformis; and*
- *Eremophila magnifica subsp. magnifica.*

Propagation options for *Acacia bromilowiana* and *Eremophila magnifica* subsp*. magnifica* are under investigation to determine how to include this species in rehabilitation activities. Based on their natural habitat, these species are expected to perform at their best in blocky waste materials, which may only be present in small volumes in the closure landform.

Eremophilas are very difficult to germinate from seed. Similarly field observations of *Acacia bromilowiana* have noted the absence of seed set after mass flowering, suggesting this could be a sterile or low fecund hybrid species. Consequently, cuttings may be required to successfully propagate *Acacia bromilowiana* or *Eremophila magnifica* subsp*. magnifica*.

The suitability of *Acacia subtiliformis* for rehabilitation purposes is still under investigation. This species prefers flat areas near calcrete geology. Again, these conditions will occur in limited areas within the closure landform.

Revegetation activities and replacement of topsoil should ideally be timed so that rehabilitated areas are completed prior to the summer wet season, usually commencing in November. This should give the seeds in the rehabilitation area the best chance of germination and survival.

16.3 INVASIVE SPECIES MANAGEMENT

16.3.1 WEEDS

A Weed Management Plan will be developed prior to closure. The Weed Management Plan will build on the Weed Management Plan implemented during operation of the site, and include procedures to:

- identify, control and eradicate target weeds, in accordance with Parks and Wildlife weed species ranking action response recommendations;
- weed hygiene activities for vehicle and earthmoving machines to minimise the distribution of weeds; and
- monitor the effectiveness of weed control measures to minimise the spread of weed species, prevent the introduction of new weeds, and control and / or eradicate high and very high risk weeds across the rehabilitated area.

16.3.2 INVASIVE ANIMALS

Feral carnivores (e.g. cats, dogs, foxes) can create locally increased predation pressure on native fauna as well as increase competition with native species for resources such as space, water and food.

Herbivores (e.g. cattle, camels, donkeys) can also have a significant impact in Rangeland areas, such as the Pilbara. In dry times, grazing pressure reduces the abundance of palatable native species, impacting biodiversity and can create conditions that encourage weeds to grow. Foot traffic impacts the soil conditions, and in combination with over grazing, can encourage erosion. Foot traffic has also been the cause of damage to cultural landmarks and Aboriginal sites. Overgrazing and damaged soils has a flow-on effect to native fauna species that rely on this vegetation for food and shelter.

Strategies for post-closure management of invasive animals will be developed as the site approaches closure, building on successful strategies implemented during the site operation.

16.4 PROGRESSIVE REHABILITATION RESULTS

No rehabilitation has been undertaken at Baby Hope to date. However, Rio Tinto, as manager for the site, has extensive experience in rehabilitating similar landforms in the Pilbara.

17 POST-CLOSURE SAFETY FEATURES

17.1 ABANDONMENT BUNDS

Abandonment bunds will be constructed from inert mineral waste, with a height of at least 2 m, width of at least 5 m at the base, and side slopes greater than 15 degrees (depending on the material type characteristics). Abandonment bunds will be located 10m away from the geotechnical zone of instability. Abandonment bunds located within areas expected to be inundated during a peak maximum precipitation flood event zone will require rock armour. The sizing of the rock armour requires further investigation.

17.2 ACCESS TO HERITAGE SITES

Traditional Owners require ongoing access to sites of cultural significance. The cultural significance of caves located to the north (above) of the Baby Hope pits will be investigated during the operation of the site. Safe access to these caves will be discussed with Traditional Owners, with consideration given to neighbouring land users’ activities (i.e. other mine developments) and other land-use conflicts that may restrict access to the caves over the long term.

17.3 SIGNAGE

Signage will be developed in consultation with the relevant authorities immediately prior to closure. This includes signage of an appropriate size, colour and font, and safety symbols, where appropriate.

IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

18 ISSUE EVALUATION

A closure risk assessment was completed on the proposed closure strategy for Baby Hope. The risk register developed from the risk assessment is included in Appendix C.The assessment was completed by a panel of multi-disciplinary subject matter experts with the aim of:

- identifying hazards, aspects and opportunities that could influence the successful closure of the site;
- evaluating the resulting risks to people, property and the environment; and
- defining the actions required to reduce the risk to below the risk acceptance threshold.

18.1 HAZARDS / ASPECTS IDENTIFICATION

The context and acceptability criteria for the risk analysis was established by reviewing baseline studies, stakeholder consultation, learnings from work undertaken at other sites, and research etc. to identify any knowledge gaps.

Controls and commitments that are currently in place to manage each hazard were subsequently identified. This identification process included a review of the effectiveness of current management plans, procedures, work practice guidelines etc. to identify any management gaps.

Table 18-1 summarises the topics raised / discussed during the evaluation session(s). Aspects reviewed as part of the closure risk evaluation included:

- mineral waste characterisation;
- pit lakes and ground water;
- landform stability;
- surface water implications;
- decontamination;
- biodiversity;
- visual amenity;
- cultural heritage; and
- local communities, communication and consultation.

Table 18-1: Closure context for Baby Hope risk evaluation process

Aspect	Current status
Mineral waste characterisation	Geochemical characterisation of mineral indicates a low potential for AMD generation. Management plan in place to encapsulate fibrous materials when encountered. Large proportion of highly erodible mineral waste.
Water	Use of surface water diversions up stream of pits will be limited. Flow expected to enter pits. Pebble Mouse Creek flows will not be changed as a consequence of mining or closure of Baby Hope. Groundwater will not be altered as a consequence of closure of Baby Hope.
Landform stability	Waste dump footprints are constrained, such that they don't impinge on the Pebble Mouse Creek floodplain extent. Opportunities exist for mineral waste to be returned to the HD1 South and Baby Hope mine voids Stability of pit wall adjacent to Pebble Mouse Creek is expected to be acceptable, but requires validation on mining. Runoff from adjacent hills onto waste dumps, including in pit waste dumps, will require management.
Biodiversity	200 mm topsoil may not be available across the entire area, due to natural skeletal soil. Subsoil will be used. Standard rehabilitation practice is expected to establish sustainable endemic vegetation. Post-closure landforms will not impact on functioning of adjacent communities.
Cultural heritage	No high significance heritage sites located in Baby Hope development area. Section 18 in place, and expect potentially impacted sites to be cleared before closure. Access to sites and repatriation requirements yet to be discussed directly with Traditional Owners.
Other stakeholders	Integration with HD1 closure plan required. Regulatory expectations for closure objectives and criteria for HD1 site may need to be revised / contemporised and further developed.
Visual impact	Potential for public access is limited.
Contamination	Standard management measures sufficient to manage fibrous materials and potential contamination.
Decommissioning of infrastructure	Minimal amount of infrastructure proposed to be established at Baby Hope.

18.2 RISK EVALUATION

Risk was evaluated on the basis of the maximum reasonable outcome consequence and the likelihood of that consequence occurring, e.g. rare, unlikely, possible, likely or almost certain. Risks were evaluated inclusive of current management and commitments, and represent current residual risk. A summary of the risk titles and evaluated risk class are provided in

Table 18-2.

Consequences included in the evaluation were:

- Health: reversible health effects of little concern (very low) to multiple fatalities (very high);

- Personal safety: inconvenient first aid treatments (very low) to multiple fatalities (very high);
- Environment: reversible impact (very low) to widespread, long-term impacts (very high). As some environmental impacts can escalate if immediate identification and remediation is not possible, environmental consequences are also evaluated by:
  - On-site: referring to impacts that occur during the pre-closure and decommissioning phases, when staff are able to utilise site equipment and quickly react to remediate impacts; and
  - Off-site: referring to impacts that occur during the post-closure phase, when remediation may not immediately follow impact identification, due to a need to bring equipment and experts back to site to remediate.
- Community trust: mistrust amongst a small section of the wider community (very low) to widespread mistrust with key stakeholders (very high); and
- Compliance: non-conformance to internal requirements (very low) to prosecution for breach of regulatory licence(s) (very high).

Risks resolved from the evaluation were classified as follows:

- Low (Class I): Risks that are below the risk acceptance threshold and do not require further management.
- Moderate (Class II): Risks that lie on the risk acceptance threshold and require regular review to ensure management remains adequate and fit-for-purpose.
- High (Class III): Risks that, based on the current level of knowledge, could exceed the risk acceptance threshold and require proactive management and / or resolution of knowledge gaps.
- Critical (Class IV): Risks that, based on the current level of knowledge, will exceed the risk acceptance threshold and need urgent and immediate attention to develop an alternative approach.

Actions were assigned to risks that exceeded the risk acceptance threshold. Actions were also assigned to address knowledge gaps and assigned where subject matter experts requested the performance of existing controls and commitments be re-evaluated at some later date. These actions are captured in Appendix C.

Table 18-2: Summary of closure risks at Baby Hope

Risk title	Maximum reasonable consequence evaluation		Risk
	Likelihood	Consequence	
Under-estimated general contaminant clean up requirements	Rare	Low	Class I
Under-estimated acid and / or metalliferous drainage management requirements during operations (pre-closure) & decommissioning phase	Unlikely	Low	Class I
Acid and / or metalliferous drainage generation (after closure) creates a contaminated site	Unlikely	Low	Class I
Human health impacts from in situ fibrous material exposures	Possible	High	Class III
Lake and / or lake fringe habitat has undesirable impacts on general ecosystem function.	Unlikely	Moderate	Class II
Lake poses public liability and / or health risk	Rare	Moderate	Class II

Degradation of regional groundwater quality or levels	Rare	Low	Class I
Wall failure within mine void compromises closure outcomes	Unlikely	High	Class III
Built landforms (excluding mine void areas) erode and / or collapse	Unlikely	Moderate	Class II
Surface treatment on landforms limits vegetation growth	Possible	Low	Class II
Vegetation is not self-sustaining (due to cattle grazing impacts)	Possible	Moderate	Class III
Access through area post-closure poses public liability risk	Unlikely	Moderate	Class II
General environment outside of approved mine disturbance areas is adversely impacted	Unlikely	Low	Class I
Adverse impact to flora or fauna with conservation status or wider regional impact to high value environment	Rare	Very low	Class I
Heritage site condition / cultural value is degraded as a result of implementing the closure plan	Unlikely	Moderate	Class II
Consultation fails to identify stakeholder concerns	Unlikely	Moderate	Class II
Closure outcomes do not meet stakeholder(s) / community expectations	Possible	Low	Class II
A stakeholder's expectations conflict with that of another stakeholder, causing delays to plan approval and / or closure	Unlikely	Low	Class I
Closure strategy prevents or limits future exploitation of resources	Likely	Very low	Class II
Mine closure has a significant, long-term detrimental impact on local communities	Rare	Low	Class I
Closure is not implemented in accordance with the approved closure plan	Rare	Moderate	Class II

18.3 KEY RISKS

Of the 21 risks evaluated three risks were identified that exceeded the risk acceptance threshold. All three were assessed as high (Class III) risks. These risks were associated with:

- fibrous materials management at closure;
- pit wall failure impact to Pebble Mouse Creek; and
- vegetation sustainability given the presence of cattle.

A description of these risks and required actions is provided below. Implementation of the actions is expected to reduce the Class III risks to Class II; however, the risk will be reassessed following implementation of the individual actions.

18.3.1 FIBROUS MATERIALS

Mineral waste characterisation has identified the presence of fibrous materials within the pit shell. A Fibrous Materials Management Plan has been successfully implemented at the Hope Downs 1 operation, encapsulating designated hazardous fibres within in pit waste dumps, and will continue to operate at Baby Hope. At present, however, there is insufficient detail within the Baby Hope mine models to accurately classify and map areas of hazardous (respirable) fibres in the final pit walls. Once the mine models are updated with the latest mineral waste characterisation information, it will be possible to identify potential pit wall exposures and integrate closure solutions into the mine plan.

Fibrous materials risk reduction activity:

Reference	Task
BH-01	Update mine models with fibrous materials risk flags
BH-02	Investigate and map areas of fibrous materials as part of pit design update
BH-03	Identify opportunities to cover declared hazardous fibrous areas during operations or identify how exposures will be covered on closure.

18.3.2 PIT WALL STABILITY

Although the southern pit wall will be located outside the Pebble Mouse Creek floodplain, there is the potential for the pit wall to collapse post-mining. The zone of collapse, also referred to as the geotechnical zone of instability, has been mapped as falling outside the Pebble Mouse Creek 100 year floodplain. However, it is recognised that the true nature of the geology will only be understood once mining has been completed, and this could influence the stability of the pit wall.

It will be necessary to review the pit wall stability at the end of mining, to ensure the zone of collapse does not extend into the Pebble Mouse Creek Floodplain. If the extent of the zone of collapse may intersect the Pebble Mouse Creek floodplain, measure will be required to stabilise the problematic southern pit wall to ensure the zone of collapse does not intersect Pebble Mouse Creek.

Pit wall stability risk reduction activity:

Reference	Task
BH-05	Review the geotechnical zones of instability, considering pit wall conditions, and undertake action to stabilise if zone intersects Pebble Mouse Creek floodplain
BH-06	Identify opportunities, such as in pit backfill, to strengthen pit walls

18.3.3 ESTABLISHING VEGETATION

Cattle incursion has presented challenging conditions for vegetation establishment at a number of Pilbara rehabilitation sites. Predominantly, cattle have been observed to preferentially feed on the emergent seedlings. As a result, sustainable vegetation communities have not been established at some rehabilitation sites and re-seeding has been required in order to try to establish vegetation.

While pastoral tenure is limited to the north-west corner of the wider M282SA mine lease, stray cattle have been observed to graze in the vicinity of the Baby Hope deposit. Options for preventing or limiting cattle incursion into the rehabilitation areas will need to be developed, to enable emergent vegetation to mature to self-sustaining levels.

Vegetation risk reduction activity:

Reference	Task
BH-08	Review and implement options for preventing cattle access to establishing vegetation.

18.4 RESEARCH AND INVESTIGATION TASK LIST

Table 18-3 summarises the actions identified through the risk evaluation process that require research or form part of significant ongoing investigations. It is not expected that this list includes all of the mine activities undertaken that relate to closure, only the key activities that are necessary to manage or prevent unacceptable closure risks.

Table 18-3: Baby Hope Closure Task List

Aspect	Reference	Task	Due date
Fibrous materials	BH-01	Update mine models with fibrous materials risk flags	Next mine model update (expected within 2 years)
	BH-02	Investigate and map areas of fibrous materials as part of pit design update	Next pit design updated (expected within 2 years)
	BH-03	Identify opportunities to cover declared hazardous fibrous areas during operations or identify how exposures will be covered on closure.	Next pit design updated (expected within 2 years)
Water	BH-04	Review water balance within the mine voids, to determine if there is the potential for temporary pools to form.	Prior to finalising closure plan
Mine void	BH-05	Review the geotechnical zones of instability, considering pit wall conditions, and undertake action to stabilise if zone intersects Pebble Mouse Creek floodplain	Prior to finalising closure plan
	BH-06	Identify opportunities, such as in pit backfill, to strengthen pit walls	Next waste dump design review (expected within 2 years)
Waste dumps	BH-18	Review water management for waste dumps that abut the landscape to minimise run-on to dumps at closure.	Next waste dump design update
	BH-19	Review mineral waste competency and update waste dump designs accordingly.	Ongoing
Soil	BH-07	Undertake topsoil reconciliation following clearing activities. Review alternative soil treatments if recovered topsoil return rates are predicted to be less than 100mm across entire disturbance area.	Annual process
Revegetation	BH-08	Review and implement options for preventing cattle access to establishing vegetation.	Ongoing
Public liability	BH-09	Review locations of significance with Traditional Owners	Before next closure plan update
	BH-10	Integrate safe access routes to stakeholder (TO) nominated sites into the closure plan	Prior to finalising closure plan

Aspect	Reference	Task	Due date
Stakeholders	BH-11	Undertake closure specific consultation with TO's, include wider HD1 area closure	Before next closure plan update
	BH-12	Undertake closure specific consultation with DMP, include wider HD1 area closure	Before next closure plan update
	BH-13	Undertake closure specific consultation with OEPA include wider HD1 area closure	Before next closure plan update
	BH-15	Review stakeholder consultation response and revise objectives, completion criteria and measurement tools where appropriate	Before next closure plan update
	BH-16	Integrate Baby Hope and HD1 into a Greater HD1 closure plan	For next update
	BH-17	Review data collected and information developed through the operation life. Use data / information to improve models, interpretations and verify predictions	Ongoing

CLOSURE IMPLEMENTATION

19 IMPLEMENTATION SCHEDULE

Baby Hope is expected to commence decommissioning and rehabilitation at the cessation of mining activities, after 2024. Infrastructure will be fully utilised until the end of the mine life.

