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31 March 2014

Our reference: RTIO-HSE-0208486
Your reference: Ministerial Statements 914

Yandicoogina Closure Plan

Please find enclosed one hard copy and one electronic copy of the April 2014 Yandicoogina Closure Plan. The document addresses closure of several mining areas associated with the Yandicoogina Iron Ore Project, including future expansion areas and ancillary infrastructure.

The document is submitted to comply with the requirements of MS914 (Yandicoogina Iron Ore Project – Expansion to Include Junction South West and Oxbow Deposits) Condition 9-1:

> Within 12 months following commissioning of the Junction South West or Oxbow pits, whichever is first, the proponent shall prepare and implement a Yandicoogina Decommissioning and Rehabilitation Plan in accordance with the *Guidelines for Preparing Mine Closure Plans, June 2011* and any updates to the requirements of the CEO on advice of the Department of Mines and Petroleum.

The Junction South West pit at Yandicoogina was commissioned on 1 April 2013.

Yours sincerely

Kirsty Beckett
Specialist Closure Planning
Rio Tinto Iron Ore Group

Rio Tinto Iron Ore

Yandicoogina closure plan

1 April 2014

RTIO-HSE-0208486
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Corporate closure planning statement

Rio Tinto considers closure planning to be an integral part of its business. The process of preparing for closure begins in the early stages of project development, and continues throughout the life of the mine.

Within the Rio Tinto Iron Ore business, a team of in-house rehabilitation and closure planning specialists has been established to manage this aspect of our operations. A Rehabilitation and Closure Working Group has been established to facilitate integration of closure planning into the broader mine planning framework, and to oversee the research and improvement projects recommended in each closure plan. In this way, Rio Tinto aims to continually improve both its understanding of closure risks, and the strategies employed to mitigate them.

This plan documents the current closure knowledge base for Yandicoogina. It outlines the objectives that need to be met at closure, the strategies and plans to be employed to achieve them, and provides an indication of the criteria that will be used to assess closure success.

However; this is not a static document. Rio Tinto will continue to revisit its closure plans on a regular basis to ensure that the objectives to which it is working towards remain relevant and aligned to stakeholder expectations, and to revise its strategies and plans where appropriate to achieve improved closure outcomes.

I hereby certify that to the best of my knowledge, the information within this 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.

Allan Jackson
General Manager, Climate Change Water and Environment

Executive summary

Scope

This closure plan is designed to address the closure requirements for Rio Tinto Iron Ore's Oxbow, Junction South West (JSW), Junction Central (JC), Junction South East (JSE) and the Billiards expansion deposits, as well as associated mine site infrastructure. Closure is assumed to include progressive rehabilitation that will occur throughout the life of the mine.

The closure plan scope does not include the rail component of the project. Rio Tinto Iron Ore (RTIO) considers its rail network across the Pilbara in a separate Rail Network Closure Statement.

The closure plan has been developed to meet the requirements of the Rio Tinto Closure Standard and the OEPA/DMP Guidelines.

Obligations and commitments

Yandicoogina is subject to the *Iron Ore (Yandicoogina) State Agreement Act 1996* and one current Ministerial Statement, Statement 914. Ministerial Statement 914 addresses the mining requirements for the Oxbow, JSW, JC and JSE deposits and supersedes the implementation conditions of previous Statements 417, 523 and 695. Environmental approval for the Billiards expansion deposits has yet to be requested.

Overview

The Yandicoogina channel iron deposits (CID) are located near the junction of Marillana Creek and Weeli Wolli Creek, approximately 90km northwest of Newman in the Pilbara region of Western Australia. The CID is a local aquifer, located adjacent to and under the current creek system. The CID is removed using open cut, conventional drill-and-blast and load-and-haul mining methods. Waste generated through mining is deposited in temporary stockpiles adjacent to the pit, until sufficient void space becomes available for the material to be returned to the void. The mine has been operating continuously since 1998.

Closure challenges for Yandicoogina are largely associated with water management. These challenges include the rehabilitation and stability of the creek systems, to ensure continuity of surface water flow regimes and preservation (where possible) of riparian ecosystems, and the management of water quality in line with post-mining land use requirements.

Post-mining land use

The pre-mining land use of pastoral activities is not considered to be compatible with basic landforms that will be left as a consequence of mining, eg waste dumps, pit voids and pit lakes. Alternative land use options are continuing to be investigated in consultation with local communities and Traditional Owners.

Until an alternate land use is agreed, the closure and rehabilitation strategy focuses on the following, to ensure the system remains compatible with general Pilbara land uses:

- create landforms that are stable for access by humans and native fauna;
- ensure water systems support existing riparian vegetation and are compatible with the natural system dynamics; and
- establish ecosystems with similar biodiversity and cultural heritage values as surrounding reference sites.

The ultimate goal for closure will be to relinquish the site to the Western Australian State Government.

Closure objectives

The following closure objectives have been developed for Yandicoogina:

- rehabilitated landforms are stable and designed to manage floodwater appropriately;

- the environmental and cultural heritage values associated with creek flows and function are maintained post-closure;
- environmental values of Fortescue Marsh are not compromised;
- water quality within pit lakes support natural ecosystems and are compatible with post-mining land use;
- alluvial groundwater systems support remnant phreatophytic vegetation;
- final landforms are rehabilitated to be compatible with post-mining land use; and
- public safety hazards have been addressed.

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 the ability to successfully relinquish the site will be assessed.

Closure strategies

Landform design

Design of the post-closure landform at Yandicoogina has considered, in order of priority:

- safe, stable, non-polluting landforms;
- preservation of creek ecosystems, including riparian habitat;
- minimum impact to surface water flow paths, volumes and levels;
- achieving the lowest lake water salinity, preferably stock drinking water quality or lower; and
- minimum rehandle of mineral waste.

The conceptual closure landform created for Yandicoogina is inclusive of all Rio Tinto proposed mining activities and facilitates progressive rehabilitation of the Yandicoogina operation. The landform will continue to be refined as further investigations resolve the local water and environmental outcomes, influences and impacts, and as additional input is received from stakeholders.

Decommissioning of infrastructure

RTIO's strategy for decommissioning infrastructure across the Pilbara involves:

- arranging with the Western Australian State Government (State) for handover of relevant infrastructure at closure, in accordance with State Agreement requirements;
- removal of the remaining equipment or items as agreed between RTIO and the State;
- actively investigating opportunities to salvage materials for recycling or reuse as the site approaches closure;
- removing materials that have the potential to be hazardous to the environment or human health from site and disposing in accordance with Western Australian Government Controlled Waste Guidelines;
- completing contaminated sites assessment before removing infrastructure, with remedial action taken, if required to ensure that it is safe to do so;
- demolishing for scrap or burying any infrastructure not retained by the State Government on site, or deconstructing to enable recycling or reuse
- retaining buried services / infrastructure in situ when it is more than one metre below the final ground level, after any potentially hazardous materials have been removed.

Decontamination

Rio Tinto Iron Ore maintains a Contaminated Sites Management Plan to manage contaminated sites issues. Investigations are undertaken regularly during the course of operations, and suspected and known contaminated sites are reported to the Government in accordance with legislative requirements. A final contaminated sites assessment will be undertaken as the site approaches closure, and appropriate management actions developed and implemented if required.

Rehabilitation

Rehabilitation measures ensure that the final closure landscape achieves the specific objectives established for the site, and will be undertaken progressively throughout the life of the mine when areas become available. Rehabilitation will be undertaken in accordance with standard procedures, which include:

- maximising progressive backfill of pits during operations to reduce the ultimate closure liability;

- ensuring that final landforms are constructed or reshaped in accordance with RTIO Landform Design Guidelines, to ensure long term stability;
- encapsulating potentially hazardous materials in accordance with the RTIO Fibrous Minerals Management Plans; and
- revegetating with seeds of local provenance in accordance with the RTIO Rehabilitation Handbook, to improve slope stability, cover system performance and biodiversity outcomes.

Human Resources
Rio Tinto Iron Ore is developing a strategy for workforce closure management strategy that will cover all its operations in the Pilbara. A workforce management plan specific to the Yandicoogina operation will be developed as the site approaches closure.

Heritage
Rio Tinto Iron Ore maintains a Cultural Heritage Management Plan for Yandicoogina which is under regular revision with traditional owners and will next be scheduled for discussion with the group in 2014. Archaeological and ethnographic investigations are always undertaken prior to initial ground disturbance. Identified sites may be preserved, or salvaged and destroyed in accordance with Government statutory consent. The management activities undertaken for any site are carried out in consultation with the traditional owners.

Anticipated closure outcome

The legacy of mining at Yandicoogina will be a series of lakes with varying water quality and the introduction of small pockets of new habitat with characteristics similar to wetland systems.

The lakes are expected to be disconnected from the Marillana Creek surface flows, allowing the water table under the creek to recover and sustain the riparian (including phreatophytic) ecosystem. A large, deep lake will be allowed to develop in Weeli Wolli Creek. This lake will be sustained by groundwater during the dry season and will capture low flow events during most of the year. Following large rainfall and flood events, however, the lake may overtop and the water would be conveyed through to Fortescue Marsh, to maintain the flood frequency within the Marsh.

Outside of the lakes, most of the disturbed land will be revegetated to create habitat that functions with a similar performance to the pre-mining areas. This includes re-establishment of a large section of the Weeli Wolli Creek floodplain and minor remediation of other disturbed riparian areas; while new wetland type habitat will be created around the fringes of the lakes.