20 REMOVAL OF INFRASTRUCTURE

Decommissioning plans will be developed in the lead up to closure, approximately 2 years prior to the end of the mine life. Decommissioning will include:

- negotiating with Government prior to the removal of infrastructure as required under State Agreement requirements;
- actively seeking opportunities to recycle or reuse infrastructure that is to be removed;
- removing any environmentally hazardous materials in accordance with Controlled Waste Regulations; and
- where recycling and reuse opportunities are not available or viable, demolishing inert infrastructure and burying it onsite.

The decommissioning will be undertaken in accordance with the requirements outlined in Table 20-1. Decommissioning requirements may vary from Table 20-1, depending on the infrastructure present at the site at the point of closure.

Table 20-1: Decommissioning requirements for Baby Hope

Category	Closure method	Relevant indicative completion criteria
General	Any equipment, steel structures or material that is not suitable for reuse are to be completely removed to an approved disposal site. If encountered, any asbestos-containing building product or pipe work is to be disposed appropriately.	4a, 4d, 4e
Above ground structures (e.g. buildings, tanks)	Brick, block work and steel frame structures are to be dismantled and salvaged or appropriately disposed. Any container or tank that has held hazardous materials is to be drained/emptied and then disposed. Bullet tanks and storage tanks 4 m diameters and less will be disposed of whole. Bins and storage tanks greater than 4 m diameter will be cut into transportable sizes for removal.	4a
Reinforced soil walls	Remove any structures, footings, slabs and equipment supported by the wall and its backfill. Dismantle wall and remove backfill back to a natural surface profile. Any part of the wall that will be more than 1m below the finished ground surface can remain in place.	4a
Ground slabs	Remove all attached steelwork, block work, services and equipment. Break up and dispose of the concrete and full removal is practicable / required. Otherwise leave the slab in place and cover with earth to a natural profile, and with minimum cover of 1 m.	4a

Category	Closure method	Relevant indicative completion criteria
Footings and associated pedestals	Remove all attached steelwork and equipment. If the footing and associated pedestals are less than 2 m^3, remove and dispose of them. Otherwise cut and remove pedestals if required, and cover with earth to a natural profile, and with minimum cover of 1 m.	4a
Above-ground concrete plinths (e.g. pump plinths) and structures (e.g. crusher blocks)	Remove all attached steelwork and equipment. Where practicable, remove concrete intact to disposal. Otherwise, break concrete items and remove to disposal.	4a
Culverts	Remove all fill back to natural surface profile. Remove culvert.	4a
Sedimentation basins, ponds and reservoirs	Dispose of liquid and sediments prior to deconstruction. Break up and remove all concrete.	4a
Roads and hardstand areas	Remove any bituminous material to a disposal pit.	4a
Below ground infrastructure	Services and infrastructure less than 1 m below ground level to be removed. Services and infrastructure greater than 1 m below ground level to be left in situ.	4a

21 CLOSURE DOMAINS

Closure domains are used to group areas with common features, rehabilitation and decommissioning requirements. Figure 21-1 illustrates the closure domains that have been established for Baby Hope. These domains include:

- **Open pits**: Includes proposed pits associated with Baby Hope deposit;
- **Waste dumps**: Includes mineral waste dumps constructed from inert materials either within a mined pit or external to the pit areas, and long term low grade material stockpiles that are not currently planned to be utilised in processing but may prove to be economic in the distant future;
- **Other disturbed areas – low level of disturbance:** Only low disturbance rated areas are expected to remain on closure. This disturbance class includes, for example, laydown yards, unsealed roads, temporary stockpiles, access tracks and cleared areas following removal of structures (as described in Table 20-1). These areas will require a low level of earthworks to achieve final landforms.

The closure method required for each domain is described in Table 21-1. Refinement of the closure domains and associated detailed plans for the rehabilitation and decommissioning of these areas will be developed as areas become available or, alternatively, immediately prior to closure.

Table 21-1: Baby Hope implementation strategies by domain

Domains	Closure method	Area	Relevant indicative completion criteria
Pit	Review geotechnical zone of geotechnical instability (collapse) and strengthen / modify pit wall if potential to impact Pebble Mouse Creek is identified. Abandonment bunds are to be constructed around the perimeter of pit / pit clusters, where topography allows, outside of the zone of geotechnical instability. Ensure adequate erosion protection for abandonment bunds located near drainage lines.	All pits	1b, 3a, 4a, 4b, 4d, 4e
Mineral waste	Confirm material properties presenting on the face of the waste dumps and review design if characteristics are different from plan. Shape waste dump according to agreed waste dump design, in accordance with the Rio Tinto iron ore Landform Design Guidelines. Topsoil / subsoil blend will be spread over the dump surface where available to a depth of up to 0.2m and a deep rip and seed applied.	All waste dumps and long term low grade stockpiles	1a, 1b, 2a, 2b, 2c,3a, 4a, 4d, 4e
Other disturbed areas (low)	Scatter any dead vegetation or rocks over the rehabilitated surface to increase habitat diversity and reduce wind and water erosion. Natural drainage lines to be re-established where practicable. Where top soil has not been removed and compaction is limited to two wheel tracks the area will be left to rehabilitate naturally. Other tracks should be ripped. On slopes, rip parallel to contours.	Roads Laydown yards Unsealed roads and access tracks	1a, 1b, 2a, 2b, 2c,4a, 4c, 4d, 4e

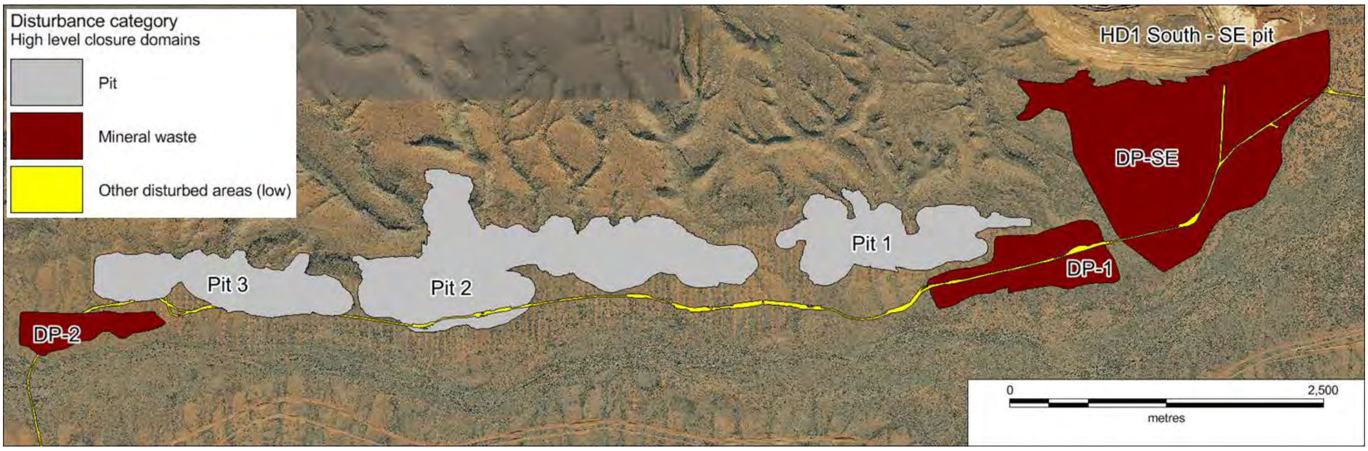

Figure 21-1: Baby Hope closure domains.

22 PREMATURE CLOSURE AND OTHER FACTORS

The closure implementation schedule may be influenced by factors outside of the current mine plan. These factors include:

- suspension of operations under care and maintenance; this could occur if production costs exceed product value, e.g. due to commodity price changes;
- unexpected closure; this could occur if there was major change in global demand for iron ore; and
- future proposals; these could occur if iron ore deposits of appropriate quality are identified adjacent to the existing deposits.

22.1 CARE AND MAINTENANCE

In the event of temporary closure, measures will be undertaken to transfer the site from operations into a care and maintenance regime and relevant authorities notified. A Care and Maintenance Plan will be developed prior to the care and maintenance period, which demonstrates how on-going environmental obligations associated with the site will continue to be met during the period of care and maintenance. Social obligations and responsibilities will also be addressed in this plan.

22.2 UNEXPECTED CLOSURE

Whilst Hamersley HMS considers the risk of unexpected closure to be minimal, there are numerous factors that could force early closure of one or several sites. Even if some level of contraction were to occur, it is reasonable to assume that Hamersley HMS would continue to operate in the Pilbara and that it could continue to manage closure of its sites.

In the event of unplanned or sudden closure, Hamersley HMS will notify all relevant authorities including the DMP. The existing closure plan for the site would then be revised and the final closure plan prepared and submitted to the DMP and other relevant authorities within 12 months of notification of closure. The final closure plan will include undertaking detailed consultation with stakeholders. Once the plan is approved by the relevant authorities, work will commence on closure implementation activities.

CLOSURE MONITORING AND MAINTENANCE

23 CLOSURE MONITORING PROGRAMS

An environmental monitoring program will be established to track the performance of the operation, identify potential environmental impacts and to better understand the environment surrounding the mine in order to avoid or minimise future environmental impacts. This includes:

- Baseline monitoring, which is conducted as operations expand into new mining areas.
- Operational monitoring, which occurs throughout the life of the mine, in line with regulatory requirements and the Rio Tinto operational standards.

Results from the operational environmental monitoring program that are relevant to closure are summarised in this closure plan.

A phased approach to closure monitoring is proposed for Baby Hope:

- **Pre-closure monitoring**: occurs as the site approaches closure to establish post-mining baseline conditions (where required). Aspects that may need to be collected to establish the post-mining conditions include water levels outside the active mine area, riparian vegetation condition, and potentially terrestrial fauna.
- **Decommissioning monitoring**: conducted during the period of active site decommissioning and rehabilitation. This monitoring plan will be developed as part of the final closure plan, to ensure the activities do not adversely impact the environment; and
- **Post-closure monitoring**: conducted on a scheduled basis until the completion criteria have been met. This monitoring plan will be developed as part of the final closure plan.

The monitoring aspects expected to be undertaken at each phase of monitoring are listed in Table 23-1. It is expected that the monitoring programs will be sufficiently flexible to enable adjustments to be made if results indicate that more or less monitoring is warranted at any particular phase.

Table 23-1: Indicative closure monitoring schedule

Monitoring aspect	Phase		
	Pre closure	**Decommissioning**	**Post closure**
Vegetation (rehabilitation)	✓	✓	✓
Fauna	✓	✓	✓
Erosion	✓	✓	✓
Weeds	✓	✓	✓
Water quality and contaminants	✓	✓	✓
Heritage	✓	✓	

23.1 REHABILITATION MONITORING

Rehabilitation monitoring tracks the progress and evaluates successional development of rehabilitation areas. This information will be used to assess progress towards long term rehabilitation objectives and to improve rehabilitation techniques.

Habitat characteristics will be recorded by quadrat at intervals along transects at established in rehabilitation and associated reference sites. Qualitative assessment of erosion, soil surface, perennial vegetation cover, species richness, weeds and general condition will also be recorded.

The monitoring program is expected to include:

- Number of plants by species;
- Percentage cover by species;
- Bare areas in quadrat;
- Percentage of perennial cover;
- Percentage of spinifex cover;
- Percentage of grass cover (excluding spinifex);
- Percentage of native perennial shrub cover (0.5m to 2m);
- Percentage of litter cover;
- Percentage of tree cover >2m;
- Presence of annuals;
- Presence of weeds, and species; and
- If burnt since last monitoring.

Monitoring of rehabilitation and reference sites will generally be scheduled annually for the first three years after establishment, biennially from years five to nine and (approximately) triennially thereafter, until sufficient information is gathered to validate the performance of the rehabilitation.

23.2 FAUNA MONITORING

Fauna monitoring is undertaken in conjunction with rehabilitation monitoring schedule. Fauna monitoring will review transects as a whole to record:

- Number of logs (>10cm diameter and >30cm long);
- Number of rocks (>15cm diameter);
- Presence of scat;
- Presence of ants;
- General animal sighting (including tracks, burrows and nests);
- Flowering and fruiting species; and
- Extent of grazing.

As with rehabilitation monitoring, fauna monitoring will continue until sufficient information is gathered to describe the environmental conditions with respect to fauna.

23.3 EROSION MONITORING

Erosion monitoring will involve the examination of transects for the number of rills and gullies, recording their width and depth. These measurements will be compared over time to determine if the landform has stabilised; for example erosion rates are within the accepted completion criteria range or rill and gully geometry is similar to the surrounding landscape. If a landform fails to stabilize further management / intervention will be applied.

23.4 WEED MONITORING

Weed monitoring will be undertaken in accordance with the Weed Management Plan. This plan will include targeted weed inspections (and controls) undertaken annually and following significant rainfall events, during the pre-closure and decommissioning phases. During the post-closure phase, weed monitoring will be undertaken in line with the rehabilitation monitoring schedule.

23.5 WATER QUALITY AND CONTAMINANTS

Water monitoring networks will be established during the life of the mine and during the decommissioning phase to validate groundwater and surface water predictions. It is expected that monitoring for water level, pH, EC, alkalinity/acidity, major cations and anions will be undertaken every six months until sufficient information is gathered to validate the water recovery (due to passive dewatering from the HD1 operation) and quality predictions.

23.6 HERITAGE

Heritage will continue to managed and monitored in accordance with the Cultural Heritage Management System until the land tenure is relinquished to the State Government.

FINANCIAL PROVISION FOR CLOSURE

24 PRINCIPLES OF RIO TINTO CLOSURE COST ESTIMATION

Closure cost estimates are determined in accordance with internal accounting policy methods, with the level of accuracy increasing as the site approaches closure. During the life of the operation, two closure costs will be developed:

- A Present Closure Obligation (**PCO**) which is indicative of costs associated with closure of the mine given its current footprint.
- A Total Projected Closure (**TPC**) cost which predicts the cost (in current terms) associated with closure at the end of the life of the mine. The TPC includes areas that are not currently approved, but that feature within the life of mine plan and that are considered likely to be developed in the future.

The cost estimates consider the following components:

- Decommissioning (i.e. removal of infrastructure)[3];
- Final landform construction;
- Rehabilitation and biodiversity management;
- Heritage management;
- Workforce management (i.e. training costs and redundancy payments)[4];
- Monitoring costs;
- Costs associated with the development of the final closure plan;
- Costs associated with undertaking a final shutdown of operations;
- Allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas;
- Assignment of indirect costs in accordance with internal accounting policies; and
- A contingency allowance.

The amount recognised for closure at any given time will be determined by using the best and most recent estimate of the expected cost at that time.

The PCO estimate for each site is revised on an annual basis, whilst the TPC estimate is revised whenever a formal closure plan review is conducted. Note that for commercial reasons the actual estimate is not documented in this closure plan.

[3] The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. However; opportunities for salvage and recycling will be sought as the site approaches closure.

[4] Workforce management costs are only included in the TPC.

MANAGEMENT OF INFORMATION AND DATA

25 IRON ORE DOCUMENT MANAGEMENT SYSTEM

Hamersley HMS operates a document management system, with electronic records of all key information and data. The document system, known as Iron Ore Document Management System (**IODMS**) is linked to other business units within the Rio Tinto group of companies, and processes are in place to ensure that the data contained within this system is appropriately backed up and protected. Each document stored within this system is given a unique document number which identifies the document and enables it to be accessed. This system will continue to operate following site closure, and all relevant data will be retained accordingly.

An audit will be conducted prior to closure to ascertain whether there is any additional information stored in hard copy form at the site. Such data will be scanned and entered into IODMS to ensure that it is appropriately retained post-closure.

Hard copies of confidential information stored at the site (such as employee records) will be destroyed at the time of closure.

26 CLOSURE KNOWLEDGE BASE

The closure knowledge database is a knowledge management process designed to bring closure related research and monitoring outcomes together into one searchable location. It uses a single entry form to capture the key characteristics of all new ongoing and completed closure related studies. The same form is used to inform the closure team that work has commenced, to provide progress updates and to report on the outcomes of the work.

Key characteristics provided include where the report is stored and where the research can be applied. This information is then managed by the Closure team within a secure database.

Reports generated from the database will be used to track research projects, communicate closure obligations and automate compilation of information used in our closure planning.

27 ENVIROSYS

EnviroSys is a desktop application, with a web based interface, that manages environmental and hydrogeological parameters collected in the field and their logical context. The tool is used to store, monitor and analyse those parameters and report trends on data collections.

Data collected includes:

- Groundwater – biological, chemical, field, levels, production;
- Marine water – biological, chemical, field;
- Soil chemistry;
- Surface water – biological, chemical, field, levels, production;
- Tonnes and moisture;
- Water meters; and
- Weather (rainfall, temperatures etc.).

EnviroSys is used to support the building of closure knowledge bases, as well as ensure compliance with operating licenses pertaining to data management.

28 LEGAL AND OTHER REQUIREMENTS SYSTEM

The Legal and Other Requirements System (**LAORS**) is used by Hamersley HMS to manage the following:

- Approval and Legislation Reports, which provide a high level snapshot of approvals and legislation and is used to check the status and expiry dates of approvals.
- Approval and Legislative Requirements Reports, which list:
  - accountabilities for specific conditions within approvals and clauses within legislation;
  - required actions to comply with approvals and or legislation; and
  - due dates for specific requirements.
- Statutory Position Appointed Persons reports, which list individuals appointed to a statutory position.
- Statutory Position Accountabilities Reports, which identify clauses of legislation that the statutory position is accountable for.

APPENDIX A - REGISTER OF KEY CLOSURE OBLIGATIONS

BABY HOPE CLOSURE OBLIGATIONS REGISTER

Legal Obligations

Ministerial Statement 584	
Condition No.	**Closure conditions**
1-1	The proponent shall implement the proposal as documented in schedule 1 of this statement subject to the conditions of this statement.
2-1	The proponent shall implement the environmental management commitments documented in schedule 2 of this statement.
2-2	The proponent shall implement subsequent environmental management commitments which the proponent makes as part of the fulfilment of the conditions in this statement.
Commitment No.	**Closure commitments**
Schedule 1	Critical to the prevention of unacceptable impacts on Weeli Wolli Spring as a result of the dewatering operation are the following management strategies: 1. maintenance of spring flow by direct discharge of water to the spring during dewatering 2. in the long-term: (a) backfilling of the mine pits to above the water table level; and (b) a 20 year post-mining phase where approximately 40 000 kilolitres of water per day is pumped into the spring and the dewatered ground water system, until the natural groundwater system has been re-established (This water will come from outside the catchment of the project area).
Schedule 1	Disposal of excess to Weeli Wolli spring to sustain ecological requirements and aquifer storage with recovery post mining.
Schedule 1	The total area disturbed for the mining area is not more than 3750 hectares with an area of 2990 hectares to be rehabilitated.
Schedule 1	The total area disturbed for the rail corridor is not more than 1080 hectares of which no more than 338 hectares will be permanent disturbance and all other disturbed areas to be rehabilitated.
Schedule 2 Commitment 2	Prepare, implement and regularly revise a Life of project Environmental Management Plan (EMP),consisting of an EMP prepared for the construction phase and an EMP prepared for the operations phase, the objective of the EMP is to manage the potential impacts of the construction and operations phases of the project. The EMP will contain plans, guidelines and procedures to manage environmental issues associated with construction and operation of the project including: • surrounding environment • vegetation clearing and management • overburden storage • surface water quality and quantity • groundwater quality and quantity • flora and fauna particularly introduced species • Aboriginal heritage • Greenhouse gases • dust and noise • fire • waste and hazardous materials • decommissioning and rehabilitation • contracting • continuous improvement Measurement / compliance criteria: EMP implemented and regularly revised. Results provided in annual and triennial reports.
Schedule 2 Commitment 6	Prepare a Vegetation Monitoring Programme, the objective of the programme is to monitor phreatophytic vegetation in Weeli Wolli Creek. A Vegetation Monitoring Program will be prepared and implemented to quantify any project-induced effects on phreatophytic vegetation within the project area, monitoring to be implemented prior to productive mining / operations and to continue through decommissioning. Measurement / compliance criteria: Results provided in annual and triennial reports.

Schedule 2 Commitment 7	Provide water supplementation to maintain phreatophytic vegetation in the Weeli Wolli Creek system. Measurement/compliance critieria: as determined from monitoring results, no project induced, long term adverse impacts on phreatophytic vegetaiton. Results provided in annual and triennial reports.
Schedule 2 Commitment 8	Design and implement flood diversion works to maintain existing catchment flow volumes and quality. Decommissioing stratgeies may involve aquifer recovery through artifical recharge of flood flows in some sub-catchments.
Schedule 2 Commitment 9	Enhance the recovery of the groundwater system following mine closure, to meet the objective to sustain phreatophytic vegetation and restore a self-sustaining spring flow at Weeli Wolli Spring within a reasonable period following mine closure (decommissioning period). The proponent will prepare and implement strategies to enhance the recovery of regional groundwater levels (these strategies to be refined during mining operations). This will include an investigation of the practicality of Aquifer Storage and Recovery. Should this prove practicable, any sites considered for ASR will be discussed and agreed with relevant Government agencies and other mining companies, if they are likely to be impacted by such activities. Measurement / compliance criteria: Monitoring of recovering groundwater levels and spring flows. Groundwater recovery to support a self-sustaining spring and phreatophytic vegetation. Results provided in annual and triennial reports during decommissioning period.
Schedule 2 Commitment 10	Backfill the Hope North and Hope South pits such that there is no generation of standing water unless a closure strategy can be developed and approved by Government approval that demonstrates that Weeli Wolli Spring flow can be maintained by an alternative means. The objective with backfilling is to ensure that Weeli Wolli Spring flow is self-sustaining following mine closure and there is no unacceptable deterioration in groundwater quality. Backfilling of the Hope North pit will ensure that Weeli Wolli Spring flow is self-sustaining in the long term following mine closure. Investigate alternative strategies that will achieve the same objective and may not require 100% backfill to the pre-existing water table. Any alterative strategy will require acceptance and approval by government before being implemented. Investigations will continue as necessary during the life of the mine. Prior to closure the final strategy will be developed and submitted to the relevant authorities for approval. Measurement / compliance criteria: Weeli Wolli Spring flow is self-sustaining in the long term.
Schedule 2 Commitment 11	Prepare and implement a Mine Closure Plan to cover: • the removal of redundant infrastructure • rehabilitation • management of the final void • groundwater recovery and • post mining monitoring (post mining land uses to be identified pre-construction) The objective of the plan is to ensure that a self-sustaining walk-away solution is implemented as soon as practicable following the completion of mining. The plan will include an assessment of the need to import water following the cessation of mining to increase the rate of ground water recovery. The plan will be progressively developed in relation to the stage of project development. Measurement / compliance criteria: Mine closure plan meets or exceeds regulatory requirements.

Ministerial Statement 893	
Condition No.	**Closure conditions**
7-1	The proponent shall ensure that supplementation of Weeli Wolli Springs protects dependent environmental values, as defined by the High Level Values Statement Weeli Wolli Springs and Creek November 2011, or subsequent revisions approved by the CEO of the Office of the EPA.

Iron Ore (Hope Downs) Agreement Act 1992	
Clause No.	**Closure obligations**
7(1)	The Company shall subject to the EP Act and the provisions of this Agreement submit to the Minister on or before 30 June 1998 to the fullest extent reasonably practicable its detailed proposals (including plans where practicable and specifications where reasonably required by the Minister) with respect to the production of iron ore from the area or areas approved pursuant to subclause (1) of Clause 6 and the transport and shipment of iron ore produced which proposals shall make provisions for the Company's workforce and associated population required to enable the Company to mine and recover iron ore from the mining lease and transport and ship the iron ore and shall include the location, area, lay out, design, quantities, materials and time programme for the commencement and completion of construction or the provision (as the case may be) of each of the following matters, namely : (m) an environmental management programme as to measures to be taken, in respect of the Company's activities under this Agreement, for rehabilitation and the protection and management of the environment.
16 (1) &(2)	(1)The Company shall in respect of the matters referred to in paragraph (m) of subclause (1) of Clause 7 and which are the subject of approved proposals, carry out a continuous programme of investigation research and monitoring to ascertain the effectiveness of the measures it is taking both generally and pursuant to such approved proposals for rehabilitation and the protection and management of the environment. (2) The Company shall during the currency of this Agreement submit to the Minister at yearly intervals commencing from the date when the Company's proposals are approved or determined (except those years in which a comprehensive report is required to be submitted) a brief report concerning investigations research and monitoring carried out pursuant to subclause (1) and the implementation by the Company of the elements of the approved proposals relating to rehabilitation and the protection and management of the environment in the year ending two calendar months before the due date for the brief report and, at three yearly intervals commencing from such date a comprehensive report on the result of such investigations research and monitoring and the implementation by the Company of the elements of the approved proposals relating to rehabilitation and the protection and management of the environment during the three year period ending two calendar months before the due date for the comprehensive report and the programme proposed to be undertaken by the Company during the following three year period in regard to investigations research and monitoring pursuant to subclause (1) and the implementation by the Company of the elements of the approved proposals relating to rehabilitation and the protection and management of the environment.

38(2) & (3)	(2) Subject to the provisions of subclause (3) upon the cessation or determination of this Agreement except as otherwise determined by the Minister all buildings erections and other improvements erected on any land then occupied by the Company under the mining lease or any other lease licence easement grant or other title made under or pursuant to this Agreement shall become and remain the absolute property of the State without the payment of any compensation or consideration to the Company or any other party and freed and discharged from all mortgages and other encumbrances and the Company shall do and execute all such deeds documents and other acts matters and things (including surrenders) as the State may reasonably require to give effect to the provisions of this subclause. (3) In the event of the Company immediately prior to the cessation or determination of this Agreement or subsequently thereto desiring to remove any of its fixed or movable plant and equipment or any part thereof from any part of the land occupied by it at the date of such cessation or determination it shall give to the State notice of such desire and thereby shall grant to the State the right or option exercisable within 3 months thereafter to purchase in situ such fixed or moveable plant and equipment at a fair valuation to be agreed between the parties or failing agreement determined by arbitration under this Agreement.
39	Nothing in this Agreement shall be construed to exempt the Company from compliance with any requirement in connection with the protection of the environment arising out of or incidental to its activities under this Agreement that may be made pursuant to the EP Act.

Mining Act 1978	
Mining Lease M282SA	
Condition No.	**Closure conditions**
n/a	n/a

Native Vegetation Clearing Permit
No permits identified

Land Administration Act 1997
No tenure identified

RTIO and Nyiyaparli People Claim Wide Participation Agreement (March 2011) & RTIO and Nyiyaparli People Indigenous Land Use Agreement (July 2012)	
Clause	**Content relevant to closure**
26	This clause relates to the establishment and function of a Local Implementation Committee (LIC), with reference to the Regional Framework Deed under the commitments of Schedule 9 - Life of Mine Planning and commitments around closure. The LIC provides the forum for consultation on several issues including cultural heritage management, land access, environmental management and life of mine planning - accordingly this is the forum for discussion regarding closure outcomes. Note that consultation to date has not yielded any specific closure commitments or obligations.

Regional Framework Deed - Nyiyaparli People (March 2011)	
Clause	**Content relevant to closure**
9	Schedule 9 of the Regional Framework Deed relates to the Life of Mine Planning regional standard and the establishment of forums where Life of Mine commitments including closure are communicated. The LIC provides the forum for consultation on several issues including cultural heritage management, land access, environmental management and life of mine planning - accordingly this is the forum for discussion regarding closure outcomes. Note that consultation to date has not yielded any specific closure commitments or obligations.

High Level Values Statement Weeli Wolli Springs and Creeks November 2011	
Clause	**Commitment**
1	Hydrogeology: Weeli Wolli Springs are supported by a combination of shallow and deep groundwater flows and surface run off. Where the gorge narrows and groundwater intercepts the surface, seepage 'springs' occur with resultant surface flow of ground water.
2	Ecological: Weeli Wolli Spring supports a large diversity of vegetation and high floristic richness due to the varied geology and landscape of the area in association with the shallow water table, pools and permanent spring flow that are defining features of Weeli Wolli Springs. It is the shallow nature of the groundwater, and its permanent surface expression in the area that sustain the ecosystem in, around and downstream of the springs. The flora, microbat assemblage and stygofauna community are the main groups of biota that are considered to distinguish the Weeli Wolli Creek ecosystem
3	Flora: Weeli Wolli Springs and Creek support an unusual vegetation assemblage of high floristic richness with a few specific species of high conservation significance. Four main vegetation communities exist within the springs area. One community is more restricted regionally, and at Weeli Wolli is associated with the localised pools in the springs. This community is 'an Open Woodland of Eucalyptus victrix, Eucalyptus camaldulensis var. obtusa, Melaleuca argentea over Acacia citrinoviridis, Acacia coriacea supsp. Pendens, Acacia sericophylla and Melaleuca lasiandra over Cyperus vaginatus on major creeklines with pools with alluvial soils of variable composition' (Pers. comm. L. Mattiske, 04/09/2009). An important aspect of this community is the composition of the understorey, in particular the sedge and herb assemblages. Species of high conservation significance include Stylidium weeli wolli and a hybrid zone between two native cotton species (Gossypium sturtianum and G. robinsonii). Other flora of conservation or biological significance that occur in the spring include: Fimbristylis sieberiana, Fimbristylis oxystachya, Fimbristylis rara, Elytrophorus spicatus, Mollugo cerviana, Rotala diandra and Rotala mexicana.
4	Fauna: Weeli Wolli Springs and Creek and the underground water body provide habitat for a wide range of fauna, including terrestrial, avian, aquatic and subterranean. Assemblages include aquatic fauna (micro and macro invertebrates and fish), stygofauna, microbats and animals of the hyporheic zone. Specific bat species of conservation significance at Weeli Wolli include the Ghost bat (Macroderma gigas) - identified by the DEC as a Priority fauna species (P4) and the most northerly distribution of the Chocolate Wattle Bat (Chalinobolus morio).
5	Heritage and Social: Aboriginal culture is spiritually and physically connected to the landscape through Jukurppa. (Dreaming) stories, ceremony, and physical places such as ethnographic and archaeological heritage sites. Weeli Wolli Creek is an important permanent water source, food source, camping and meeting place and has been visited by the Traditional Owners of the area for many thousands of years. Significant ethnographic and archaeological heritage sites are also associated with the Weeli Wolli water course. The Weeli Wolli Springs holds special significance for the Traditional Owner groups of the region as a place where the snake spirit or rainbow serpent (Warlu) resides. Weeli Wolli Spring and Creek are significant for tourism in the region.