DMP/OEPA Guidelines checklist

Q	Plan Checklist	Y/N	Page	Comments
1	Has the checklist been endorsed by a senior representative within the operating company?	Y	ii	
2-5	Questions relevant to DMP administration of closure plans	n/a	-	
6	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	7	
7	Has a consolidated summary or register of closure obligations and commitments been included?	Y	15	See also Appendix B.
8	Has information relevant to mine closure been collected for each domain or feature?	Y	18	
9	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?	Y	100	
10	Have all stakeholders involved in closure been identified?	Y	73	
11	Has a summary or register of stakeholder consultation been provided, with details as to who has been consulted and the outcomes?	Y	75	
12a	Does the plan include agreed post-mining land use?	Y	79	
12b	Does the plan include closure objectives?	Y	79	
12c	Does the plan include a conceptual landform design diagram?	Y	83	
13	Does the plan identify all potential (or pre-existing) environmental legacies which may restrict the post mining land use (including contaminated sites)?	Y	86	
14	Does the plan identify all (known) key issues impacting mine closure objectives and outcomes?	Y	86	
15	Does the plan include proposed management or mitigation options to deal with these issues?	Y	86	
16	Have the process, methodology and rationale been provided to justify identification and management of the issues?	Y	86	

Q	Plan Checklist	Y/N	Page	Comments
17	Does the plan include an appropriate set of specific completion criteria and/or closure performance indicators?	Y	93	
18	Does the plan include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	99	
19	Does the plan include a process for regular review of the financial provision?	Y	99	
20	Does the plan include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	102	
21	Does the plan include a closure work programme for each domain or feature?	Partial	105	Closure domains are identified. Work programmes for domains will be developed as part of the Decommissioning Plan.
22	Have site layout plans been provided to clearly show each type of disturbance?	Y	9	
23	Does the plan contain a schedule of research and trial activities?	Y	100	
24	Does the plan contain a schedule of progressive rehabilitation activities?	Y	106	
025	Does the plan include details of how unexpected closure and care and maintenance will be handled?	Y	110	
26	Does the plan contain a schedule of decommissioning activities?	N	-	Decommissioning activities will be addressed in Decommissioning Plans. Decommissioning principles are detailed in this closure plan.
27	Does the plan contain a schedule of closure performance monitoring and maintenance activities?	Y	113	
28	Does the plan contain a framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance?	Partial	113	Detailed plan for post-closure monitoring and maintenance will be addressed in the Decommissioning Plan.
29	Does the mine closure plan contain a description of management strategies including systems and processes for the retention of mine records?	Y	116	

Ministerial Statement compliance checklist

The Yandicoogina Closure Plan has been prepared to satisfy multiple objectives, including compliance with obligations arising from environmental approvals.

This checklist has been provided to facilitate audits of compliance against Ministerial Statement 914 Condition 9-3, which specifies: "*The Yandicoogina Decommissioning and Rehabilitation Plan required pursuant to Condition 9-1 shall set out procedures to:*" (as follows)

Clause		Relevant sections	Page
(1)	manage long-term hydrogeological impacts of mining the channel iron deposit	Section 13 *Water* *Discussion in Section 13.3* Water systems after closure	34
(2)	model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of waste material landforms	Section 13 *Water* *Discussion in Section 13.4* Water systems after closure	34
(3)	manage over the long-term the surface water systems affected by the open pit	Section 12.3.3 Waterway design Section 13 *Water* *Discussion in Section 13.3* Water systems after closure	31 34
(4)	progressively rehabilitate all disturbed areas to a standard suitable for the agreed end land use(s), with consideration and incorporation of:		
	(a) the characteristics of the pre-mining ecosystems within the project area (through research and baseline surveys)	Section 14.1 *Habitat*	52
	(b) the performance of previously rehabilitated areas within the mining lease	Section 14.5 *Progressive rehabilitation activities*	64
	(c) the performance of rehabilitation areas at the proponent's other operations in the Pilbara	Section 28.3 *Rehabilitation performance and validation* Appendix A Rio Tinto Iron Ore (WA) rehabilitation guidance	107 118
	(d) best practice rehabilitation techniques used elsewhere in the mining industry	Appendix A Rio Tinto Iron Ore (WA) rehabilitation guidance	118
(5)	develop and identify completion criteria	Section 24 *Completion criteria*	93
(6)	monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria	Procedures established in Section 14.4 *Revegetation and Section* *Discussed in Section 24.3* Biodiversity	61 96
(7)	report on the rehabilitation and monitoring results	Section 14.5 *Progressive rehabilitation activities*	64
(8)	remove all infrastructure	Section 29 *Decommissioning*	108
(9)	develop management strategies and/or contingency measures in the event that operational experience and/or monitoring identify any significant environmental impact as a result of the proposal	Section 30 *Unexpected closure and temporary closure*	110

Clause		Relevant sections	Page
(10)	manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates	Section 12 *Land* Section 32 *Closure monitoring programmes*	12 114
(11)	develop a 'walk away' solution for the decommissioned mine site	Section 20 *Post-closure landform* *Discussion also in Appendix D*	81

Table of acronyms

Acronym	Description
AHIS	Aboriginal Heritage Information Service
AMD	Acid and Metalliferous Drainage
AWT	Above Water Table
BIF	Banded Iron Formations
BWT	Below Water Table
cm	Centimetre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSMP	Contaminated Sites Management Plan
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DMP	Department of Mines and Petroleum
DoW	Department of Water
DSD	Department of State Development
EFA	Ecosystem Function Analysis
EMP	Environmental Management Plan
ENSO	El Nino Southern Oscillation
EP Act	Environmental Protection Act
EPA	Environmental Protection Authority
FIFO	Fly in Fly out
GARD Guide	Global Acid Rock Drainage Guide; available at www.gardguide.com/index.php/Main_Page
Ha	Hectare
ILUA	Indigenous Land Use Agreement
IOD	Indian Ocean Dipole
IODMS	Iron Ore Document Management System
JV	Joint Venture
LFA	Land Function Analysis
m^3	Metres cubed
MCA	Minerals Council of Australia
mm	Millimetre
Mtpa	Million tonnes per annum
NGO	Non-Government Organisation
ºC	Celsius
OEPA	Office of the Environmental Protection Authority
PAF	Potential Acid Forming
PCO	Present Cost Obligation
PER	Public Environmental Review
RDL	Department of Regional Development
RQM	Rehabilitation Quality Metric
S&E	Social and Environmental
SCARD	Spontaneous Combustion and Acid Rock Drainage
TO	Traditional Owner
TPC	Total Project Closure
WA	Western Australia
WFSF	Waste Fines Storage Facility

Contents page

List of figures

List of tables

Introduction to closure planning

This section provides a brief introduction to the management of closure for Rio Tinto's Pilbara iron ore operations.

1. What is a closure plan?

Closure plans document 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 closure of Rio Tinto Iron Ore mine sites. Closure plans also document tasks the company has committed to undertake to improve closure outcomes.

Closure plans are intended to be used by site personnel to inform ongoing 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.

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

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

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, with a detailed Decommissioning Plan prepared when the site is five years from scheduled closure.

Decommissioning plans provide the implementation details for the physical closure, dismantling or demolition and subsequent rehabilitation of the site (excluding progressive rehabilitation), and include location specific management plans for each closure aspect in each closure domain identified.

2. The closure planning process

Rio Tinto Iron Ore integrates closure planning into the mine planning process. As a result, closure planning is not a standard-alone process. Activities within the business that specifically address closure and closure impacts include:

- life of mine and short term plans;
- expansion studies;
- mine and waste dump design reviews;
- progressive rehabilitation;
- internal technical studies and Rio Tinto supported research activities;
- internal annual social and environmental (S&E) reporting; and
- Rio Tinto Iron Ore Closure and Rehabilitation Working Group.

Closure plans are reviewed on a regular basis in accordance with both internal and external planning obligations. The review process brings technical and site experts together to discuss current performance, changes including knowledge base improvements, stakeholder feedback on the current plan, future options and remaining knowledge gaps. At the end of the review improvement actions are assigned and integrated into work plans, and the closure plan is updated to record the review outcomes.

Scope and purpose

This section defines the content and context of this closure plan for Rio Tinto Iron Ore operations at Yandicoogina

3. Purpose

Planning for closure of a site is a critical business process that demonstrates Rio Tinto Iron Ore's commitment to sustainable development. The report follows the format and content requirements for mine closure plans as recommended by the Western Australian Government *Guidelines for Preparing Mine Closure Plans*[1], and is designed to comply with Rio Tinto's internal management expectations for mine closure as defined in the Rio Tinto Closure Standard[2].

This report documents the outcomes of the closure planning process which:

- facilitates early identification of site-specific closure objectives and closure issues for the site;
- develops preliminary strategies to meet these closure objectives and manage closure issues;
- identifies actions that are (or will be) integrated into normal activities to manage closure issues, to facilitate efficient and effective closure in the future;
- identifies research actions that may assist in achieving improved closure outcomes;
- describes the process used to estimate costs associated with closure; and
- develops a multi-disciplinary information resource for the operation (knowledge base).

4. Outline

This document is divided into several broad sections, as recommended in the *Guidelines for Preparing Mine Closure Plans;*

- a corporate closure planning statement and plan endorsement;
- an introduction to closure planning within Rio Tinto Iron Ore;
- a statement of the **purpose and scope** of this closure plan;
- a **project overview** that establishes the context of the mining operation within the broader landscape;
- a register of **closure obligations and commitments** relevant to the project;
- a **knowledge base** that provides a summary and analysis of the key technical, environmental and social data that may be relevant to closure of the site;
- a **register of current stakeholders** and a **communication register** to summarise the general outcomes of stakeholder consultation undertaken to date relevant to closure of the site;
- identification of a **post-mining land use** and **closure objectives** that describe the outcomes sought in association with closure of the site;
- risk based evaluation of **issues associated with closure objectives and strategies** for reducing risk;
- a description of **completion criteria** that may be employed to measure successful implementation of closure;
- the process used by Rio Tinto to develop the **financial provision** for closure;
- a **closure implementation section** which outlines how closure will be implemented for the site and the current gaps in knowledge which need to be addressed to ensure successful closure is achieved. This section also details current or planned research relevant to closure outcomes for the site and how progressive rehabilitation will be managed;

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[1] Department of Mines & Petroleum and Office of the Environmental Protection Authority (2011) Guidelines for Preparing Mine Closure Plans, June 2011, http://www.dmp.wa.gov.au/documents/Mine_Closure(2).pdf.

[2] Rio Tinto (2013) Closure Standard, March 2013, http://www.riotinto.com/documents/Library/Closure_Standard_EN.pdf

- an unexpected or temporary closure section, which addresses management measures in the event of sudden or temporary closure;
- an indicative **closure monitoring and maintenance** program; and
- a strategy for **management of information and data** during and post closure.

5. Inclusions and exclusions

This report covers the closure of all of the areas outlined in Figure 1, excluding the rail way, loop and sidings; rail service roads; rail signal; and other rail infrastructure[3].