BABY HOPE CLOSURE OBLIGATIONS REGISTER

Relevant Legislation

Closure planning and implementation requires consideration of general legislative requirements beyond those that apply to a specific site. A list of potentially relevant legislation is provided below, but is not necessarily exhaustive. A comprehensive legal review will be required as closure approaches to ensure that all relevant legislative requirements are identified.

Australian Commonwealth Legislation

Environmental Protection and Biodiversity Conservation Act 1999
Native Title Act 1993
Aboriginal and Torres Strait Islander Heritage Protection Act 1984
Workplace Relations Act 1996

Western Australian State Legislation

Environmental Protection Act 1986
Environmental Protection Regulations 1987
Environmental Protection (Controlled Waste) Regulations 2004
Environmental Protection (Unauthorised Discharges) Regulations 2004
Contaminated Sites Act 2003
Contaminated Sites Regulations 2006
Conservation and Land Management Act 1984
Mining Act 1978
Mining Regulations 1981
Parks and Reserves Act 1895
Rights in Water and Irrigation Act 1914
Wildlife Conservation Act 1950
Aboriginal Heritage Act 1972
Aboriginal Affairs Planning Authority Act 1972
Mines Safety and Inspection Act 1994
Mines Safety and Inspection Regulations 1995
Occupiers Liability Act 1985
Criminal Code Compilation Act 1913

BABY HOPE CLOSURE OBLIGATIONS REGISTER

Relevant Guidelines and Standards

Closure planning and implementation requires consideration of relevant guidelines and standards, some of which may have regulatory consequence through being referenced in regulatory documents. A list of key guidelines and standards that are routinely considered is provided below, but is not exhaustive due to the breadth of the closure planning discipline. This closure plan has been prepared so as to be considered with relevant content of these guidelines and standards.

Guideline or Standard	Author
Guidelines for the Preparation of Mine Closure Plans (2015)	Western Australian Department of Mines and Petroleum and Environmental Protection Authority
Leading Practice Sustainable Development Program for the Mining Industry - Mine Closure and Completion (2006)	Commonwealth Department of Industry Trade and Resources
Mine Rehabilitation Handbook (1998)	Minerals Council of Australia
Guideline for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems (2006)	Western Australian Environmental Protection Authority
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council
Mine Void Water Resource Issues in Western Australia (2003)	Western Australian Water and Rivers Commission
Contaminated Sites guideline series	Western Australian Department of Environmental Regulation
Environmental Notes on Mining: Acid Mine Drainage (2009)	Western Australian Department of Mines and Petroleum
Environmental Notes on Mining: Waste Rock Dumps (2009)	Western Australian Department of Mines and Petroleum
Safety Bund Walls Around Abandoned Open Pit Mines (1997)	Western Australian Department of Industry and Resources
Global Acid Rock Drainage Guide (2014)	International Network for Acid Prevention
Australian Standard 2601: The Demolition of Structures (2001)	Standards Australia
Australian Standard 4976: The Removal of Underground Petroleum Storage Tanks (2008)	Standards Australia
Demolition Work Code of Practice (2015)	Safe Work Australia

APPENDIX B - CLOSURE KNOWLEDGE DATABASE

Rio Tinto Hope Downs 1 closure knowledge database

The closure knowledge database is a summary of the technical reports that directly or indirectly contribute to the development of the closure plan. These documents do not form part of the report and are for indicative purposes only.

The knowledge and understanding of closure issues and management strategies evolve and improved over time, coincident with the development of the mining operation. As a result, some components of some reports and studies may be superseded by new research or studies. While the closure plan addresses the current state of understanding and strategy for closure, the closure knowledge database captures the historical development of closure knowledge, and demonstrates how experience and knowledge developed at other Rio Tinto sites has been considered during the development of the closure plan and across the life of the operation. Accordingly, some information presented in the closure knowledge database may be obsolete.

Technical reports supporting the closure of the operation will be presented as part of the last plan produced prior to the implementation of closure (also known as the Decommissioning Plan).

CONFIDENTIAL

Geochemical characterisation

Review of Waste Rock Geochemistry a.General Overview of Acid Base Accounting — 2006

This report contains a general overview of acid base accounting and a summary of the geochemical test work that has been previously completed for various sites and lithologies.

Internal reference: RTIO-PDE-0021130

There are large discrepancies in the total sulfur concentration measured using XRF and LECO machines. The XRF machine underestimates the sulfur concentration at values greater than 2%. Materials with total sulfur concentrations less than 0.1% can contain low capacity PAF material, however, it is considered only to be low additional acid and metalliferous risk if the boundary for inert material and potentially acid forming material is shifted from 0.02%S to 0.1%S. A paste pH result of less than 7 should be sent to the black shale dump and a paste pH result of greater than 7 can be sent to an inert material waste dump.

Western Turner Syncline (B1), Hope Downs 1 North and East Angeles - Geochemical Characterisation and ARD Assessment of Drill Chip Samples — 2007

An acid and metalliferous drainage assessment was undertaken on drill chip samples from the Western Turner Syncline, Hope Downs 1 and East Angeles projects. Hope Downs 1 results only are summarised below.

Internal reference: RTIO-PDE-0034855

All but one of the samples from Hope Downs 1 were classified as potentially acid forming. Based on the characterisation, acid neutralisation capacity is ineffective for acid neutralisation. Samples had a short lag of days to months. The samples included detritals, banded iron formation and siderite. Samples were enriched in As, B, Bi, Hg, S, Sb and Se and metals/metalloids such as Al, Cd, Co, Fe, Mn, Ni, SO4, Se and Se were soluble.

Mineralogical Analysis of Potentially Acid Forming Materials — 2008

Quantitative mineralogy (QEM-Scan) for samples of rock collected from Tom Price, Channar, West Angelas, Brockman, Paraburdoo, East Extension, Western Turner Syncline and Hope Downs 1 North was undertaken. Comparisons were made between two methodologies use to characterise potentially acid forming materials; acid base accounting and mineralogical analysis.

Internal reference: RTIO-PDE-0053725

All samples contained elevated total sulfur concentrations and the lithologies were either shale, banded iron formation or dolomite. Pyrite was the dominant mineral contributing to acidity and the dominant sulfate secondary mineralisation consisted of alunite and jarosite.

Geochemical Characterisation of Hope Downs 1 and Mesa G Samples — 2008

A geochemical assessment of samples for Hope Downs 1 and Mesa G were undertaken to establish the acid generating potential of the samples, leachable contaminants and oxidation rates.

Internal reference: RTIO-PDE-0051612

From the Hope Downs 1 samples, 20 were classed as potentially acid forming, 48 non acid forming and 18 uncertain. There is a possibility that aluminosilicates control the neutralisation capacity of a sample, meaning that non acid forming materials could potentially be classified incorrectly. In at least some of the samples Ag, As, Au, B, Bi, C, Cd, Co, Fe, Hg, Mn, N, S, Sb and Se were enriched. The elements founds in readily leachable form are B, Cd, Hg, Ni, Sr, Se, Co and Zn.

Determination of ARD potential of Rio Tinto Iron Ore (WA) Waste Rock Samples — 2008

This report investigates the use of mineralogy to predict acid and metalliferous drainage potential. Analysis of numerous rocks was undertaken using QEM-SCAN.

Internal reference: RTIO-PDE-0051613

Areas of waste rock which have underdone oxidation can be identified where sulfur-bearing minerals vary between samples in the form of pyrite, alunite and jarosite. The variability of gangue mineral phases suggest that some areas of composite waste rock pile may provide some neutralising potential while other areas will have no neutralising potential. Variable textural and mineralogical controls on sulfide mineral occurrence result in decreased accessibility of pyrite to oxidising fluids.

Assessment of Neutralising Capacity, Hope Downs **2009**

An assessment into the neutralising capacity of the calcrete from the Hope Downs 1, North Deposit, NE3 pit was undertaken.

Internal reference: RTIO-PDE-0061683

The dominant mineral present in the calcrete is dolomite; calcite was not detected. Acid neutralising capacity (ANC) values of the sub-samples averaged 290kgH2SO4/t which was well below the theoretical ANC values. The acid buffering characteristic curve values for the four of the five sub-samples indicate a buffering capacity significantly less than the measured ANC values. Current ANC could indicate the potential for acid neutralisation, however, there are some anomalies in the results.

Hope Downs 1 South ARD and Geochemical Risk Assessment **2010**

The current (2010) acid and metalliferous drainage risk for Hope Downs 1 South have been investigated.

Internal reference: RTIO-PDE-0075639

The HD1S deposit poses a moderate acid and metalliferous drainage risk and there is potential to mine sulfidic lignite, siderite, and banded iron formation. It is possible that sulfidic lignite will be exposed on the walls of the SC Pit shell. However, if the pit is backfilled at closure and assuming effective calcrete can be effectively used in the dumping/backfilling strategies, the risk of generating acidic pore water in the backfilled void upon closure would be low. Enrichment of Al, Co, Fe, Mn, Ni and Zn in sulfidic rock types may pose a geochemical hazard.

Hope Downs 1 North ARD and Geochemical Risk Assessment - Update **2010**

Acid and metalliferous drainage (AMD) risks were originally investigated in 2007. This investigation re-visits AMD risks based for the current (2010) Hope Downs 1 North deposit geological model, samples and mine plan.

Internal reference: RTIO-PDE-0028857

The HD1N deposit poses a moderate-high acid and metalliferous drainage risk. It is expected that a low amount (up to 3.5% of waste) of sulfidic lignite, siderite and Banded Iron Formation may be exposed, however, neutralising waste rock (eg calcrete) is also expected to be mined. Whilst it is likely sulfidic materials will be exposed on the walls of NW and NE pit shells, the risks associated with generating acid pore water should be low assuming pits are backfilled and there is an effective use of calcrete. There is enrichment of As, Cd, Hg, S, Sb and Se and all except Hg and Sb have the potential to become soluble. Al, Co, Fe, Mn, Ni and Zn are mobile elements in solution.

Scoping Study to Investigate the Use of Alkalinity Producing Materials to Minimise Acid and Metalliferous Drainage from Waste Rock Piles and Pit Wallrock **2010**

The value of using alkalinity generating cover technology and alkalinity infiltrating trench / pond technology to minimise acid and metalliferous drainage (AMD) from waste rock and pit wall rock containing sulfides at the Tom Price and Hope Downs 1 mine sites was investigated in this report.

Internal reference: RTIO-PDE-0078370

Alkalinity generating cover technology and alkalinity infiltrating trench / pond technology could add considerable value to existing AMD management strategies at the Tom Price and Hope Downs 1 sites.

Calcrete, Dolomite and BIF Assessment of Neutralising Potential, Hope Downs 1 **2010**

An assessment of the neutralisation potential of samples of Banded Iron Formation (BIF), calcrete and dolomite from Hope Downs 1 was undertaken

Internal reference: RTIO-PDE-0080855

The acid neutralisation capacity (ANC) values measured range from 134 to 885 kgH2SO4/tonne. Generally, the highest values were associated with dolomite rich samples. For eight of the samples, acid buffering characteristic curve (ABCC) tests suggest that a large portion (more than 60%) is readily available for neutralisation. For five samples, less than 50% of the ANC was readily available. This corresponded to the combined contribution of calcite and dolomite present in the sample.

Environmental Status of Selenium (Se) in the Pilbara Region of Western Australia – Potential Risk from Iron Ore Mining **2011**

This report includes information about Selenium geochemistry, distribution in the environment, occurrence in rocks in the Pilbara and potential risks to the environment.

Internal reference: RTIO-PDE-0103857

The Selenium (Se) content of shales containing significant pyrite should be recorded as part of the overall risk assessment for acid and metalliferous mine drainage. However, it should also be noted Se solubility is far less constrained by pH than in the case of metals and near neutral drainage may contain significant Se concentrations in solution. It would be most useful to study the Selenium budget of the wetlands in the Pilbara as, apart from the chance poisoning of livestock from the consumption of plants that have taken up high concentrations of Selenium, impacts are most likely to be felt in wetlands receiving mine site drainage.

Contaminant Leaching from Non-Sulfidic Waste Material **2011**

The available leach extract data and information pertaining to the distribution of metals and metalloids in non sulfur materials at neutral pH was reviewed. Based on this review conceptual models for controls on their leaching and mobility were developed.

Internal reference: RTIO-HSE-0145041

The review found that contaminant leaching from non-sulfidic materials was generally very limited. Usually the pH in leach tests was near-neutral (pH 6 to 8), and dissolved contaminant concentration were at or below detection limits. It is believed that a primary leachable contaminant source is the oxidation of sulfide minerals. Release from oxidising sulfides leads to release of soluble reaction products. Under neutral pH conditions, there is the potential for release of these contaminants when those products dissolve.

Geochemical Characteristics and Column Leach Testing of Lignite, BIF and Siderite Samples from Hope Downs 1 **2011**

Internal reference: RTIO-PDE-0090688

The acid and metalliferous drainage and leaching characteristics of lignite, Nammuldi Banded Iron Formation, calcrete and siderite which are materials that are to be placed in an above ground waste rock dump were assessed.

Low S lignite (0.3%S) is non-acid forming (NAF) and a poorly reactive acid neutralising capacity (ANC). SO4 and Mn tend to be release with acidic conditions and Fe sometimes being released with neutral pH. High S Lignite (10.9%S)is potentially acid forming (PAF) and is likely to have a short lag period within days to weeks. Under acidic conditions SO4, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, U and Zn may be released. Nammuldi banded iron formation (7.64%S) is classified as PAF by static tests, however the column pH determine neutral. The calcrete had a high ANC, equivalent to 80% CaCO3, with 60% readily available. Low S Siderite (0.31%S) is NAF and had elevated concentrations of SO4 and Mn. High S Siderite (1.44%S) is PAF and upon acidification will release SO4, Mn and minor Co, Fe, Ni and Sr.

Solute Sorption onto Nammuldi and Hope Downs 1 Samples **2011**

Internal reference: RTIO-PDE-0090375

Sorption of arsenic, cobalt, copper, chromium, nickel, selenium, uranium and zinc onto a range of lithologies from Nammuldi and Hope Down 1 was investigated.

In general, selenium and zinc tended to be weakly sorbed, whereas, cobalt was strongly sorbed. Sample mineralogy exerted a strong control on sorption and most elements showed the strongest sorption onto samples with high goethite and kaolinite content. Significant increases in solution ionic strength decreased sorption, likely due to increased competition for sorption sites.

Contaminant Leaching from Low-Sulphur Waste Minerals (Summary) **2011**

Internal reference: RTIO-PDE-0090689

RTIO's Geochemical Database was reviewed and based upon this data, conceptual models for controls on the leaching and mobility of a range of metals and metalloids were developed. This summary also describes potential controls on the amount of dissolved element that may be released. This is a summary of a comprehensive report RTIO-PDE-0100104.

For most contaminants, dissolved concentrations at circum neutral pH (pH 6 to 8) were very low, typically at or below detection limit. Geochemical modelling indicates that water-rock interactions are controlled by equilibrium, for salt, carbonates and sulphates this equilibrium is often source term limited whilst hydroxyl-sulphates and hydroxides are solubility controlled. Results also indicate that sorption plays an important role in solute concentration; weak (but detectable) sorption occurred for selenium and zinc whilst the strongest sorption was evident for cobalt. The review suggested that storage waste facilities containing low-sulfur materials pose a low level of environmental risk however, there is a small risk of increased in mobility of some contaminants if acidic conditions arise. Acidic conditions can sometimes arise from the interactions between iron and aluminium hydroxyl-sulphates and hydroxides.

Geochemical Characteristics and Column Leach Testing of Lignite, BIF and Siderite Samples from Hope Downs 1 **2012**

Internal reference: RTIO-PDE-0096190

This report assesses the acid and metalliferous drainage (AMD) characteristics of materials to be placed in an above ground waste rock dump at Hope Downs 1. Testing was carried out on lignite, Nammuldi banded iron formation, calcrete and siderite samples. The results from the 30 month lignite and Nammuldi banded iron formation columns and the 18 month siderite columns are also presented.

Results indicate that Low S Lignite and Low S Siderite are non-acid forming (NAF) and the results of column leach testing support the AMD classification. Neutral mine drainage from materials represented by these samples may have elevated concentrations of Fe, Mn and SO4. Materials represented by the High S Lignite sample are potentially acid forming (PAF) and pose a significant environmental risk. Blending with calcrete may be used to increase the lag period of the High S Lignite and Siderite before onset of acid conditions. Spreading crushed calcrete in active mining area could be used to extend lag times and help reduce AMD generation during exposure. Nammuldi banded iron formation could be blended with calcrete at a ratio of 70:30 to produce a non acid forming waste instead of potentially acid forming, however blending needs to be carefully controlled.

HD1 AMD Risk Assessment **2013**

Internal reference: RTIO-PDE-0104717

This study defines the acid and metalliferous drainage (AMD) risks at Hope Downs 1 (HD1) North and South deposits, using the RTIO Geochemical Risk Assessment Process (2011).

The overall AMD risk for HD1 North is High. 4.7Mt of waste (2%) has a high AMD risk. 0.4Mt of this material is expected to be lignite and the remainder will consist of siderite and sulfidic BIF. High AMD risk material also exists within the groundwater cone of depression (particularly the north wall). 7.5Mt of calcrete and 1.2Mt of dolomite is expected to be mined. 3.8% of the final pit shell is expected to consist of AMD risk material. All exposures are predicted to be below the pre-mining water table. Enriched elements in the rocks include: Fe, As, Mn, and Sn (based on GAI triggers) and Cr, Pb, and V (based on DEC/EPA triggers). Sulfidic waste is enriched in As, Cd, Hg, S, Sb, and Se. As, Cd, S, and Se have the potential to solubilise. Whilst not enriched, the elements Al, Co, Fe, Mn, Ni, and Zn may also mobilise in solution. The overall AMD risk for HD1 South is Moderate. 0.8Mt of waste (<1%) has a high AMD risk. 0.1Mt of this material is expected to be lignite and the remainder is likely to be sulfidic BIF. 5.9Mt of calcrete and >< 65kt of dolomite is expected to be mined 1,800m2 of lignite exposures are predicted on the final pit wall with all exposures likely to be below the pre-mining water table. Enriched elements in the rock include: Fe, As, Mn, and Sn (based on GAI triggers) and Co, Cr, Cu, Pb, V, and Zn (based on DEC/EPA triggers). Sulfidic waste is enriched in As, Cd, Hg, S, Sb, and Se. As, Cd, S, and Se have the potential to solubilise. Whilst not enriched, the elements Al, Co, Fe, Mn, Ni, and Zn may also mobilise in solution.

Geochemical characteristics and column leach testing of Lignite, BIF and Siderite samples for HD1 **2013**

Internal reference: RTIO-PDE-0096190

Investigate the potential for acidity and contaminant generation of waste at HD1. Investigate the use of calcrete to reduce contaminant generation.

Kinetic test work confirms that sulfidic lignite and siderite with 0.3% S was Non Acid Forming however concentrations of sulfate, manganese and iron can be elevated in the leachate. High S lignite (10.9%) rapidly produced acidity and numerous metal contaminants. High S Siderite (1.44%) produced pH below 5 in the first 6 months but the pH thereafter slowly increased to near neutral and minor trace metals were present. Nammuldi BIF (7.6% S) was potentially acid forming in static tests however these kinetic tests showed near neutral pH most of the time. Further test work is required on other Nammuldi BIF samples to confirm the acidity generation potential. A calcrete blend with the high S lignite sample in the ratio 40:60 was not adequate to maintain the pH consistently above 6 and some metal concentrations were elevated. The High S Siderite and Calcrete blend of 97:3 increased the pH however was ineffective at reducing metal concentrations. Test work confirms that higher ratios of calcrete are required. This testing has also indicated that crushed calcrete or fine lime may be required to counteract the fast generation of acidity produced when the potentially acid forming material is placed back in pit below water table.

Tom Price and Hope Downs 1 Talus Characterisation **2013**

Internal reference: RTIO-PDE-0119195

This report summaries the results of geochemical characterisation of expected reactive talus material collected from Hope Downs mine. The reactive talus material, a potential source for AMD, has been identifed as an uncertainty in pit lake water quality modelling.

The results of the testing indicate that reactive talus material has the potential to be highly acid generating and store acidity if allowed to remain on pit benches. The smaller particle size and open location on a bench facilitates cycles of sulfide oxidation and flushing of acidic water during rain events. If reactive talus is allowed to remain post-closure, it could leach acidity into the base of a pit, or contribute to poor pit lake water quality over the long term

Baby Hope (Hope Downs 1 South West) geochemical assessment of samples **2014**

Internal reference: RTIO-PDE-0119240

This study undertook geochemical test work on a total of 63 samples from the Baby Hope Downs deposit. Samples were submitted for acid base accounting test work comprised material taken from detrital, siderite, lignite, West Angela Member, Newman Member and the MacLeod Member.

Overall most material is expected to pose a low AMD risk with only the lignite and siderite being classified as PAF. In terms of neutralisation capacity only one siderite sample was found to have neutralising material readily available, while two other samples with ANC values in excess of 100 kg H2SO4/t providing no neutralising capacity whatsoever. All other samples had low ANC values and thus were classified as Barren (negligible ability to offset any acid produced). In terms of chemical enrichment the samples were generally enriched in As, Bi, Fe, Sb and Se, with Lignite also having enriched levels of Cd, Hg and S. Although enriched, the results of leach testing indicate that these enriched elements were not readily mobilised with only the lignite samples leaching any detectable levels of Se and Cd. The major elements leached from all samples tested include Ca, Cl, K, Mg, Na and SO4.

Geochemical Assessment of Tailings from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J **2014**

Internal reference: RTIO-PDE-0123030

This report presents the results from geochemical testing and saline solution extraction of tailings samples from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J deposits.

Overall the tailings from these operations are unlikely to generate acid and are not expected to leach significant levels of metals under oxidising or saline conditions.

Oxidation and solute accumulation in dewatered pit wall rocks **2014**

Internal reference: RTIO-PDE-0109045

Dewatering and removing the water table may result in de-saturation of sulphide-bearing lithologies. This study was undertaken to review how oxygen ingress and consequent sulphide oxidation of Mount McRae Shales could impact water quality when the groundwater table rebounds after mining.

Large Scale Column Construction Procedure and Initial Chemistry **2014**

Internal reference: RTIO-PDE-0123894

Large scale column experiments have been constructed to examine the reactivity of hot and cold black shale material in an operational environment. The memo describes the construction of the columns and the first geochemistry data collected after small rainfall events at Rhodes Ridge.

Initial results suggest that effluent water retains the chemistry of the incident rainfall. Constituents to note in the initial chemistry include nitrate and ammonia detected in the hot black shale effluent. This study provides an important comparison between laboratory characterisation studies and field reactivity of waste rock. Data from the large scale column tests can be applied to reactivity of in pit waste/talus as well as waste rock dumps. It can be used as an intermediate to predict long term reactivity of waste rock.

Physical characterisation

Hope Downs 1 Mining Operation Proposed Irrigation Agriculture Project Nutrient and Irrigation Management Plan
2009

This report describes the soil of the Hope Downs 1 area, as part of a review into alternative water use option. Note, the irrigation option was not considered viable, and will not be implemented.

Internal reference: RTIO-EP-0307896

The soil types present on the site belong to the Boolgeeda, and Calcrete Land Systems. The dominant soil types are deep red loamy earths of the Boolgeeda Land System. They have fine sandy clay loam to light clay texture and vary in gravel content. The soils are well structured and are of a non-cracking nature. Field test carried out on the soils determined that they slake rather than disperse. The soils are non-sodic in nature, with low electro-conductivity throughout the profile, and typically acid to neutral in the upper 20 cm of the profile with the subsoils being neutral to alkaline. Trace element analysis does not indicate any potential deficiencies or toxicities. The average Phosphorus Retention Index (PRI) for the topsoils across the site is greater than 50.

Net solute load response to the installation of infiltration limiting dry cover systems over acid forming waste piles
2014

This work was conducted to verify the central design concept of store-and-release covers over sulfidic above water table waste dumps that is, whether limiting net percolation volume through the cover results in a lesser sulfate and acidity load being realised generated and passing through the dump.

Internal reference: RTIO-PDE-0128431

The results from this thesis project confirm that the central aim of store-and-release covers to reduce net percolation volume is a valid measure for reducing the net loading of sulfate and acidity. The mechanism through which decreasing net percolation (applied water volume) results in a lesser sulfate and acidity load was identified, however further work in a site context is needed to assess how this relationship between percolation volume and loading persists in the real-world environment.

Groundwater

2012 Review of Existing Water Quality Data, Hope Downs 1
2013

The historical and 2012 water quality from surface and groundwater monitoring locations in and surrounding the Hope Downs mine site were evaluated. This report focusses on the trends in the 2012 geochemical data.

Internal reference: RTIO-PDE-0104687

Overall groundwater quality at Hope Downs 1 in 2012 was good, with circum-neutral pH and low sulfate concentrations. Measured parameters were generally below regulatory guidelines, with TDS concentrations reporting the majority of guideline exceedance, continuing the increasing trend observed in many bores since 2007. In 2011 and 2012 Zn concentrations have generally decreased and stabilised in all bores of concern.

Surface water

2012 Review of Existing Water Quality Data, Hope Downs 1
2013

The historical and 2012 water quality from surface and groundwater monitoring locations in and surrounding the Hope Downs 1 mine site were evaluated. This report focuses on the trends in the 2012 geochemical data.

Internal reference: RTIO-PDE-0104687

Overall the water quality was good for Weeli Wolli Creek, with circum neutral pH and low sulfate concentrations. TDS concentrations appear to have stabilised in 2011/12 since a gradual increase was observed during 2007 to 2010. An increase in Zn concentration was noted in 2010 and in 2011/12 this trend began to decrease and remain stable at lower concentrations towards the end of 2012. There is no indication of AMD influence on the surface water.

Water interactions and pit lakes

Hope Downs 1 South and North Pits: Water Quality Predictions
2011

Water quality within the pit, pre- and post-closure, will be affected by waste materials returned to the pit, talus on benches, sulfide rich zones exposed on pit walls and fractured due to blast damage or within dewatered wall rock. This report investigates potential water quality conditions and solute loadings during operations (from rainfall and runoff) to post-closure (with groundwater recovery).

Internal reference: RTIO-PDE-0090415

Results indicate that water in an open pit void could become acidic (pH<6) after three to four years. Once the pit is backfilled, the largest contributor to solute loadings in the groundwater will be the oxidised waste rock placed in the pit. It is assumed that sulfidic and non-sulfidic waste rock would be mixed during the backfilling process. During the operation phase, oxidation of sulfides disseminated throughout the waste rock dumps will generate solutes which, after backfilling and with groundwater recovery, mobilise in the groundwater. Oxidation trends indicate that sulfides in some waste rock dumps will be depleted (completely oxidised) before the waste rock is placed back in the pit. Thus waste dump designs that reduce oxidation within the waste rock dumps during the operation phase could significantly limit the impact on water quality after closure. It is suggested that there is sufficient neutralisation potential present in the calcrete scheduled to be mined and backfilled at Hope Downs 1 to neutralise all the acidity that may be generated in the pit void pore water. However strategic management of the calcrete will be required to ensure the material is appropriately disseminated. If the calcrete and sulphide materials are not well mixed, the porewater is expected to become acidic and contain elevated concentrations of solutes.

Geochemical and hydrological processes controlling groundwater salinity of a large inland wetland of northwest Australia — **2013**

Internal reference: RTIO-HSE-0198428

Understanding mechanisms of hydrochemical evolution of groundwater under saline and brine wetlands in arid and semiarid regions is necessary to assess how groundwater extraction or injection in large-scale basins may affect the natural interface between saline–fresh aquifers in those systems. This paper investigated the evolution of groundwater of the Fortescue Marsh, a large inland wetland of northwest Australia.

The deep groundwater (>50m depth) of the Fortescue Marsh is highly saline (>100g/L), whilst shallow groundwater (~0–20m depth) and surface water are mainly fresh or brackish. Currently, the marsh is mainly recharged by occasional floodwater. Consequently, salt in the marsh is concentrated by evaporation of rainfall. It was found that groundwater associated with the marsh could be divided into two groups characterised by their stable isotope compositions; i) fresh and brackish groundwater (TDS b10 g L−1; δ18O −8.0 ± 0.9‰) and ii) saline and brine groundwater (TDS N10 g L−1, δ18O varies from +2.5 to −7.2‰). Fresh groundwater was evaporated by<20% compared to rainwater. Brackish water mainly reflects modern recharge whilst saline and brine groundwater reflects mixing between modern rainfall, brackish water and relatively old groundwater.

Flora

Review of Flora and Vegetation along Weeli Wolli Creek East of Hope Downs North Mine — **2008**

Internal reference: RTIO-HSE-0259492

The report provides an independent assessment of the condition of the flora and vegetation along Weeli Wolli Creek, to the east of the Hope Downs 1 operation.

The condition of the flora and vegetation along the Weeli Wolli valley system has been influenced by a range of factors including: recent fires; recent (natural) hydrological shifts influencing the surface soil conditions including shifts in the depth and extent of localised pools; impacts from tourism and human activities including local erosion along tracks; cattle grazing impacts; and the establishment of the Hope Downs 1 discharge outlet. The result of these influences is the loss of leaf foliage on some trees (mainly due to fire), loss of condition in the saplings and mature trees near sample location WW2 and the loss of condition in the saplings and mature trees in the discharge area from WW6 to WW8.

Flora and Vegetation of the Hope Downs 2 Area — **2010**

Internal reference: RTIO-HSE-0087740

This study summarises the botanical aspects of the Hope Downs 2 area.

A total of 212 taxa from 39 families and 96 genera were recorded. The most common families recorded were Fabaceae (57 taxa), Poaceae (28 taxa), Asteraceae sp. (13 taxa), Myrtaceae (12 taxa), Malvaceae (11 taxa), Goodeniaceae (11 taxa) and Amaranthaceae (10 taxa); constituting a floral composition typical of the Pilbara Region. It was considered that over 70% of the flora expected to occur was recorded as a result of the 2007 survey. No Declared Rare Flora were recorded. One Priority Flora species (Ptilotus mollis) was recorded. Four introduced species were recorded in the survey area, although none of the weeds are Declared Plant species. None of the plant communities are considered Threatened Ecological Communities. The range of species within the plots located within the Hope Downs 2 survey area was quite variable, with the alluvial flats and plains and the upper slopes supporting the highest number of species.

Baby Hope Downs Flora and Vegetation Survey — **2014**

Internal reference: RTIO-HSE-0251163

This study summarises the botanical aspects of the Baby Hope area.

A total of 12 vegetation units were described from the study area. The majority of the vegetation in the study area was ranked as being in Excellent condition. None of the vegetation units comprise listed Threatened Ecological Communities or Priority Ecological Communities, and none appear to be locally restricted. Vegetation units that are considered to be of local significance comprise scattered riparian eucalypts in Pebble Mouse Creek (D1 and D2), currently in Very Good condition. Gorge and gully habitat (G1) also has value as refugia for fire-sensitive species and other species that prefer rocky, mesic habitats. A total of 354 native vascular flora species have been recorded from the study area, which is within the expected range for an area of this size in this locality. No Threatened flora species have been recorded. Priority flora species have been recorded to date, comprising Eremophila sp. Hamersley Range, Hibiscus sp. Gurinbiddy Range, Eremophila magnifica subsp. velutina, Goodenia lyrata and Eremophila magnifica subsp. magnifica. Ten introduced flora (weed) species have been recorded within the study area. None of these weeds are listed as declared pests.