Decommissioning and removal of the rail network has been specifically excluded from this closure plan to reflect the minimum expectation of the *Iron Ore (Yandicoogina) Agreement Act 1996*, clause 39 (2) which requires all buildings, erections and other improvements erected on any land then occupied by the Company to become property of the State. This exclusion is subject to review with each revision and update of the closure plan.

6. Closure plan review history

Closure plans for Yandicoogina have been regularly updated to inform environmental approval and impact assessments and for internal mine planning and closure costing estimation activities.

The initial Yandicoogina mine proposal for the western half of the Junction Central deposit was assessed by the EPA[4] in 1996. The resulting Ministerial Statement 417[5] identified long term management of water and associated vegetation as key closure issues, addressed through Condition 5-1 Decommissioning[6]. The proposal to extend the mining area to the east (the Hairpin and Waterstand areas) was assessed by the EPA[7] via a s46 and Ministerial Statement 523[8] was issued as an amendment in 1999, preserving the Ministerial Statement 417 Decommissioning conditions.

Even in these initial proposals Yandicoogina was expected to have insufficient mineral waste to backfill the mine void. The creation of pit lakes was recognised early in the closure planning process, and is acknowledged in the initial Yandi Operations Closure Statement in 1999 [9] as an expected outcome from mining. The Yandicoogina closure plan was subsequently updated in 2000. This update was formally approved by Government in August 2000[10]. The plan was then updated for internal use in 2001[11].

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[3] Pilbara rail network closure is addressed via a separate Rail Closure Statement

[4] Yandicoogina iron ore mine and railway, Hamersley Iron Pty Limited, Report and recommendations of the Environmental Protection Authority, Bulletin 809 April 1996. http://www.epa.wa.gov.au/docs/773_B809.pdf

[5] Statement that a proposal may be implemented (pursuant to the provisions of the Environmental Protection Act 1986) Yandicoogina Iron Ore mine and railway, 90 kilometres north west of Newman, Hamersley Range. Assessment number 979, EPA Bulletin 809, Ministerial Statement 417, 24 May 1996. http://epa.wa.gov.au/EPADocLib/417_BOUND.PDF

[6] MS 417 Condition 5-1,2 (prepare a plan which) provides for the long term management of salinity in the mined-out pit; Condition 5-1, 4 (prepare a plan which) has the objective of protecting the water resources and phreatophytic vegetation of the area

[7] Yandicoogina iron ore mine and railway, Hamersley Iron Pty Limited, Section 46 report and recommendations of the Environmental Protection Authority, Bulletin 946 August 1999. http://www.epa.wa.gov.au/docs/908_B946.pdf

[8] Statement to amend conditions to a proposal (pursuant to the provisions of the Environmental Protection Act 1986) Yandicoogina Iron Ore mine and railway, 90 kilometres north west of Newman, Hamersley Range. Assessment number 1174, EPA Bulletin 946, Ministerial Statement 523, 1 October 1999. http://edit.epa.wa.gov.au/EPADocLib/000523.pdf

[9] Sinclair Knight Merz (1999) Decommissioning and rehabilitation plans, Yandi Operations Closure Statement. Prepared for Hamersley Iron Pty Ltd, February 1999. RTIO-HSE-0108412.

[10] Letter signed by Dr Bryan Jenkins, CEO Department of Environmental Protection, 26 August 2000. Internal reference RTIO-HSE-0058547

[11] Hamersley Iron (2001) Yandicoogina Closure Plan, September 2001. Internal reference RTIO-HSE-0010900

The Yandicoogina closure plan was significantly updated in 2003[12] and formally approved by Government in 2005[13] as part of the Junction South East (JSE) deposit assessment (Ministerial Statement 695[14][15]). In this proposal, Rio Tinto suggested it was possible to prevent the development of a pit lake and associated salinity problems at JSE by mining an adjacent hill to filling the void to the 490mRL[16], the nominated post-closure groundwater level. In response, Ministerial Statement 695 included Condition 6 Post-closure Backfill Source, to address issues other than water management associated with the proposed backfill closure strategy, including Aboriginal ethnographic and archaeological, vegetation, flora and fauna values. The introduction of Condition 6 highlights the balance that needs to be achieved within the Yandicoogina closure plan, to ensure that one value system is not sacrificed to achieve another without due consideration, consultation and engagement with stakeholders.

In 2008 a closure management study was prepared and submitted to Government regulators for review pursuant to condition 5.1 of Ministerial Statement 695. The EPA was unable to make an assessment of the proposal, citing the closure management study did not meet the requirements of condition 5.1[17].

The next version of the closure plan was completed in 2011 and provided as part of the submission to expand the operation to include the Junction South West (JSW) and Oxbow deposits. Approved[18] in 2012, with the understanding there are future expansions yet to be proposed, Ministerial Statement 914[19] was issued such that the Statement supersedes the implementation conditions of Statements 417, 523 and 695 in accordance with section 45B of the *Environmental Protection Act* 1986.

With respect to closure, minor additions were made to (now) Condition 9 Decommissioning and Rehabilitation in Ministerial Statement 914, reflecting the increasing expectations for materials characterisation and acid and neutral mine drainage management.

Under the closure strategy for the JSW and Oxbow proposal, it was recognised that mining neighbouring hills (as was proposed for JSE) was not an appropriate strategy when extended to the Life of the operation. Ministerial Statement 914 therefore excluded specific reference to the previous “Post-closure backfill sources” condition.

However, the importance of the riparian ecosystems was emphasised through the introduction of Ministerial Statement 914 Condition 7-3 to ensure “there is no irreversible impact to riparian vegetation or groundwater dependent ecosystems” within specified

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[12] Hamersley Iron Pty Ltd (2003) Hamersley’s Yandicoogina Project Closure Plan First Review and Update, October 2003, internal reference RTIO-HSE-0013555

[13] Letter from Lisa Chandler, Manager DOE Environment Audit Section dated 15 March 2005. Internal reference RTIO-HSE-0013554.

[14] Yandicoogina Junction Southeast Mine, Hamersley Iron Pty Limited, Report and recommendations of the Environmental Protection Authority, Bulletin 1195 September 2005. http://epa.wa.gov.au/EPADocLib/2111_B1195.pdf

[15] Statement that a proposal may be implemented (pursuant to the provisions of the Environmental Protection Act 1986) Yandicoogina Junction South-East mine, Mining Lease 274SA, Shire of East Pilbara. Assessment number 1590, EPA Bulletin 1195, Ministerial Statement 695, 25 October 2005. http://edit.epa.wa.gov.au/EPADocLib/000695.pdf

[16] Ministerial Statement 695, Schedule 1, dot point 10, proposal description to include “permanent loss of at least part of a nearby hill to partially fill the pit void to at least 490 metres Relative Level”.

[17] Letter from Ross Atkin, Project Manager Investment Facilitation (DOIR), dated 8 October 2008, available at RTIO-HSE-0071273

[18] Report and recommendations of the Environmental Protection Authority, Yandicoogina Iron Ore Project - Expansion to include Junction South West and Oxbow Deposits, Report 1448 August 2012. http://edit.epa.wa.gov.au/EPADocLib/Rep%201448%20Yandicoogina%20PER%20270812.pdf

[19] Statement that a proposal may be implemented (pursuant to the provisions of the Environmental Protection Act 1986) Yandicoogina Iron Ore Project – Expansion to include Junction South West and Oxbow Deposits. Assessment number 1726, EPA Bulletin 1448, Ministerial Statement 914, 18 October 2012. http://edit.epa.wa.gov.au/EPADocLib/Statement%20No.%20914.pdf

along both Marillana and Weeli Wolli Creeks. This requirement could potentially conflict with some proposed closure strategies, such that new closure strategies have been investigated and are included in this closure plan in consideration of this Condition.

Through the 2012 EPA assessment[20] of the JSW and Oxbow proposal, it was subsequently requested that the closure plan be reviewed to align with the *Guidelines for Preparing Mine Closure Plans* and provide an integrated closure plan for all existing and proposed Yandicoogina operations. Subsequently this closure plan has been prepared pursuant to condition 9.1 of Ministerial Statement 914, to prepare and implement the Yandicoogina Decommissioning and Rehabilitation Plan within 12 months following the commissioning of the first JSW pit.

This report was developed using information that was current in October 2013, incorporating information developed as part of the life of mine planning process for Yandicoogina. This report has been prepared for external release and will supersede all previous closure plans.

Future reviews of the closure plan will:

- Incorporate improvements that have been made to the closure knowledge base in the course of mine development, and through the implementation of research projects.
- Consider progress against previous task lists, ascertain whether incomplete tasks are still relevant, and develop new tasks where appropriate.
- Review closure objectives and indicative completion criteria to ensure they remain relevant and consistent with stakeholder expectations.
- Incorporate management strategies for various aspects of closure, prepared to an increasing degree of detail relevant to the stage of operation.
- Update the closure cost estimate to an increasing level of accuracy as strategies are progressively developed, and underlying assumptions are validated.

Yandicoogina operations are subject to a Ministerial Statement condition[21] that requires formal review by the EPA every 3 years. The next formal review of the closure plan is scheduled to occur in 2016.

Rio Tinto Iron Ore will commence development of the decommissioning components of the closure plan approximately five years prior to scheduled closure, during which time one of the main aims will be to facilitate stakeholder engagement and endorsement of the final completion criteria.

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[20] Report and recommendations of the Environmental Protection Authority, Yandicoogina Iron Ore Project - Expansion to include Junction South West and Oxbow Deposits, Report 1448 August 2012. http://edit.epa.wa.gov.au/EPADocLib/Rep%201448%20Yandicoogina%20PER%20270812.pdf

[21] Ministerial Statement 914 Condition 9-4 "The proponent shall review and revise the Yandicoogina Decommissioning and Rehabilitation Plan required by condition 9-1 at intervals not exceeding three years."

Project overview

This section describes the site, and provides context for the operations within the broader landscape.

7. Site context

7.1 Location

Rio Tinto Iron Ore Yandicoogina operation (Figure 1) is located in the Shire of East Pilbara, approximately 90km northwest of Newman within the Weeli Wolli Creek catchment. The mine is sufficiently remote that mining is operated on a 100% fly-in fly-out (FIFO) basis.