Fauna

Baby Hope Downs Deposit Targeted Fauna Survey — **2015**

Internal reference: RTIO-HSE-0263461

This report summarises the fauna values associated with the Baby Hope Downs deposit study area.

The report concluded that the habitats within and adjoining the area support a fauna community that is typical of the Hamersley Ranges, well documented by existing data, and that most components of the expected assemblage would not be of elevated conservation significance. The exceptions to this finding were the potential occurrence of the Northern Quoll, Orange Leaf-nosed Bat and Pilbara Olive Python, which are all specially protected at State and Federal levels. The presence of one SRE mygalomorph spider, *Aname* sp. N37, was confirmed. Schizomids were the only confirmed troglobitic taxa recorded that are of conservation significance, and all specimens collected belonged to the genus *Draculoides*. Reviews of geological information suggest that trogolofauna habitat in the study area is represented stratigraphically by hydrated zones in the profile, which spatially equates to surface geology units mapped locally as valley fill colluvium and Marra Mamba outcrop.

Baby Hope Downs Troglofauna Survey Phase 2 — **2015**

This report documents the results of a second troglofauna sampling campaign, in addition to collating all data on known conservation significant taxa from the study area.

Internal reference: RTIO-HSE-0263448

Singleton records were collected from the orders Palpigradi and Pseudoscorpiones (family Chthoniidae; species *Lagynochthonius* sp.'PSE096'). Four specimens were collected from the hexapod order Diplura and eight from the arachnid order Schizomida. Genetic analysis of Schizomida revealed the presence of three distinct lineages, *Draculoides* sp. BHD3, *Draculoides* sp. BHD4 and *Draculoides* sp. BHD5. None of these species are restricted to the Baby Hope Downs project area. Habitat mapping suggests that suitable troglofauna habitat extends north of the project area boundary.

Biodiversity improvement studies

Evaluation of mine waste materials as alternative rehabilitation growth medium — **2010**

This study reviewed the physical and chemical properties of soil, tailing and mineral waste from select Pilbara mining operations, to identify waste material and material combinations for use as a topsoil substitute or supplement.

Internal reference: RTIO-HSE-0109961

The study showed plant-available nutrients held within the waste materials, although variable, was characteristically low and comparable to natural soils in the region. The majority of the waste materials had macro and micro nutrient concentrations within the range or above the levels measured in benchmark Pilbara topsoil and rehabilitated soils. The pH and phosphorus buffering index of most waste materials were also comparable to that of the benchmark topsoil materials. However, some of the waste types and tailings may need to be mixed with rocky material due to poor physical / erodibility characteristics.

Irrigated seed orchard trial — **2011**

Commencing in 2011 (and still ongoing), a trial irrigated seed orchard was established at the Hamersley Agriculture Project (Marandoo). The purpose of the trial was to identify an alternate method of addressing seed deficits. If successful, the project may be implemented at other Rio Tinto operations, such as the Nammuldi agriculture project.

Internal reference:

Genetic diversity in Eucalyptus leucophloia across the Pilbara: Provenance zone implications — **2011**

This study was undertaken to define the provenance seed collection zones for a common species of the Pilbara, Eucalyptus leucophloia (Snappy Gum). This report details information on genetic analysis conducted on E. leucophloia. Collections of E. leucophloia were made from 20 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Internal reference: RTIO-HSE-0108843

Genetic diversity in E. leucophloia was high and was typical of that found in other eucalypt species with wide spread distributions. Across the species the level of population differentiation was low and the majority of the diversity was maintained within populations with only 6% of variation partitioned between populations. Genetic variation in E. leucophloia showed little structure across the Pilbara with no clustering of populations based on any geographical proximity or in association with obvious topographical, physiogeographical or geological features such as the Hamersley or Chichester Ranges. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within E. leucophloia implies that seed resources for rehabilitation can be selected from a wide range within the Pilbara.

Genetic diversity in Acacia ancistrocarpa across the Pilbara: Provenance zone implications — **2011**

This study was undertaken to define the provenance seed collection zones for Acacia ancistrocarpa (Fitzroy Wattle). This report details information on genetic analysis conducted on Acacia ancistrocarpa. Collections were made from 24 populations across the Pilbara bioregion and genetic analysis was conducted on 16 populations using microsatellite markers.

Internal reference: RTIO-HSE-0119260

Genetic diversity in A. ancistrocarpa was high but lower than that in E. leucophloia, another widespread species in the Pilbara. Across the species Pilbara range the level of population differentiation was low and the majority of the diversity was maintained within populations with only 3% of variation partitioned between populations. Genetic variation in A. ancistrocarpa showed little structure across the Pilbara with no clustering of populations based on geographical proximity or in association with obvious topographical, physiogeographical or geological features. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within A. ancistrocarpa implies that seed resources for land rehabilitation and mine-site revegetation programs can be selected from a wide range within the Pilbara

Root hydraulic conductance and aquaporin abundance respond rapidly to partial root-zone drying events in a riparian Melaleuca species — **2011**

This study examined partial root zone drying (PRD) responses of Melaleuca argentea.

Internal reference: RTIO-HSE-0252171

The results demonstrate that PRD can induce rapid changes in root hydraulic conductance and aquaporin expression in roots, which may play a role in short-term water uptake adjustments, particularly in species adapted to heterogeneous water availability.

Baseline Terrestrial Fauna Assessment of Pilbara Rehabilitation Areas **2012**

Internal reference: RTIO-HSE-0134168

In 2011 a fauna survey was conducted within established rehabilitation areas at Brockman 2 and Tom Price mine sites, with the aim of identifying whether fauna is recolonising rehabilitation sites in assemblages comparable to reference sites.

The study found that at least 85 species of native vertebrate fauna, as well as representatives from each of six major groups of invertebrate fauna, are using rehabilitation areas at Brockman 2 and Tom Price, with species compositions that were broadly similar to reference sites. Ant collections were typical of the Pilbara bioregion, with an absence of invasive ant species. The study found greater data correlation between monitoring sites at a particular mine site (Tom Price or Brockman 2) than between rehabilitation and reference sites, indicating the importance of selecting local reference sites. The study concluded that the best candidates for bio-indicators are ants and reptiles.

Genetic diversity in Aluta quadrata:Implication for management and provenance zone **2012**

Internal reference:

This study was undertaken to define the provenance seed collection zones for Aluta quadrata. This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 8 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. quadrata was moderate and lower than in the other two more widespread Pilbara species, E. leucophloia and A. ancistrocarpa. The findings suggest that its populations may have fluctuated significantly in size over time with genetic drift and possibly inbreeding resulting in a reduction in genetic variability, particularly in rare alleles. Despite the narrow geographic range, the level of population differentiation in A.quadrata was relatively high with 25% of the genetic variation maintained between populations and 19% due to differences between the three different locations. This significant genetic structure indicates that A. quadrata consists of three conservation or management units, Western Ranges, Pirraburdoo and Howie's Hole.

Genetic diversity in Acacia atkinsiana across the Pilbara: Provenance zone implications **2012**

Internal reference:

This study was undertaken to define the provenance seed collection zones for Acacia atkinsiana (Atkins wattle). This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 16 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. atkinsiana was low and lower than that observed in its congener Acacia ancistrocarpa, a widespread species across northern Australia. The level of population differentiation was high and 30% of the diversity was partitioned between populations across the range of A. atkinsiana. Genetic variation in A. atkinsiana showed some structure across the Pilbara with clustering of populations in the western part of the distribution and from the Hamersley Range, along with other populations that were divergent from these groups. The low levels of genetic diversity and high levels of differentiation within A. atkinsiana implies that seed for land rehabilitation and mine-site revegetation programs should be restricted to specific zones. For rehabilitation of sites within the Hamersley Range we recommend seed collections be restricted to that region. Similarly, for rehabilitation in the part of the distribution west of Pannawonica, seed collections should be restricted to that area.

Rehabilitation Quality Metric (RQM) Project **2012**

Internal reference: RTIO-HSE-0164020

Western Australia has no formal process to measure habitat quality and as such RTIO has needed to design its own customised metrics. Vegetation condition scoring has previously been developed by RTIO through a Biodiversity Net Positive Impact Assessment, but a more precise metric was needed. The Rehabilitation Quality Metric (RQM) project was developed to provide a repeatable method to assess rehabilitation quality against pre-determined reference sites, on a site by site basis, to predict rehabilitation ecosystem quality at the time of relinquishment.

The RQM methodology employs seventeen parameters to characterise the landscape, including vegetation, fauna habitat, fauna presence, erosion, and ecosystem function. Parameters are tailored to be an applicable measure for both rehabilitation and native vegetation (reference sites). Parameters are scored, based on measured or observed characteristics, with a value between 0 and 1, with 1 being functional (terrestrial ecosystem is functioning for the maintenance of biodiversity values at a local or property scale) and 0 being dysfunctional (terrestrial ecosystem is failing; indicators of ecosystem function have scored below acceptable levels). Both rehabilitation areas and reference sites are scored. Scores are subsequently determined for the entire mine lease, based on the condition of the land before mining (extrapolated from the reference sites, area weighted) and the likely post-mining conditions (extrapolated from the rehabilitation areas and expected closure domain distribution, area weighted, ie pits with no rehabilitation score 0). The difference between the pre-mining and post-mining scores represents the residual impact of mining.

Propagation of Pilbara spinifex (Triodia sp.) **2012**

Internal reference: RTIO-HSE-0169744

Triodia has often been observed to have very poor establishment from broadcast seed. This project investigated alternatives to growing Triodia (spinifex) from seed, focussing on ways to propagate seedlings from wild harvested material.

The project found the most successful propagating material was stolons. Greatest propagation success was achieved when Triodia were collected when semi to fully dormant (mid Winter-Spring). The 'Moist Root Induction Method' recommended by previous researchers was less successful than the standard propagation techniques employed in this project. Success varied notably between populations. Consequently, any future collections of propagating material should target multiple populations to maximise potential for success.

Pilbara Seed Science Project, Part 2 Final Report Jan 2012 **2013**

Undertaken between 2009-2012, this seed research investigated germination, biology, dormancy classification and treatments for dormancy alleviation for a range of species from the Pilbara.

Internal reference: RTIO-HSE-0174944

The *Acacia atkinsiana, Indigofera monophylla and Sida echinocarpa* seed lots have physical dormancy. Heat treatments and mechanical scarification improved germination on dormant seeds, however, heat treatments killed non-dormant seeds. The treatments used for *Goodenia stobbsiana* seeds failed to overcome dormancy, suggesting deep physiological dormancy. The *Hakea lorea/ chordophylla* seed lots were found to be non-dormant, with very high germination results in the controls. As such, they will not require any pre-treatments prior to direct seeding. The florets surrounding the *Triodia pungens* and *T. wiseana* seeds were found to restrict germination, however, many of the freshly extracted seeds out of the florets were found to be physiologically dormant. Treatments for dormancy include mechanical scarifier to rupture seed coat, hot water (noting potential damage to immature or non-dormant seeds) and increases to germination through wet / dry cycling and / or temperature cycling.

Morphological variation in the western rainbowfish (Melanotaenia australis) among habitats of the Pilbara region of northwest Australia. **2013**

The aim of this honours thesis was to determine and quantify the extent of morphological variation present in M. australis and relate this to environmental variables, which will provide the first step to understanding how the species copes with environmental change.

Internal reference: RTIO-HSE-0252169

This results of this thesis found that there was limited evidence that fish morphology correlated with environmental variables

Patterns of water use by the riparian tree Melaleuca argentea in semi-arid northwest Australia **2013**

This thesis examines the water use physiology of the riparian tree Melaleuca argentea, and the ways in which this species may respond to anthropogenic disturbances to hydrologic processes.

Internal reference: RTIO-HSE-0249538

M. argentea displays highly plastic root-level responses to heterogeneous water availability and to waterlogging, facilitating high rates of water use and growth in the riparian wetland habitats of the Pilbara. Mature M.argentea trees appear to tolerate groundwater drawdown of at least several metres, most likely by employing the same plastic root strategies to access deeper water. M.argentea can also withstand short periods of severe drought, by adopting a 'waiting' strategy of ceasing growth and shedding leaves to avoid moisture loss, a state from which they can then recover. M. argentea populations are unlikely to thrive under large and prolonged reductions in water availability.

Priority Species Seed Quality and Germination Final Report **2013**

This study investigated the quality and germination biology of a range of priority and keystone (Triodia) plant species from the Pilbara.

Internal reference: RTIO-HSE-0207487

Eremophila magnifica subsp. Magnifica has physical & physiological dormancy. Propagation methods other than seed may be more successful. Geijera salicifolia and Olearia mucronata has physiological dormancy. Temperature cycling may be required to stimulate germination. Indigofera ixiocarpa and Indigofera sp. Bungaroo Creek has physical dormancy or is non-dormant. Mechanical scarification may be required. Ptilotus subspinescens is non-dormant and will germinate easily without removal from the perianth sheath. However, seed is likely to lose viability with a few years. Sida echinocarpa and Sida sp. Barlee Range has physical dormancy. Seeds should be removed from the mericarp and then scarified in order to germinate. Triodia pungens has T. wiseana non-deeep or deep physiological dormancy. Germination of de-husked seeds can be improved by applying gibberellic acid or 1% smoke water and wet/dry cycling.

Early physiological flood-tolerance and extensive morphological changes are followed by slow post-flooding root recovery in the dryland tree Eucalyptus camaldulensis subsp. Refulgens **2014**

This study investigated physiological and morphological response to flooding and recovery in Eucalyptus camaldulensis subsp. Refulgens, a riparian tree species from a dryland region prone to intense episodic flood events.

Internal reference: RTIO-HSE-0252170

E. camaldulensis subsp. Refulgens underwent considerable morphological changes during flooding, including extensive adventitious root production, increased root porosity and stem hypertrophy. Physiologically, net photosynthesis and stomatal conductance were maintained for at least 2 weeks of flooding before declining gradually. Despite moderate flood-tolerance during flooding and presumably high environmental selection pressure, recovery of reduced root mass after flooding was poor.

Priority Species Project Progress Report 2013 **2014**

The Priority Species Project, initiated in 2012, aims to improve knowledge of priority plant species and develop methods to successfully germinate and establish priority species, to enable priority plant species to be integrated into Rio Tinto rehabilitation programmes. This work is being undertaken in conjunction with the Department of Parks and Wildlife.

Internal reference: RTIO-HSE-0207486

13 plant species were selected as being potentially suitable for establishment in rehabilitation: Eremophila magnifica subsp. magnifica, Indigofera sp. Bungaroo Creek, Indigofera sp. gilesii, Acacia bromilowiana, Sida sp. Barlee Range, Ptilotus subspinescens, Ptilotus mollis, Acacia subtiliformis, Isotropis parviflora, Grevillea sp. Turee, Hibiscus sp. Canga, Themeda sp. Hamersley Station, and Aluta quadrata. Indigofera sp. Bungaroo Creek and Ptilotus subspinescens were found to readily germinate in laboratory conditions, and a field trial was established at Brockman 4 late in 2013.

Regional Variation in Metal Concentrations of Pilbara Fish in Relation to Concentrations in Water and Sediments 2014

This study aimed to characterise and document natural, background metal concentrations in freshwater fishes from different locations across the Pilbara in order to understand how local geology may affect baseline metal levels in fish tissues and surface waters. Metal concentrations were analysed from water, sediment and muscle and liver tissues from fish collected from up to 13 sites as yet unimpacted by mining across the Pilbara during October (dry season) of 2012.