The mine is one of several operations within a localised area along a channel iron deposit (CID) (Figure 2). The CID is characterised by continuous iron mineralisation along a palaeochannel in the lower reaches of the Weeli Wolli Creek catchment. The CID snakes over 100km from the Munjina Claypan in the west down Marillana Creek and its tributaries and into Weeli Wolli Creek, terminating somewhere under Fortescue Marsh.

The first mine to be developed, commencing in 1991, was the BHP Billiton Iron Ore (BHPBIO) Yandi mine (also known as Marillana Creek) located approximately 12km west and immediately upstream of Rio Tinto Yandicoogina mine on Marillana Creek. Iron Ore Holdings (IOH) with Mineral Resources also operate Phil's Creek Iron Ore Mine immediately north and upstream of Yandicoogina on Phils Creek. Other iron ore mining companies seeking to establish operations in the immediate vicinity of Yandicoogina include Iron Ore Holdings (IOH) Iron Valley project situated approximately 5km to the north-east, adjacent to Fortescue Metals Group (FMG) Nyidinghu project, and immediately downstream of the Yandicoogina mining lease (M274SA); and the Brockman Mining Limited Marillana Iron Ore Project is located approximately 20km to the north of Yandicoogina and downstream of the IOH Iron Valley and FMG Nyidinghu projects.

Due to the proximity of the mines, mining and closure activities at Yandicoogina are expected to influence the mine and closure strategies at the BHPBIO Yandi mine, the IOH Iron Valley project and the FMG Nyidinghu project.

Other major mines within the Weeli Wolli Creek catchment, upstream of Yandicoogina and adjacent to Weeli Wolli Creek, include: BHPBIO Mining Area C (MAC) mine and Jinidi expansion project approximately 32 km to the south-east and the Rio Tinto Hancock Joint Venture Hope Downs 1 mine approximately 22 km to the south. Rio Tinto also hold leases over the Snooker and Meander deposits, located upstream of the BHPB Yandi operation. As Yandicoogina is located downstream and outside the influence of these areas, closure is not expected to impact these areas. However, activities at these mines and at BHPBIO Yandi mine may influence Yandicoogina's mine and closure strategies.

7.2 Tenure

Mining areas at Yandicoogina, along with several future deposits, overlay Pastoral Lease L3114 984, operated as Marillana Station by BHPBIO. Only the JSW-A and Oxbow deposits partially overlays vacant crown land (Figure 2).

Mining is enabled by the *Iron Ore (Yandicoogina) Agreement Act 1996*, which has the effect of excising a portion of the pastoral lease for Rio Tinto Iron Ore mining purposes. Special leases have been issued following negotiation with BHPBIO for infrastructure locations (e.g. Yandicoogina camp).

Upon cessation of the State Agreement and special leases, tenure for the excised areas would revert to Pastoral Lease L3114 984. Proposed final land uses will therefore require negotiation with BHPBIO.

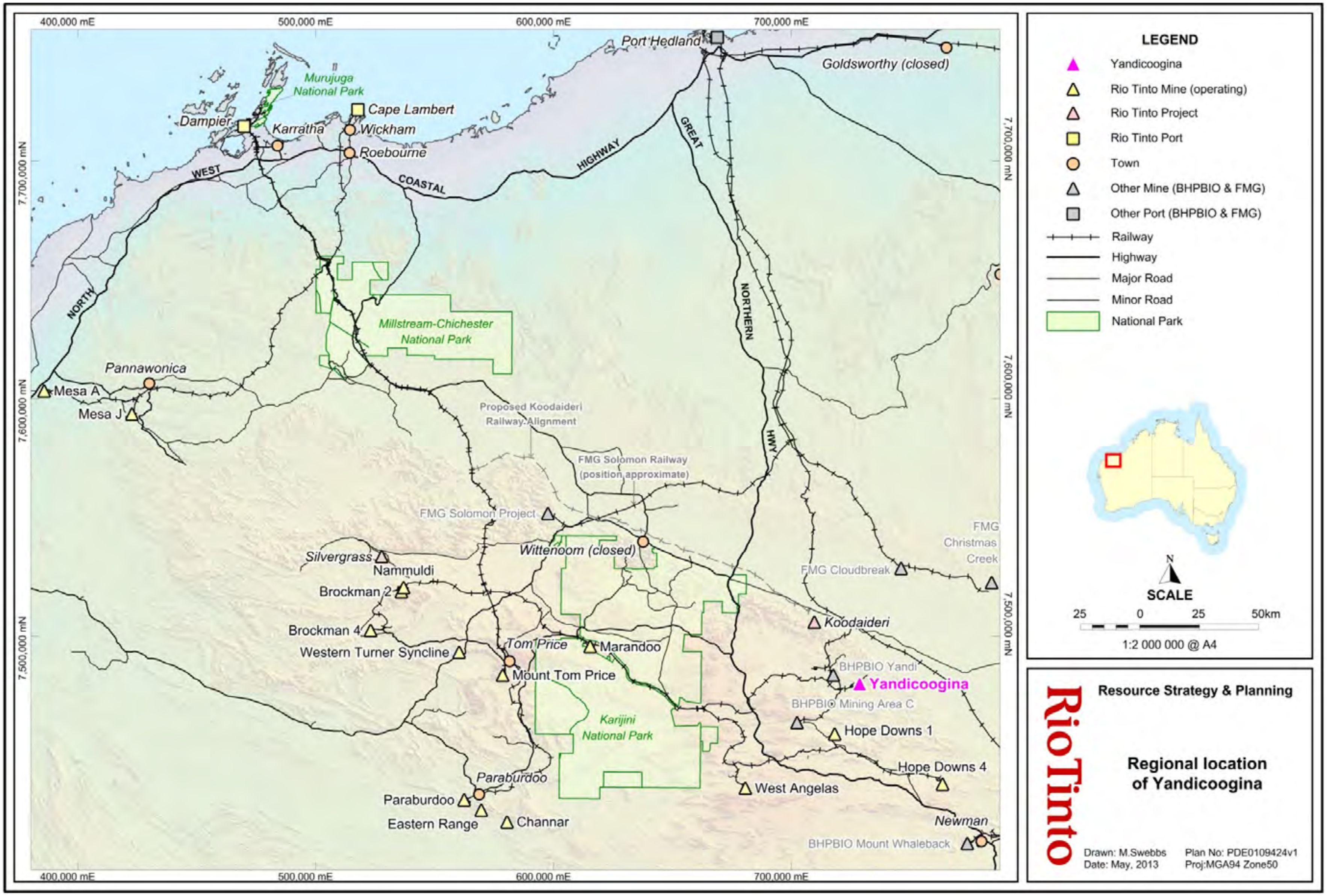

Figure 1: Location of Yandicoogina mine.

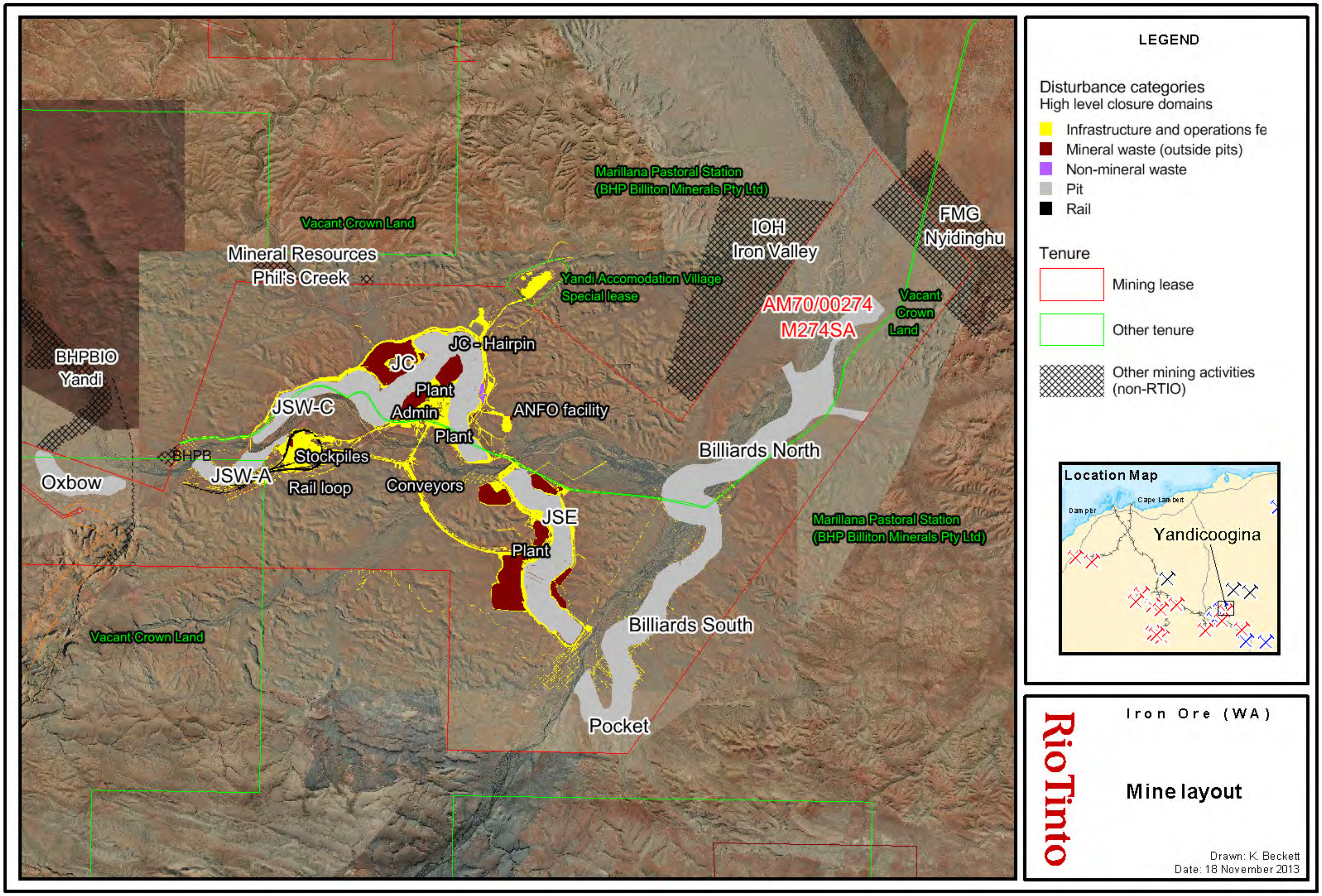

Figure 2: Yandicoogina mine layout.