Internal reference: RTIO-HSE-0216967

Levels of dissolved metals from water samples were generally low. However, some elevated concentrations of Boron, Copper and Zinc were recorded. Concentrations of heavy metals in sediments were variable across the Pilbara. Generally, sediment concentrations were well below the Interim Sediment Quality Guidelines (ISQG). However, metal concentrations in excess of ISQG TVs were recorded for Chromium and Copper at some sites. There was no relationship between metal concentrations in sediment and those in water. Metal concentrations in fish tissue (muscle and liver) varied between species with some significantly higher in some particular species. The study concluded that variation in metal concentrations in water, sediment and fish across pools in the Pilbara was likely to be mainly dictated by the local geological setting in which the pool occurs.

Marandoo Native Pivot. Scope 2 Monitoring. Final Monitoring Report 2014

The Native Pivot Project involves a series of scientific trials into the effect of fertigation on plant species native to the Pilbara region. This report details the results from the first year of monitoring.

Internal reference:

Fertigation is resulting in measurable differences to soil properties. Soil moisture was higher in the '2x' and the '1x treatments than the '0.5x' and the '0x' treatments. Soil moisture was observed to converge in all treatments during the wet season in Jan/Feb 2014. The germination of target species was low in the seeded species trial component, the presense of non-target native species is thought to have affected germination. The fertigation treatments were determined to have had a significant effect on the abundance, cover and health scores of native vegetation in the Pivot trials.

Dampier Port Rehabilitation Trials 2014

This report presents the results of a final monitoring survey of two rehabilitation trials established at the Dampier Port. The aim of the trials was to evaluate the effect of a range of mulch and soil treatments on the success of rehabilitation.

Internal reference: RTIO-HSE-0246218

The outcome of the trial in terms of informing rehabilitation methods for the dredge spoil areas, is that the soil properties in both locations support native vegetation growth without treatment or amelioration (the soil has no properties that are considered inhibitive or detrimental to the growth of Pilbara native species). In addition the treatments were shown to have no significant effect and therefore won't be incorporated into future rehabilitation. Salinity and sodicity of the dredge spoil decreased over time and it is likely it will continue to decrease with time, which is considered an improvement in soil properties to enable native vegetation growth

Progress Report 2014, Ecological responses of native fishes to dynamic water flows in northwest arid Australia 2014

This three year Australian Research Council linkage Project commenced in 2013 and aims to increase understanding of the effects of altered stream flows on the Pilbara freshwater aquatic environment. Project aims: 1. Quantifying fish biodiversity and population structure in relation to hydrological and environmental parameters to identify thresholds of ecological concern for water management; 2. Determine the fundamental physiological, morphological and behavioural adaptations of fishes to variations in water quality using experimental manipulations; and 3. Examine spatial scales of gene flow to determine if increased flows increase genetic connectivity relative to natural-flow sites.

Internal reference: RTIO-HSE-0246021

To date work has focuses on characterisation of baseline physicochemical parameters across aquatic habitats within the Fortescue River catchment (Aim 1), analysis of variation in rainbow fish morphometrics and mechanosensory lateral line systems in response to geographic region and water management regime (Aim 2), and extraction of DNA samples from 17 populations across the Fortescue River catchment (Aim 3). The project will culminate in the development of a predictive model for stream restoration relevant to future closure scenarios for above and below-groundwater mines. Results from an honours thesis indicate that rainbow fish body shape varies according to geographic region but fish from a dewatered site (WW Ck) were more streamlined than other populations from the upper Fortescue catchment. This statement of results has been superseded by the results of the actual thesis report RTIO-HSE-0252169.

Landform design

Results of flume investigations of the stability of rock mulches 1998

This study assessed the potential for rock mulches to be stripped from the soil surface by overland flows.

Internal reference: RTIO-HSE-0109221

Although 150-300mm diameter BIF was not removed by simulated overland flows, even for 100mm/hr simulated runoff on 55% gradients, considerable scour of the spoil between the rocks was observed, indicating potential for long-term development of rills or gullies if the level of rock cover was less than 100%. Large reductions in sediment concentrations were observed when finer rocks were mixed with BIF. The data indicate that it is crucial for any rock mulch to cover a wide range of particle diameters, including a component of finer rocks. The resulting mixed rock created a framework of large rocks that resist movement by flows, while the smaller rocks reduce erosion being anchored within the larger (framework) rock. For rock mulches with a mixture of rock diameters, 80% cover produced acceptable erosion rates. Sediment loads were slightly higher for 40% cover by rock of mixed diameters, and it was speculated that this may also achieve acceptable erosion rates with the addition of vegetation.

Final Landform Design Criteria for Use During Mine Planning **2012**

Internal reference: RTIO-PDE-0159989

Rio Tinto Iron Ore WA have historically designed closure landforms for waste materials with berms ~10 m, lifts ~20 m and ad hoc alterations to batter gradients where erosion rates have been perceived to be unacceptably high. This report integrates recent advances in characterisation and modelling of materials, climate and erosion processes to provide appropriate final landform batter characteristics for key Pilbara mineral wastes and soils.

Material properties of mineral wastes were assessed and classified for the range of mineral wastes found across Rio Tinto Pilbara sites. Climate sequences were used to model and test potential erosion rates for a range of batter configurations (shapes (linear, concave), heights, gradients, berm capacity) and validated against existing slopes for which material and climate data were available. This information was used to develop a searchable waste dump batter database for all major mineral wastes and soils, intended for use during mine planning design.

Contamination

Impact of Nitrogen from Explosives on Mine Site Water Quality **2008**

Internal reference: RTIO-PDE-0054638

The likely issues associated with the use of nitrogen based explosives on mineral waste and any leachate water are explored in this report. The amounts of explosives used on site are described, along with nitrogen chemistry and toxicity. Nitrogen concentrations for various mine sites and specific lithologies are presented which includes concentration in rock assays and liquid extracts.

It was concluded that the largest risk of nitrogen contamination is likely to arise from the discharge of surface waters that have been in contact with blasted materials and are discharged off site into creeks or waterways. This becomes a more significant issue if the water is also acidic. Algae (ie cyanobacteria) plumes have been identified in acidic water at Tom Price

Control Measures for Potentially Acid Forming Pit Wall Rocks **2010**

Internal reference: RTIO-PDE-0079541

Desktop study of potential strategies to manage exposed sulfidic materials and find viable options for management was conducted with a focus on the Hope Downs 1 and Tom Price sites.

Chemical treatments have the potential to be effective only in the short-term and only for minor water quality issues. Grouting of the pit walls is expected to have limited applicability, although grout curtains behind the wall may have success (untested). Cover technologies have the greatest potential to be effective over the long term, but would need to be resistant to puncture by underlying rocks, resistant to weathering and UV damage ie shotcrete, geomembranes. For long term performance the exposed surface need to be as stable and free of loose material as possible. Treatment effectiveness will also depend on the site conditions, eg chemical less effective at Tom Price.

Workshop Summary and Desktop Review: Dewatering and Sulfate Accumulation **2012**

Internal reference: RTIO-PDE-0101903

This is a summary of a workshop held to determine the risks of dewatering sulphides within the pit wall. The outcomes from this workshop will be used to develop models to estimate the mass of sulfate produced as a consequence of dewatering activities.

There are many processes that contribute to poor pit water quality. Most of these processes are known and accounted for in existing models. However, the science of fluid flow in fractured rock is not well developed and this lack of knowledge restricts the outcomes of studies on pit water quality. There is a general lack of empirical data for estimating parameters used in models, creating a large degree of uncertainty in predictive models. Sensitivity analysis can be used to overcome some of these challenges.

Development of a conceptual model: Sulfate accumulation as a consequence of pit dewatering activities, memo **2012**

Internal reference: RTIO-PDE-0101903

Mine dewatering and the consequent lowering of the water table may result in desaturation of sulfide bearing lithologies. The objective of this work was to develop a conceptual model of the associated processes: where sulphide bearing rock intersects the pit walls, and where the sulphide bearing rock is located behind the pit walls but not directly exposed on the pit wall face.

The conceptual model developed estimates the mass of sulfate produced as a consequence of dewatering activities, considering processes during operations and after operations cease, and using sensitivity analysis where parameter inputs are uncertain. The model output provides the basis for an assessment of potential impacts on water quality for general risk assessment applications. Further work was identified to improve parameterisation of the model, including the collection of additional empirical data for pit wall fracturing, saturation of pit wall fractures and sulfide oxidation rates in talus and on pit walls.

Ethnographic or archaeological values

Water and Indigenous People in the Pilbara: A Preliminary Study, CSIRO: Water for a Healthy Country **2011**

Internal reference: RTIO-HSE-0218222

Water resources are vital to Indigenous identities, beliefs, environmental philosophies and livelihoods. This report provides a broad-scale scoping study of Indigenous relationships to water in the Pilbara and considers the potential impacts of Indigenous water values.

Indigenous belief systems perceive water as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Water sources were derived during the Dreaming and are the most important features in the Pilbara cultural landscape. Interviews raised issues of long term drying, obstruction of water flow, over-extraction, inappropriate discharge from de-watering and access restrictions.

APPENDIX C - CLOSURE RISK REGISTER

Risk Type (T=T	Category	Subcategory	Item	Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments
Ref.				Risk Description Evaluated 21 of 21 risks		
T	**A**			**Planning and knowledge**		
T	**A**	**01**		**Contaminated sites**		
T	A	01	01	Under-estimated general contaminant clean up requirements	• Use of chemicals and hydrocarbons during operations • Housekeeping practice and maintenance of work areas and equipment	• Regular maintenance / inspection / audit of work place procedures • Spill management kits readily available • Contaminated sites register maintained across life of operation
T	A	01	02	Under-estimated acid and / or metalliferous drainage management requirements during operations (pre-closure) & decommissioning phase	• Materials characterisation has not identified any potential acid forming materials • Mining activities occur above the water table	• Ongoing mineral waste characterisation
T	A	01	03	Acid and / or metalliferous drainage generation (after closure) creates a contaminated site	• Materials characterisation has not identified any potential acid forming materials • Mining activities occur above the water table	• Ongoing mineral waste characterisation
T	A	01	04	Human health impacts from in situ fibrous material exposures	• Hazardous fibres exposed in situ by mining, mined and moved to encapsulated areas or naturally present in soils disturbed by mining / rehabilitation activities • Erosion of materials containing hazardous fibres post-closure	• Physical materials characterisation, some fibres present in mineral waste materials • Fibrous materials management plan enacted
T	**A**	**02**		**Void management**		
T	A	02	01	Lake and / or lake fringe habitat has undesirable impacts on general ecosystem function.	• Open water bodies in Pilbara naturally attract fauna (feral and native species) for food/ water/ refuge, safe access to water required • Concentration of natural groundwater or mineral waste derived salts through evapoconcentration in open water bodies • Release of metals from natural geology or mineral waste into water (infiltration or groundwater flow) • Water provides opportunity for plant /weed growth, good and bad (toxic algal blooms, noxious weeds) • Certain plant / animal species bio-accumulate / magnify toxic metals • Instability associated with saturated, unconsolidated ground, can be increased by high trafficability	• All mining activities will occur above the water table
T	A	02	02	Lake poses public liability and / or health risk	• Lake(s) in a location that is easily accessible by the general public e.g. near or visible from a public road • Lake(s) is near an existing attraction e.g. area of cultural significance or tourist attraction • Access to the lake edge is not via a dedicated, safe path • Contaminants well above recreational guidelines • Strongly acidic or alkaline lake water, or releases noxious gases • Toxic algal blooms and / or noxious weeds • Waterborne pests and disease e.g. mosquitos	• All mining activities will occur above the water table
T	A	02	03	Degradation of regional groundwater quality or levels	• Concentration of natural groundwater or mineral waste derived salts through evapoconcentration in open water bodies • Groundwater flow through pit lake or mineral waste with connection to regional aquifer • Density driven saline groundwater flow from groundwater sink-style pit lakes • Downstream groundwater users (people, plants or animals)	• Mining will occur above the water table.
T	A	02	04	Wall failure within mine void compromises closure outcomes	• Influence of erosion, subsidence, seismicity, wall slip • Influence of groundwater recovery and surface water flow on stability. • Creek system neighbouring or within zone of instability, potential stream capture • Poor communication of zone of instability to facilitate identification of important features	• Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required • Pit walls design factor of safety 1.3, geotechnical assessment show zone of collapse for high risk locations (near creeks, infrastructure etc.) • Conceptual location for abandonment bunds established

Risk Type (T=T	Category	Subcategory	Item	Site specific overview	Evaluation Rationale (Maximum reasonable consequence)	Likelihood	Health	Safety	Environment On-site	Environment Off-site	Environment Community	Trust Compliance	Risk Management	Detailed Action Descriptions
T	**A**													
T	**A**	**01**												
T	A	01	01	• Potential for hydrocarbon spills. Spill management in place at site.	Hydrocarbon contamination is identified during decomissioning of site infrastructure.	R			L				I	
T	A	01	02	• Potential acid forming material in Categoies 2 or 3 have not been identified at Baby Hope	A small volume of previously unidentified PAF material is excavated during mining. Additional investigations are require to resolve why material was not identified through normal operating procedures.	U			L				I	
T	A	01	03	• Potential acid forming material in Categoies 2 or 3 have not been identified at Baby Hope	A small volume of previously unidentified PAF material is excavated during mining. Material is disposed of into normal waste dump.	U			L				I	
T	A	01	04	• There is potential for respirable sized fibres to be encountered while mining. Site has Fibrous materials management plan in place to address issues. Excavated fibres will be encapsulated in +2m inert material and preferrebtially disposed into area that won't be moved/ reshaped at closure, e.g. centre of waste dump. • Some fibrous material may be left exposed in pits walls at closure. Will require follow up during life of mine to validate fibre risk (not all fibres are of respirable size and therefore harmful) in wall exposures. • Need to investigate how declared hazardous fibrous material exposed in pit walls can be covered over at closure. Need further data to accurately predict potential exposure areas.	Hazardous fibrous materials are exposed in pit walls on closure.	P	M						III	BH-01 Update mine models with fibrous materials risk flags BH-02 Investigate and map areas of fibrous materials as part of pit design update BH-03 Identify opportunities to cover declared hazardous fibrous areas during operations or identify how exposures will be covered on closure.
T	**A**	**02**												
T	A	02	01	• All mining activities will occur above the water table. • Groundwater levels in the area have been passively dewatered by the Hope Downs 1 mining activities. • Due to the absence of long-term groundwater monitoring information and climate change, there is the potential that the groundwater table will recover higher than the cut-off currently used to define "above water table".There is the opportunity to improve the predictions of the groundwater recovery levels during the life of the operation and use mineral waste to cover any areas through to be at risk of developing temporary pit lakes.	A temporary pit lake forms at the base of mine void, due to inaccurate groundwater recover estimation and high surface water flow contribution.	U				M			II	BH-04 Review water balance within the mine voids, to determine if there is the potential for temporary pools to form.
T	A	02	02	• Pit lakes are not planned as part of the closure strategy. • The formation of temporary / ephemeral pools in mine voids will need to be reviewed during the life of the mine, prior to closure. Actions will be taken to ensure that temporary pools are not able to develop, e.g. backfill. • If a temporary polls was to form, the depth of the pool is not expected to exceed a couple of meters, i.e. will be shallow, but is still deep enough to cause drowning.	A temporary pit lake forms at the base of mine void, due to inaccurate groundwater recover estimation and high surface water flow contribution, and creates a public health risk.	R	M						II	BH-04 repeat
T	A	02	03	• Mining will occur above the water table. • No potential acid forming or other material with potential geochemical issues have been identified. • Some trace elements of potential environmental concern (e.g. arsenic, lead) were enriched or elevated in some of the sampled ore and waste materials, these elements will not necessarily mobilise into groundwater. • Groundwater monitoring should initially include the following elements: Fe, As, Mn, Sn, S and Zn (based on GAI triggers) and Mn, V, S, Pb, Zn and Co (based on DPaW/EPA triggers)	Leaching of nutrients through waste dumps results in localised enrichment in problematic elements.	R				L			I	
T	A	02	04	• Surface water runoff expected to flow into pits. This could increase the geotechnical instability in these locations. Water management and / or alternate bunding strategies may be required in these locations. Investigations required • Pit walls located adjacent to the creek floodplain. May require buttress to stabilise the ground above the pit wall (zero zone of instability) and flood proof abandonment bunds, to ensure the creek is not captured within the pit in the future. Need to review backfill opportunities to improve long term stability in PMF area. • Geotechnical zones of instability have been established for the pits based on simple parameters. Further understanding of geological structural issues will be resolved during the life of the mine, and zones will be updated accordingly. Some structural aspects may increase instability in local areas.	In-pit mass movement (and associated erosion) of the pit wall leads to erosion and potential creek capture within the Pebblemouse Creek floodplain.	U				H	M		III	BH-05 Review the geotechnical zones of instability, considering pit wall conditions, and undertake action to stabilise if zone intersects Pebble Mourse Creek floodplain. BH-06 Identify opportunities, such as in pit backfill, to strengthen pit walls

Risk Type (T=T	Category	Subcategory	Item	Risk Description Evaluated 21 of 21 risks Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments
T	**A**	**03**		**Closure landforms**		
T	A	03	01	Built landforms (excluding mine void areas) erode and / or collapse	• Physical material properties considered in design • Drainage and erosion management • Design and construction of landforms / waste dumps • Sensitive receptors identified downstream • New waste types present requiring characterisation • Waste types erodibility characteristics differ from expected performance	• Physical materials characterisation completed for expected waste types • Multi-disciplinary pit and waste dump design sign-off processes, considers landform design guidelines and provides rehabilitation designs where appropriate • RTIO Rehabilitation handbook used for general rehabilitation activities • Rehabilitation designed to be stable without vegetation
T	A	03	02	Surface treatment on landforms limits vegetation growth	• Availability of top soil stockpile soil / poor stockpile management e.g. soil washed away • Low moisture retention i.e. hydrophobic soils development, very rocky materials • Chemical properties of materials on waste dump / rehab surface e.g. salt circulation, alkalinity • Poor quality topsoil resulting from excess rehandling	• Physical and geochemical materials characterisation complete for expected waste material types. • Topsoil and subsoil collected as disturbance occurs throughout mine life • Annual stockpile reconciliation of top soil and sub soil stockpiles, return of 200mm to create quality surface growth media • Rehabilitation handbook provides direction on alternate surface treatment options
T	A	03	03	Vegetation is not self-sustaining	• Vegetation established, but does not re-seed in same abundance • Weed competition • Species selection / insufficient species diversity • Animal interference i.e. feral animals eating new growth • Changes to soil water conditions e.g. salinity, water logging etc	• Rehabilitation handbook provides guidance on seed selection for appropriate diversity • Top soil stockpiles provide seed bank
T	A	03	04	Access through area post-closure poses public liability risk	• Post-closure access / land-use requirements, e.g. for stock, people, heritage, environmental monitoring, adjacent mining activities etc. • Potential for general public to create their own access if appropriate access not provided.	• Regular review and integration of stakeholder feedback into closure plan updates.
T	**A**	**04**		**Other regional considerations**		
T	A	04	01	General environment outside of approved mine disturbance areas is adversely impacted	• New (previously unidentified) environmental sites, not considered in existing environmental impact assessment • Changes to environmental conditions due to cessation of artificial support / mitigation activities, e.g. water supplementation • Change to drainage patterns on closure e.g. removal of temporary diversions, drains etc.	• Internal ground disturbance approval request system to prevent inadvertent disturbance • Baseline biological / ecosystem health surveys and existing monitoring to define post-mining status • GIS system includes results from all flora, fauna, vegetation surveys • Operational management plan for discharge includes actions relating to water quality and discharge extent targets, to ensure environmental issues are managed during operations • Significant species management plan implemented during operation to minimise impact to select species • Vegetation management plan implemented during operations to monitor and manage impacts to vegetation (riparian, understorey and weeds) • All activities undertaken outside the 100 year ARI Pebblemouse Creek floodplain
T	A	04	02	Adverse impact to flora or fauna with conservation status or wider regional impact to high value environment	• Scheduled, listed or declared rare and / or threatened species of flora or fauna present in/adjacent to site • Downstream regional area of high value • Environmental conditions post-closure differ significantly from pre-mining conditions • Post-mining land use differs from pre-mining land use	• Internal ground disturbance approval request system to prevent inadvertent disturbance • Baseline biological / ecosystem health surveys and existing monitoring to define post-mining status • GIS system includes results from all flora, fauna, vegetation surveys • Operational management plan for discharge includes actions relating to water quality and discharge extent targets (proximity to Fortescue Marsh), to ensure environmental issues are managed during operations • Significant species management plan implemented during operation to minimise impact to select species • Vegetation management plan implemented during operations to monitor and manage impacts to vegetation (riparian, understorey and weeds)
T	A	04	03	Heritage site condition / cultural value is degraded as a result of implementing the closure plan	• New (previously unidentified) heritage sites, not considered in existing assessment, discussions, agreements or with authority to disturb • Changes to landforms on closure have potential to alter conditions at downstream sites, e.g. consider drainage, landform footprint, erosion implications • Cessation of maintenance of / to heritage site	• Internal ground disturbance approval request system ensures heritage sites identified prior to disturbance. S18 processes followed. • GIS system includes results from heritage surveys to promote avoidance where possible • Ongoing consultation with Traditional Owners on LoM planning through Eastern Guruma Monitoring and Liaison Meetings

Risk Type (T=T	Category	Subcategory	Item	Site specific overview	Evaluation Rationale (Maximum reasonable consequence)	Likelihood	Health	Safety	Environment On-site	Environment Off-site	Community	Trust	Compliance	Risk Management	Detailed Action Descriptions
T	**A**	**03**													
T	A	03	01	• There is a high proportion of erodible material on site. • Waste dumps have been designed to landform design guidelines, consider highly erodible materials. Due to high percentage of highly erodible waste, waste segregation and capping not possible. Transportation of highly erodible materials to in pit backfill will occur. • Construction conformance to waste dump design is not at prefered performance levels at HD1. • Some waste dumps are located within the peak maximum flood extents and will require armouring around the toe of the dump.	Waste dump erodes (due to surface water flows or rainfall) and compromises structural integrity of landform, post-closure repair required.	U				M				II	BH-18. Review water management for waste dumps that abut the landscape to minimise run-on to dumps at closure. BH-19. Review mineral waste competency and update waste dump designs accordingly.
T	A	03	02	• Mineral waste characterisation suggests most waste material is inert and in general is expected to be acceptable growth media. • Top soil recovery will be limited due to rocky terrain. Topsoil reconcilitation considers current performance success, concludes topsoil shortage likely. Subsoil may be blended with topsoil to achieve 200mm targets. Age of topsoil will need to be considered. Alternative treatment to consider include mulch, fertilisers, gypsum etc. • Limited rehabilitation / revegetation has been completed at HD1 to assess if standard rehabilitation practice can achieve revegetation. Completion criteria proposed have been achieved at other Pilbara sites. But difficult to conclude that standard rehabilitation techniques will achieve at Baby Hope.	Insufficient topsoil is recovered to provide suitable growth media	P			L	L				II	BH-07 Undertake topsoil reconcilitation following clearing activities. Review alternative soil treatments if recovered topsoil return rates are predicted to be less than 100mm across entire disturbance area.
T	A	03	03	• Most revegetation activities will occur at closure. Soil stockpiles will be kept for a long time, and there is a potential for soil quality to degrade. • Seeds tested for germination as standard. Seeds sourced from reliable suppliers. • Neighbouring pastroral land use, so problematic cattle expected to impede vegetation growth. Temporary fencing or alternatives may be required. Need to protect emerging growth until vegetation is of sufficient maturity. • Invasive species management plan to be developed as part of closure activities.	Vegetation fails to establish due to cattle presence and re-work is required post-closure.	P				M				III	BH-08 Review and implement options for preventing cattle access to establishing vegetion.
T	A	03	04	• Access requirements to caves and other movement through site post-closure are recognised but yet to be formerly defined with stakeholders. • Heritage surveys are currently being undertaken, which will help define which sites need to be considered as 'significant' after closure - significant sites impacted by mining will be removed/recovered/recorded - will reduce the number of sites required for post-closure management. It is possible that there will not be any sites remaining that have significance post-closure.	Closure plan fails to provide safe access to significant cultural sites, forcing Traditional Owners onto unstable ground above pits.	U					M			II	BH-09 Review locations of significance with Traditional Owners BH-10 Integrate safe access routes to stakeholder (TO) nominated sites into the closure plan
T	**A**	**04**													
T	A	04	01	• Development of the project will terminate local surface water flow to Pebblemouse Creek. However, this impact is part of the proposal - closure plan does not propose to reverse this impact. • Waste dumps, while outside the 100 year floodplain, are within the PMF. So sediment from erosion of the toe could be transported into the creek during flood. However, the creeks naturally have high sediment loads durign flood, so downstream impact from sediment contribution is not considered to be significant. • No temporary diversion drains will be installed, so not change to local drainage systems expected on closure.	Erosion from the rehabilitated landforms enters the creek system and smothers local flora / fauna, causing stress.	U				L				I	
T	A	04	02	• Environmental avoidance areas in mine area (priority species or high value species / vegetation communities) • No species with conservation status or high environmental value is expected to be impacted through the implementation or closure of the project.	Priority species is identified in the mine disturbance area and requires change in landform design to avoid impact.	R				VL				I	
T	A	04	03	• Heritage sites located in / near mine area. Investigations are underway to establish which sites require salvage. • Goetchnical review (including zone of instability) has considered the location of caves above the pit, to advise salavage activities. Expected any potentially impacted sites to bne slavaged prior to closure. • Heritage sites located downstream - water and creek ecosystem related. Activities at site not expected to change downstream creek or water conditions. • Consultation with TO's will continue throughout life of mine, and requirements for repatriation can be integrated into design at any stage.	Closure plan implementation disturbs environmental or heritage site without approval.	U					M			II	BH-09 Review locations of significance with Traditional Owners

Risk Type (T=T	Category	Subcategory	Item	Risk Description Evaluated 21 of 21 risks Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments
T	**B**			**Stakeholders**		
T	**B**	**01**		**Consultation**		
T	B	01	01	Consultation fails to identify stakeholder concerns	• Large number of stakeholders in the project • Clarity of explanation / prediction of closure outcomes, communication styles, long term engagement of agreed outcomes through generational change. • Stakeholder expectations change over time, due to changing global benchmarks for mine rehabilitation success, intergenerational change, regulatory changes etc. • Stakeholders do not endorse site closure as their issues / concerns were not addressed	• RTIO stakeholder engagement practice with key stakeholders i.e. Traditional Owner LIC, etc. • Ad hoc consultation with key stakeholders • Detailed engagement planned during decommissioning study • Stakeholder engagement register
T	**B**	**02**		**Key stakeholder expectations**		
T	B	02	01	Closure outcomes do not meet stakeholder(s) / community expectations	• Absence of rehabilitation trial or data to support predicted outcomes, closure activties fail to achieve completion criteria • Communication of anticipated closure outcomes and post-closure land use needs i.e. wrong plant species established • Unrealistic expectations for economic potential opportunities / post-closure land use capability i.e. aquiculture in pit lakes	• RTIO stakeholder engagement practice with key stakeholders • Monitoring established for water, rehabilitation trials started • Numerical completion criteria established for some aspects
T	B	02	02	A stakeholder's expectations conflict with that of another stakeholder, causing delays to plan approval and / or closure	• Conflicting stakeholder expectations or areas of authority e.g. different regulators for environment, heritage, health, economic, tourism • Conflicting legal obligations e.g. State Agreement and EPA • Interactions between catchment land uses, including mining developments, at different points in time	• RTIO stakeholder engagement practice with key stakeholders
T	B	02	03	Closure strategy prevents or limits future exploitation of resources	• Backfill sterilises ore reserves • Habitat restoration prevent / limit future access to adjacent resources	• RTIO stakeholder engagement practice with key stakeholders • Integration of potential expansion deposits into current closure plan options • Internal approval process to commence backfill of pits
T	**B**	**03**		**Other expectations**		
T	B	03	01	Mine closure has a significant, long-term detrimental impact on local communities	• Local communities receive direct support from operation for basic community services e.g. doctor • Significant proportion of community are directly or indirectly employed by operation	• Ongoing communication with stakeholders
T	**C**			**Obligations**		
T	**C**	**01**		**Agreements and commitments**		
T	C	01	01	Closure is not implemented in accordance with the approved closure plan	• Mine development changes prevent closure plan from being implemented as planned • Closure plan proves to be overly challenging to implement or implementation results in a different outcome than anticpated	• Integration of closure plan with LoM report

Risk Type (T=T	Category	Subcategory	Item	Site specific overview	Evaluation Rationale (Maximum reasonable consequence)	Likelihood	Health	Safety	Environment On-site	Environment Off-site	Community Trust	Compliance	Risk Management	Detailed Action Descriptions
T	**B**													
T	**B**	**01**												
T	B	01	01	• Engagement on Baby Hope development has been limited - Greater HD1 site is already functioning mine. Issues raised for Baby Hope have been considered in development of Baby Hope closure plan. • Integrated approach to closure of Baby Hope and HD1 has been encouraged by DMP. • Intention is to integrate Baby Hope and HD1 into singular closure plan.	Stakeholder perceptions change over time and current plan is no longer accepted, requiring changes to the closure strategy during decommissioning	U					M		II	BH-11. Undertake closure specific consultation with TO's, include wider HD1 area closure BH-12. Undertake closure specific consultation with DMP, include wider HD1 area closure BH-13. Undertake closure specific consultation with OEPA include wider HD1 area closure BH-15 Review stakeholder consultation response and revise objectives, completion criteria and measurement tools where appropriate BH-16. Integrate Baby Hope and HD1 into a Greater HD1 closure plan
T	**B**	**02**												
T	B	02	01	• Pastoral lease only on a small area of mining lease. Not on area covered by Baby Hope. Expect land to revert to unallocated crown land; requires native vegetation growth and stable landforms for post-closure land-use compatibility. • 3D post-closure visualisation is not available. Landscape vision and potential vegetation communities have not been discussed with all stakeholders in detail.	Longer post-closure monitoring period than anticipated is required to demonstrate ecosystems are self-sustaining	P					L		II	BH-15 Review stakeholder consultation response and revise objectives, completion criteria and measurement tools where appropriate
T	B	02	02	• No conflicts have been identified. Communication with stakeholders will occur throughout mine life to identify and address potential conflicts.	Stakeholder requirements for environmental management conflict, and one stakeholders needs can't be met	U					L		I	
T	B	02	03	• Backfill is part of closure strategy and could cover some ore. Internal and External approvals to backfill over ore will be confirmed prior to undertaking activity • Further resource definition drilling is underway in the area. Subsequent mining studies could influence mine sequencing, but are not expected to significantly alter the expected closure outcomes. • Further discussion with key stakeholders and regulatory approvals are required before any below water table deposits can be mined.	Closure outcomes presented in the Baby Hope closure plan are superceded by an alternate closure strategy, due to future resource development, causing some disgruntlement within some stakeholder groups during additional Part IV approval process.	L					VL		II	
T	**B**	**03**												
T	B	03	01	• FIFO operation - limited interaction with neighbouring communities.	Provision for community transition from RTIO dependence is unavailable.	R					L		I	
T	**C**													
T	**C**	**01**												
T	C	01	01	• Implementation of the closure plan will influence site mineral waste management activities. Communication with / approval from regulators may be required prior to implementing changes to the mine plan. • Closure plan expected to require 3 yearly updates approved by EPA.	Regulator identifies an inconsistency in closure implementation and requires re-work to achieve acceptable outcome	R					M	M	II	BH-17 Review data collected and information developed through the operation life. Use data / information to improve models, interpretations and verify predictions.