7.3 Joint Venture arrangements

The operation is 100% owned by Hamersley Iron, which is a subsidiary of Rio Tinto, and is not subject to any joint venture arrangements.

8. Overview of operations

The Yandicoogina mining area consists of several deposits along the CID continuous iron mineralisation (from upstream to downstream): Oxbow, Junction South West (JSW), Junction Central (JC), Junction South East (JSE) and the yet to be developed Billiards area. The operation is open cut and utilises conventional drill-and-blast and load-and-haul mining methods. Key characteristics for the operation are summarised in Table 1.

Table 1: Key characteristics of the (site)

Component	Site characteristic	
Mining	Mine life	Projected beyond 2030 projected (+25 years)
	Deposits	Oxbow Junction South West (JSW) Junction Central (JC) Junction South East (JSE) Billiards expansion - including Pocket, Billiards South and Billiards North
	Ore below water table	Present – approximately 80%
Waste	Dumps	In pit Temporary external
	Waste fines storage facility	JC WFC1 JC WFC2 JSE WFC3
	Potentially acid forming (PAF) material	Not present
	Fibrous material	Present
	Offsite discharge	Present

8.1 Development history

JC was the first deposit to be developed at Yandicoogina and has been operating continuously since 1998. Overburden (mineral waste) material was deposited outside of the pit area to the north of the operations adjacent to Phils Creek and top soil was stockpiled immediately south of the mine area, where they remain today. As void space became available overburden was deposited (backfilled) directly into the mined out sections of the void. Mined out areas of the JC void have also been converted into waste fines storage areas for the benign waste residue generated by wet processing of the iron ore[22]. Overburden will be continually deposited back into the JC void until the deposit is exhausted.

JSE was developed in 2006. Dewatering challenges prevented the full vertical extent of the deposit from being mined simultaneously; and as a result, the overburden waste from JSE has had to be placed external to the pit. The JSE void has been nominated as a future waste fines storage area, with a new processing plant expected to be built adjacent to the pit in the near future. Waste fines cells, which contain and control fines materials within the pit, are likely to be constructed from material excavated from the adjacent

[22] The composition of the waste residue is discussed in the Collection and analysis of closure data section.

external waste dumps. This will reduce the volume of material required to be rehandled into the void prior to closure.

Mining of JSW commenced in 2013. JSW is closely connected to the local creek systems, with Marillana Creek flowing parallel to the ore body along its northern and southern lengths (crossing the ore body across its centre) and Phil's Creek flowing over the north-eastern portion of the deposit. The last 800m of Phil's Creek has been diverted temporarily to facilitate mining through the JSW deposit.

Overburden waste from JSW is deposited into existing void areas, currently within JC. As mining of JSW progresses, mineral waste will be used to engineer a land bridge to reinstate Phil's Creek (as close as possible) along its original flow path.

This strategy of maximising backfill opportunities is expected to continue with the development of the Oxbow and Billiards expansion areas.

Development of the Rio Tinto Iron Ore Meander and Snooker deposits, located upstream of the Rio Tinto Yandicoogina Oxbow and BHPBIO Yandi mines, are not considered as part of this closure plan.

8.2 Mine layout

The Yandicoogina operations in 2013 include the following major components:

- open voids with active mining at JC, JSE and JSW;
- a dewatering system to lower the water table so that the ore reserves can be mined;
- a water management system including on-site reuse of abstracted groundwater and discharge of surplus volumes into local creek systems using a series of discharge outlets along Marillana Creek;
- temporary out-of-pit waste dumps and in-pit waste backfilling of mined areas;
- topsoil and subsoil stockpiles for mine site rehabilitation;
- roads including light vehicle / heavy vehicle access and haul roads, and several floodways across Marillana Creek;
- flood protection: levees within Marillana Creek, diversion of Phils Creek and minor creeks away from the pits and into Marillana Creek, diversion of minor creeks at JSE into Weeli Wolli Creek;
- infrastructure associated with drilling/blasting, loading and haulage/conveying ore to processing facilities at JC and JSE, and rail load out facilities south-east of JSW,
- power and communications infrastructure; and
- other minor supporting infrastructure such as accommodation village, administration buildings, maintenance workshops and associated utilities and services.

The mine layout is presented in Figure 5. A full site inventory is included in closure cost estimate reports for the site and is not reproduced in this report.

8.3 Post mining and post-closure landform

This closure plan differentiates between the post-mining landform and the post-closure landform.

The post-mining landform is the landform that would be generated as a result of implementing the LoM and other standard operating practices. Examples of standard practices employed during mining at Yandicoogina, and discussed in detail in the ***Collection and analysis of closure data*** section, include:

- rehabilitation design specifications for waste dumps, which consider:
  - location (in-pit or ex-pit, consideration of surface water hydrology);
  - dump heights and footprint constraints;
  - shape of the waste dump;
  - material characteristics on outer slopes, which will determine appropriate lift heights, slope angles and berm specifications); and
  - surface treatments and vegetative cover;
- selective placement and encapsulation of hazardous mineral waste according to standard procedures; and

- progressive backfill of pit voids with mineral waste where practicable to minimize the amount of waste material stored in ex-pit waste dumps.

Issues that could potentially arise from this scenario, and strategies to manage them, are listed in the ***Identification and management of closure issues*** section. The strategies to manage issues may need to be implemented during operations or at closure.

The post-closure landform is the final landform configuration that is proposed to remain after the implementation of rehabilitation earthworks during closure. The activities required to convert the post-mining landform to the post-closure landform will be presented in detail in the Decommissioning Plan and are mentioned in brief in the ***Closure implementation*** section.

Examples of standard practices employed during the closure implementation phase include:

- earthworks to reshape waste dumps to a stable design if required (i.e. if the dumps have been constructed, for whatever reason, to specifications that are not suitable for a closure landform);
- bulk removal of mineral waste stored in ex-pit waste dumps to backfill pit voids if required (i.e. if retention of a pit lake would lead to unacceptable impacts);
- encapsulation of residual PAF exposures if required; and
- construction of abandonment bunds around pits where topographically appropriate.

The desired post-closure landform for Yandicoogina is discussed and presented in Section 20 *Post-closure landform*.

8.4 Mining schedule

Based on the current mine plan, the major proposed milestones in the development, operation and closure phases are presented in Table 2. It should be noted that mine plans undergo constant review and modification, and consequently this information should only be used as an indication of future mining and development.

Table 2: Mining and development schedule

Milestone	Commence	Complete
JC mine development	underway	2016
JSE mine development	underway	2019
JSW mine development	underway	2019
Oxbow mine development	2017	2024
Billiards South mine development (proposed) (includes Pocket area)	2017	2033
Billiards North mine development (proposed)	2027	2042
Initial JC areas available for rehabilitation	2017	undefined
Initial JSW areas available for rehabilitation	2020	undefined
Initial Oxbow areas available for rehabilitation	2023	undefined
Closure	2042	undefined

Closure obligations and commitments

A register of obligations specific to this site is presented as Appendix B.

9. Important elements of the general legislative framework

9.1 State Agreement legislation

A State Agreement is an Act of the Western Australian Parliament to govern mining activities that are of economic or strategic importance to the State. All of Rio Tinto's Western Australian iron ore mines are subject to State Agreement[23]. The Department of State Development (DSD) is the responsible agency.

A key consequence of state agreements is that they override the *Mining Act 1978* requirement to submit mining proposals, and therefore closure plans, to the Department of Mines and Petroleum (DMP).

State Agreements are structured so that laws protecting the environment, in particular requirements under the *Environmental Protection Act 1986* (EP Act) will still apply. Sites subject to State Agreements are therefore subject to environmental impact assessment by the Environmental Protection Authority (EPA) in addition to works approval and licensing by the Department of Environment Regulation (and Conservation (DER).

Yandicoogina is subject to the *Iron Ore (Yandicoogina) State Agreement Act 1996*.

9.2 Ministerial Statements

Ministerial Statements are the end result of the environmental impact assessment process for approved projects, as outlined in Part IV of the EP Act.

Part IV of the EP Act outlines the process whereby approval is given to projects which are likely, if implemented, to have a significant impact on the environment, by the Minister for the Environment under advice from the Environmental Protection Authority (EPA). The approval process is a public one, with opportunities for the public to make submissions in respect to the project and rights to appeal against the content and recommendations in the EPA's report to the Minister.

The EPA expects closure plans to be submitted with approvals documentation to facilitate the incorporation of closure issues into its environmental impact assessment.

Yandicoogina is subject to one current Ministerial Statement:

- Statement 914 came into effect in October 2012

Ministerial Statement 914 amalgamates, contemporises and supersedes the implementation conditions of the following Statements, in accordance with section 45B of the *Environmental Protection Act 1986*:

- Statement 417, covering the Junction Central deposit in 1996,
- Statement 523, largely replaced Statement 417 as part of the Junction Central mine expansions in 1999, and
- Statement 695, covering the Junction South East deposit in 2005.

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[23] Note that whilst all Rio Tinto Iron Ore mine sites are covered by State Agreements, some ancillary areas (eg camps, infrastructure services, etc) may be located outside the Agreement boundary but issued pursuant to the State Agreement.

9.3 Mining Proposals

9.3.1 Mining Act

Mining proposals are required to be submitted and approved under the *Mining Act 1978*. This is the primary legislation under which mine closure is regulated in Western Australia and the Department of Mines and Petroleum (DMP) is the responsible agency.

In accordance with amendments to the Mining Act made in 2010, all new mining proposals are required to contain a mine closure plan prepared in accordance with the DMP/EPA *Guidelines for Preparing Mine Closure Plans* (2011).

Mining Act requirements also apply to operational areas that are not covered under State Agreement legislation. Some mining areas (eg waste dumps, fines dams) and ancillary infrastructure (eg mining camps) may fall into this category. However, the DMP has indicated that it does not necessarily expect formal closure plans to be submitted with such proposals.

The Mining Act requires mining companies to review and lodge updated closure plans at least every three years (unless otherwise authorised). Rio Tinto Iron Ore mines are subject to State Agreements, which are administered by the DSD. The DSD does not require closure plans to be submitted.

As Yandicoogina is subject to State Agreement legislation, which is administered by the DSD, the requirement to submit a closure plan under the Mining Act does not apply.

9.3.2 Regulatory and Industry Guidelines

The DMP and EPA have issued guidelines to establish standards for closure plans[24] being submitted to Government. The guidelines have legislative force because the *Mining Act 1978* has been amended to specifically state that mining proposals must include a closure plan, and closure plans are defined to be a document that:

- is in the form required by the guidelines; and
- contains information of the kind required by the guidelines.

However; this legislative requirement does not apply to mines subject to state agreement.

The EPA has indicated that it expects submitted for mines being assessed under Part IV of the EP Act to be compliant with DMP/EPA issued guidelines[24].

Rio Tinto recognises that the *Guidelines for Preparing Mine Closure Plans* (2011) provide a suitable format for development of mine closure plans, and this closure plan has been prepared to comply with the key elements and structure of the guidelines.

In addition to the *Guidelines for Preparing Mine Closure Plans* (2011) the DMP has developed a number of guidelines and environmental notes in relation to mining and rehabilitation, which include:

- Environmental Notes on Mining – Waste Rock Dumps[25];
- Mine Void Water Resource Issues in Western Australia[26]; and
- Mining Environmental Management Guidelines, Safe Design and Operating Standards for Tailings Storage[27].

Other key government and industry guidelines relevant to mine closure and rehabilitation include:

- Strategic Framework for Mine Closure[28];

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[24] Department of Mines & Petroleum and Office of the Environmental Protection Authority (2011) Guidelines for Preparing Mine Closure Plans, June 2011, http://www.dmp.wa.gov.au/documents/Mine_Closure(2).pdf.

[25] Department of Mines and Petroleum (2009) Environmental Notes on Mining – Waste Rock Dumps.

[26] Johnson SL and AH Wright (2003), Mine Void Water Resources Issues in Western Australia, [Former] Water and Rivers Commission, Perth, 2003.

[27] [Former]Department of Minerals and Energy (1999) Mining Environmental Management Guidelines, Safe Design and Operating Standards for Tailings Storage, 1999.

- Enduring Value – The Australian Minerals Industry Framework for Sustainable Development [29];
- Mine Closure and Completion[30];
- Mine Rehabilitation[31]; and
- Landform Design for Rehabilitation[32].

9.4 Other statutory obligations relevant to closure

In addition to the key requirements identified, a number of additional statutes and regulations create obligations and/or considerations that may be of relevance to the rehabilitation and closure of Yandicoogina, to the extent that they are not inconsistent with the provisions of the State Agreement. These include:

- *Contaminated Sites Act 2003* (WA), and Guidelines gazetted under this Act which provide relevant criteria for investigation and remediation purposes;
- *Environmental Protection (Controlled Waste) Regulations 2004* (WA) which apply to any off-site transport of certain controlled wastes where they are not exempt due to the nature of the material or disposal site;
- *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA);
- *Environmental Protection (Rural Landfill) Regulations 2002* (WA);
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth);
- *Rights in Water and Irrigation Act 1914* (WA);
- *Wildlife Conservation Act 1950* (WA);
- *Aboriginal Heritage Act 1972* (WA);
- *Mine Safety and Inspection Act 1994* (WA);
- *Health (Asbestos) Regulations 1992* (WA);
- *Land Drainage Act 1925* (WA);
- *Dangerous Goods Safety Act 2004* (WA), and associated regulations which can include obligations in relation to storage, handling, transport and decommissioning, for example, decommissioning of storage or handling systems under regulation 63 of the *Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007* (WA); and
- *Conservation and Land Management Act 1984* (WA) and the *Land Administration Act 1997* (WA), which generally deal with the management of Crown land, together with any approvals or agreements entered into pursuant to those statutes.

This closure plan was developed to meet the requirements of the applicable Acts and legislation.

10. Yandicoogina specific closure obligations

Closure obligations arise from State and Commonwealth legislation, mining tenement conditions, commitments made in mining proposals, conditions of environmental approvals and other agreed actions. Table 3 provides a summary of key closure obligations and information with regards to the closure of Yandicoogina. (The inclusion of a particular obligation is not a representation as to its legal effect nor is Table 3 intended to give rise to any separate legally binding commitment.) Detailed descriptions of the obligations are provided in Appendix B.

Some of the information and obligations identified may not be legally binding, however the purpose of the register is to identify all existing obligations as well as information and options that have been raised relating to closure. This information has been considered in developing closure strategies and completion criteria.

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[28] Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia (ANZMEC/MCA) (2000) Strategic Framework for Mine Closure, National Library of Australia Catalogue Data.

[29] Minerals Council of Australia (2004) Enduring Value – The Australian Minerals Industry Framework for Sustainable Development.

[30] Department of Industry, Tourism and Resources (DITR) (2006) Mine Closure and Completion.

[31] Department of Industry, Tourism and Resources (DITR) (2005) Mine Rehabilitation.

[32] Environment Australia (2002) Landform Design for Rehabilitation. Best Practice Environmental Management in Mining, Commonwealth of Australia.

Table 3: Site specific closure obligations

Aspect	Obligation	Description	Status
Decommissioning	Iron Ore (Yandicoogina) Agreement Act 1996, clause 39 (2)	All buildings, erections and other improvements erected on any land then occupied by the Company shall become property of the State.	Active upon cessation or determination of Agreement
	Iron Ore (Yandicoogina) Agreement Act 1996, clause 39 (3)	Requirement to offer to the State the purchase of fixed or moveable plant and equipment at a negotiated price.	Active immediately prior to the cessation or within 3 months therefrom
Rehabilitation	Iron Ore (Yandicoogina) Agreement Act 1996 clause 6 (1) l	Submit an environmental management programme for rehabilitation and the protection and management of the environment.	Completed
	Iron Ore (Yandicoogina) Agreement Act 1996 clause 13 (1)	Carry out a continuous programme of investigation research and monitoring to ascertain the effectiveness of the measures for rehabilitation and the protection and management of the environment.	Active
	Conditions 9-1 from Ministerial Statement MS914	Prepare and implement a Yandicoogina Decommissioning and Rehabilitation Plan	Active (Within 12 months following commissioning of the J Junction South West)
	Conditions 9-2 from Ministerial Statement MS914	Closure planning and rehabilitation are carried out in a coordinated, progressive manner and are integrated with development planning, consistent with current best practice, and the agreed land uses	Active
	Conditions 9-3 from Ministerial Statement MS914	Set out procedures to: (1) manage long-term hydrogeological impacts of mining the channel iron deposit; (2) model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of mineral waste landforms; (3) manage over the long-term the surface water systems affected by the open pit; (4) progressively rehabilitate all disturbed areas to a standard suitable for the agreed end land use(s), with consideration and incorporation of: (a) the characteristics of the pre-mining ecosystems within the project area (through research and baseline surveys); (b) the performance of previously rehabilitated areas within the mining lease; (c) the performance of rehabilitation areas at the proponent's other operations in the Pilbara; and (d) best practice rehabilitation techniques used elsewhere in the mining industry. (5) develop and identify completion criteria; (6) monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria;	Active

Aspect	Obligation	Description	Status
		(7) report on the rehabilitation and monitoring results; (8) remove all infrastructure; (9) develop management strategies and/or contingency measures in the event that operational experience and/or monitoring identify any significant environmental impact as a result of the proposal; (10) manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates; and (11) develop a 'walk away' solution for the decommissioned mine site.	
	Conditions 9-4 from Ministerial Statement MS914	Review and revise Plan at intervals not exceeding three years.	Active
	Conditions 9-5 from Ministerial Statement MS914	Make Plan publically available	Not yet required
Decontamination	*Contaminated Sites Act 2003*	Obligations to report suspected and known contaminated sites. Further obligations may arise following such reports.	Active
Traditional Owners	There are no closure obligations specifically relating to Traditional Owners	n/a	n/a
Local communities	There are no closure obligations that relate to local communities currently in place	n/a	n/a

Collection and analysis of closure data

This section reflects the closure knowledge base for Yandicoogina and is intended to define current work practice, summarise key baseline and monitoring data, and document research and study outcomes that influence closure planning.

Information collated in this section reflects our current knowledge at the time of preparation of the plan. A summary of the technical reports that contribute to the closure knowledge base is provided in Appendix C.

The contents of the closure knowledge base will evolve over time. As a result, some components of some reports and studies are superseded by new research or studies or, as a consequence of changes in the mine plan, may constitute new gaps in our knowledge at the time of this closure plan update. For these reasons the technical reports are not appended to this closure plan. All technical reports relevant to the closure of the operation will be consolidated and presented as part of the final Decommissioning and Rehabilitation Plan.

11. Climate

Climate, particularly rainfall, rainfall intensity, cyclone frequency and evaporation, influence closure planning aspects such as:

- landform stability and erosion rates
- pit lake modelling, and
- revegetation success.

The climate in the Yandicoogina area can be characterised as arid tropical with two distinct seasons: hot wet summers and cool dry winters. Mean daily maxima temperatures range from 39°C in summer to 24°C in winter. Daily temperature can rise up to 50°C during the summer and drop to 0°C in winter.

Evaporation is the most important factor for biological water use in the region, influencing both plants and animals[33]. Throughout the Pilbara, potential evaporation, estimated to be around 3500mm to 3700mm[34] per year, exceeds average annual rainfall by a factor of at least eight and by up to twenty fold in the south-east (near Yandicoogina).

Rainfall in the Pilbara rainfall averages from 200mm to 400mm per year. The majority of rain falls in the three months from January to March, each averaging more than 100mm per month and often falling in heavy rainfall events associated with tropical lows. The period between May and November is practically dry, with average rainfalls of less than 20mm per month.

Rio Tinto has maintained a meteorological monitoring station at Yandicoogina since commissioning the mine in 1998. In addition, there are a number of other gauging stations managed by Government departments in the area[35]. However, the climate

[33] N.L. McKenzie, S. van Leeuwen and A.M. Pinder (2009) Introduction to the Pilbara Biodiversity Survey, 2002–2007. Records of the Western Australian Museum, Supplement 78: 3–89, 2009.

[34] Mean annual pan evaporation from Newman. Average annual evaporation rate as measure from Yandicoogina dry bulb data is around 1800mm per year, which more closely approximates actual evaporation from dam situations.

[35] Rainfall records for the Weeli Wolli Creek Catchment include: Australian Bureau of Meteorology (BOM) Rhodes Ridge 007169 (Feb 1971 to Oct 2011), Packsaddle Camp 005089 (Jan 1989 to Jun 2002), and Western Australian Department of Water (DoW) Wonmunna 11247 (Nov 1984 still open), Tarina 11220 (May 1985 still open), Munjina 11186 (Jan 1969 still open), Packsaddle 11196 (Jun 1970 to Sep 1999), Flat Rock 11193 (Mar 1970 still open), Yandicoogina 11217 (Dec 1979 to Apr 1986) and Waterloo Bore 11221 (May 1985 still open). Immediately downstream of Weeli Wolli Catchment in Fortescue Marsh gauges of relevance include

records are inconsistent, with numerous gaps in the datasets as a result of equipment malfunctions, often during extreme weather events.

From data recorded at the Rio Tinto Yandicoogina site gauge, and augmented by neighbouring stations to create a longer historic record, the average rainfall over the past 20 years at Yandicoogina is approximately 390mm to 400mm per annum. Annual rainfall is highly varied, with recorded rainfall ranging from 148mm to 890mm over a calendar year[36]. The highest recorded monthly rainfall was 480mm during December 1974, which was associated with Tropical Cyclone Joan. This system brought wide spread and, in many locations, unprecedented flooding to the Pilbara. For comparison, a single rainfall event which produces between 200mm and 370mm within 24 to 72 hours over the Marillana Creek Catchment is classified by Engineers Australia (2001)[37] as a 1 in 100 year annual recurrence interval (ARI) rainfall event. An event of this magnitude was recorded at Yandicoogina during January 2003.

The north / north-western coastline of Australia has experienced more tropical cyclones than anywhere else on mainland Australia. In this region most tropical cyclones are observed during the late summer, occurring anytime from November through to May with their maximum frequency during January and February. On average, five tropical cyclones are expected off the Pilbara coast each year, with two expected to make landfall. Tropical cyclones and tropical lows commonly produce damaging wind gusts in excessive of 150km per hour, heavy rains and regional flooding.

11.1 Climate change

Our understanding of how climate will change in the future in the Pilbara is guided by the outcomes of climate modelling, commissioned privately by Rio Tinto[38] and other Australian government agencies.

From 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.
  - For the period from 2051 to 2099, compared to present day, tropical cyclone frequency could decrease by half while the duration of a given tropical cyclone could decrease by 0.6 days on average when compared to present day. Projections also suggest, however, that tropical cyclones could increase in size and intensity[39]
- Continuation of the highly variable multi-decadal scale rainfall trends.
  - Projected rainfall reductions range from 1 to 24% for mid-century, and 9 to 24% for the end of the century[39]
- A significant warming trend, influencing maximum temperatures, with the largest changes during the January to March period.
  - On average, maximum temperatures are expected to increase by 2.1 to 3.2 ˚C by mid-century and by a total range of 3.8 to 4.6 ˚C by the end of the century. For minimum temperatures the corresponding averaged increases are 1.9 to 2.4 ˚C (mid-century) and 4.1 to 4.6 ˚C (end of the century)[39].

The main climate drivers for the Pilbara are the El Nino 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

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BOM Marillana 005009 (Dec 1936 still open) and Sand Hill 005064 (May 1971 to Jul 1984). There are no open, publically available gauges with the Weeli Wolli Creek Catchment for other climate aspects. The closest gauges are approximately 100km away and include: Newman Aero 007176 (1971 still open) and Newman Town 007151 (1965 to 2001) to the east, Wittenoom 005026 (1949 still open) to the west, and Redmont 004043 (1925 still open) to the north. Note most of these records are incomplete.

[36] Using a season split from October to September to encompass the entire wet season, rainfall extremes range from 124mm to 1060mm over 12 months with an average of 390mm.

[37] Institution of Engineers Australia (2001) *Australian Rainfall and Runoff*. Editor-in-chief D.H. Pilgrim, Barton, ACT. This report defines the standards for engineering surface water control structures in Australia.

[38] Rio Tinto climate model report (unpublished)

[39] Indian Ocean Climate Initiative (2012) Western Australia's Weather and Climate: A Synthesis of Indian Ocean Climate Initiative Stage 3 Research. CSIRO and BoM, Australia

northwest of Western Australia can vary significantly. 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, our understanding the associated impacts on water availability and to predict changes to existing ecosystems.

Consequently, at present, there is insufficient agreement on climate change within the scientific community at the level of detail that is required to inform a detailed assessment of climate change impacts on weather, stream flow, water availability and vegetation response at Yandicoogina. This position will be reviewed periodically and new knowledge will be incorporated into studies as appropriate.

11.2 Climate and landform stability

The heavy, intense rainfall experienced in the Pilbara makes rainfall the key climatic factor that influences surface stability in the Pilbara. [40] Rainfall erosivity (measured in megajoule millimetre per hectare per hour per year - MJ.mm/ha/hr/yr) is the term used to describe the erosive force of rain. For Pilbara sites, long-term annual erosivity values range from ~1,000-1,600 MJ.mm/ha/hr/yr[41]. Rainfall in the Pilbara is typically more erosive than Perth's rainfall, even though it only receives on average half the rainfall that Perth receives on an annual basis. For comparison[42], average annual erosivity values for Perth are ~1000 MJ.mm/ha/hr/yr from an average of 780 mm of rain a year.

Rainfall erosivity is highly variable from year to year, or even from event to event. Landloch (2012) studies of Pilbara rainfall concluded that at Tom Price, for example, erosivity for the period 1998 to 2009 ranged from 212 – 6,349 MJ.mm/ha/hr/yr. The most erosive year recorded was 2007 at Channar, where 421mm fell during February (704mm fell over the whole year). This singular rain period embodied 11,994 MJ.mm/ha/hr/yr of erosive force, or 89% of the entire erosivity of rain for that year. Given the pattern of intense and infrequent rainfall events in the Pilbara, it can be expected that only a few events every year (~1-3 events) will generate the majority of runoff and erosion of that occurs each year.

As described by Landloch, a rapid decline in erosion or sediment yield occurs when annual rain decreases below about 300mm per year due to a corresponding decline in rainfall volumes and rainfall erosivity. However, when annual rainfall increases above ~300mm, vegetation growth increases and becomes increasingly effective in controlling soil erosion. Hence, there is a point of maximum erosion potential at an annual rainfall value of ~200-400 mm such that surface (vegetation) cover is low due to lack of rain and ineffective for controlling erosion, yet rainfall erosivity is sufficiently high to cause erosion, as observed in the Pilbara.

Outcomes from these studies have informed development of the Rio Tinto Iron Ore (WA) Landform Design Guidelines[43] for achieving stable waste dumps.

11.3 Climate in water models

As a key component of all water models, climate always influences model results.

Most regional groundwater models in the Pilbara, for example, are innately attuned to current climate conditions as they are calibrated to observed groundwater levels. A groundwater level, as measured at a single bore, represents the result of rainfall that has infiltrated through the soil and possibly been subjected to evaporation / evapotranspiration processes. If the water is relatively young and within an unconfined

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[40] Landloch Pty Ltd (2012) Final Landform Design Criteria for Use During Mine Planning, Prepared for Rio Tinto Iron Ore Western Australia, February 2012. RTIO-HSE-0159989

[41] Rosewell C.J. (1993) Soiloss. Technical handbook No. 11 Second edition, NSW Soil Conservation Service, http://www.dnr.nsw.gov.au/care/soil/soil_pubs/soiloss/technical_handbook__may_2004.pdf

[42] Landloch Pty Ltd (2012) Final Landform Design Criteria for Use During Mine Planning, Prepared for Rio Tinto Iron Ore Western Australia, February 2012. RTIO-HSE-0159989

[43] Rio Tinto Iron Ore (WA) Landform Design Guidelines, RTIO-HSE-0015708.

aquifer, as at Yandicoogina, then today's groundwater level today reflects infiltration accumulated over the past few years. As seen in the bore logs, a few years of dry weather results in a drop in the groundwater levels while a few wet years and the levels rise.

As the reaction of a groundwater table to rainfall is not a linear relationship, if climate shifts beyond the observed climate range the model has no guidance as to how the groundwater should behave. As a consequence, the results of these deterministic models may not provide accurate predictions as the climate changes.

To overcome these limitations, work has commenced on the use of stochastic models to examine the interactions between creek and groundwater systems. Stochastic models can calculate the outcome of thousands of different theoretical climate sequences to provide guidance on the probability of certain conditions occurring. At present, the use of stochastic models is limited to simple models due to the computer processing capacity and time required to compute simple situations. However, as technology improves it is anticipated that this constraint may be overcome.

11.4 Climate and vegetation growth

Water is generally the limiting factor for plant growth in the Pilbara's arid environment. As a consequence of the hot temperatures, high evaporative demand and infrequent and irregular rainfall, much of the vegetation displays xeromorphic adaptations (plant structural adaptations for survival in dry conditions). These adaptations include the ability to regulate water loss from leaves, extract water from very dry soils and match reproductive strategies with wetter periods. Many species are ephemeral and persist in soil banks in between wetter periods.

The adaptive capacity of Pilbara species implies a degree of resilience to changes to hydrological regimes. However, the impacts to Pilbara vegetation as a consequence of climate change are not clear. Changes in vegetation density and water use will alter the amount of runoff that occurs after a rainfall event, which in turn will alter creek flows and groundwater recharge.

Some initial studies within the wider Weeli Wolli Creek catchment are underway to understand how the presence and absence of water affects vegetation growth within riparian corridors. The outcomes from these studies and other evolving research on climate change will be monitored and integrated into Yandicoogina closure studies to inform assumptions on climate influences and impacts.

12. Land

12.1 Geographical overview

Yandicoogina is located near the eastern edge of the Hamersley sub-region, adjacent to the Fortescue Plains sub-region, of the Pilbara biogeographic region[44]. As described in Table 4, the majority of the landscape within the project area is considered typical of the Hamersley sub-region, while the creek systems have affinities with the Fortescue Plains sub-region.

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[44] As defined by the Interim Biogeographic Regionalisation for Australia (IBRA) which recognises 85 bioregions across Australia: defined on the basis of climate, geomorphology, landform, lithology, and characteristic flora and fauna attributes (Environment Australia 2000).

Table 4: Important biogeographic zones

Zone	Description
Hamersley	Mountainous area of Proterozoic ranges and plateaus of mulga woodland bunch grasses on fine textured soils and snappy gum over *Triodia brizoides* on skeletal soils.
Fortescue Plains	Alluvial plains and river frontages, salt marsh, mulga bunch grass and short grass communities on alluvial plains. River Gum woodlands fringe drainage lines. Northern limit of the *Acacia aneura* complex (Mulga).

The topography of the locality is provided Figure 3. The surface topography at Yandicoogina has been shaped by alluvial processes with the existing streams winding between low lying mesas and hills. The dominant landscape features are the ephemeral watercourses that drain to the northeast to Fortescue Marsh. The creek lines follow a surface gradient sloping downwards from west to east (~520mRL at Oxbow to ~480mRL near the Marillana Creek and Weeli Wolli Creek confluence).

A row of small hills rising 800mRL to 900mRL extends from JC to the northwest with a line of slightly higher hills (900 to 1,000mRL) oriented in an east-west direction to the south of the current mining operations. The area immediately south of JSW and Oxbow rises to around 600mRL.

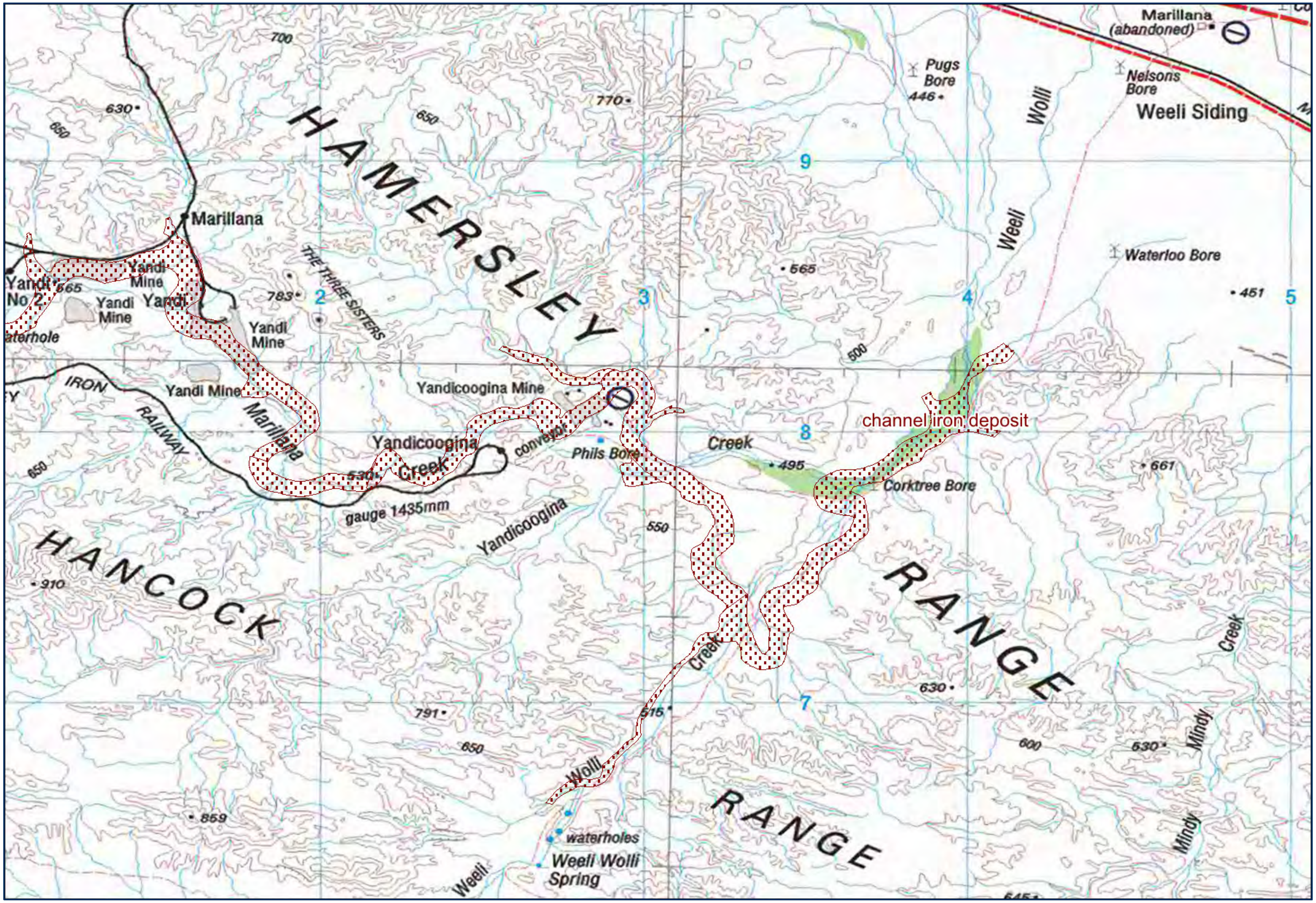

Figure 3: Topographical features including location of the channel iron deposit (CID) palaeochannel.

12.2 Mineral waste characterisation

12.2.1 Local geology

The Yandicoogina ore body is a specific type of paleochannel[45] known as a Channel Iron Deposit (CID). This ancient creek channel is located adjacent to the current Marillana and Weeli Wolli Creeks and crosses underneath these modern day creek channels in various locations, as shown in Figure 3.

The CID mined at Yandicoogina consists of three main layers:

- Overburden material. A mixture of lateritic pisolite, poorly sorted angular to sub-rounded BIF, chert and dolomite gravels in a sandy matrix. Discontinuous kaolin clay in bands and pods are common in the overburden (occurring less frequently in the iron deposits).
- Iron deposits. Mostly pisolite (iron oxide spheroids) with minor components of clay minerals (mainly kaolinite) and petrified wood mixed through the profile. The iron deposit is up to 70m thick. Once the high quality (economic) iron deposit is removed, a thin layer of clay and non-economic iron is left behind; and
- Basement rocks and altered basement rocks. The basement rocks (Weeli Wolli Formation) are what is left of the original geology that was eroded during the formation of the channel. The basement rocks have fewer fractures, gaps and pore spaces than the overlying iron deposits or overburden, such that groundwater that is accumulated within the channel tends to flow along the channel.

12.2.2 Material inventory

Mineral waste generated at the site consists largely of overburden material and CID fines. A forecast of the mineral waste types by volume (including the Billiards expansion deposits) expected to be present at closure is provided in Table 5.

Table 5: Material inventory

Mineral waste	Material volume (Mm^3)
Total generated	361 Mm^3
significant AMD potential	0
significant fibre risks	1
inert hard – low erodibility	8
inert soft – high erodibility	353

The Iron Ore (WA) Mineral Waste Management[46] work practice employed during mining documents the management and monitoring process for identifying mineral waste risks. When a risk is identified a separate plan is developed to manage the specific risk, with consideration given to the closure landform design and closure objectives.

12.2.3 Physical properties

The erodibility potential of waste types at Yandicoogina was assessed using a combination of site-specific physical test work and extrapolation from equivalent material at similar sites, to determine material type and estimated rock content.

The majority of waste expected to be produced from each deposit has been classified as high erodibility (Table 6).

[45] Paleochannels are remnants of ancient streams cut into old rocks and filled with sediments from younger rocks; such that they reflect historical drainage lines. The contemporary equivalent is called an alluvial channel.

[46] Iron Ore (WA) Mineral Waste Management Work Practice, February 2012. RTIO-HSE-0040347

Table 6: Mineral waste characterisation. (Excludes material already backfilled)

Pit	Material type	Erodibility	Tonnage (Mm^3)	
Junction Central			**Total**	**23**
	CID	high	1	
	CID / Alluvial waste in external dump	high	22	
Junction South East			**Total**	**47**
	Alluvial	high	2	
	CID	high	10	
	Weeli Wolli	low	<1	
	CID / Alluvial waste in external dump	high	35	
Junction South West			**Total**	**17**
	Alluvial	high	5	
	CID	high	12	
	Weeli Wolli	low	<1	
Oxbow			**Total**	**22**
	Alluvial	high	12	
	CID	high	9	
	Weeli Wolli	low	<1	
Pocket and Billiards South			**Total**	**139**
	Alluvial	high	95	
	CID	high	42	
	Weeli Wolli	low	2	
Billiards North			**Total**	**170**
	Alluvial	high	149	
	CID	high	21	
	Weeli Wolli	low	<1	
Total volume of waste material available				**418**

12.2.4 Fibrous materials

The Rio Tinto Iron Ore (WA) Fibrous Minerals Management Plan[47] provides guidelines for the management of fibrous minerals relating to resource development, expansion projects, and mine production. The plan aims to prevent exposure of staff and contractors to harmful levels of naturally occurring fibrous minerals in the workplace by using appropriate controls, and includes closure planning activities related to mine production and dumping strategies.

The Yandicoogina Fibrous Minerals Management Plan[48] defines the specific fibrous minerals risks, locations and management response for Yandicoogina. Fibrous minerals at Yandicoogina include:

- Riebeckite/Crocidolite - originates from narrow seams up to five centimetres wide in the Weeli Wolli Banded Iron Formation. These seams have been mapped in the hills north of Central Pit. Fragments of Crocidolite, weathered over time, have been eroded to the plains below by heavy rains. Crocidolite fragments were deposited within the alluvium/colluvium wash that overlies the Yandi CID (Hairpin, Hairpin East, Waterstand North and Waterstand South).

[47] Iron Ore (WA) (Expansion Projects and Operations), *Fibrous Minerals Management Plan,* RTIO-PDE-0062061

[48] Rio Tinto (2013) Yandicoogina Fibrous Minerals Management Plan YAN-MAN-MP-005, internal reference RTIO-HSE-0128724.

- Actinolite - identified in thin discontinuous seams within Dolerite intersected in the rail cuttings, the F5 canyon and a number of areas in proximity to the loop.

Current practice on site is to demarcate and bury designated hazardous waste in areas that will not be disturbed by future activities, such as rehabilitation, or to move designated hazardous waste to designated hazardous waste dumps in accordance with Section 13.2 of the Worksafe Australia Code of Practice – Asbestos (NOHSC 2002 (1988)).

As fibrous materials have been encountered in alluvial materials, there is the potential for rehabilitation practices to continue to encounter and disturb fibrous materials. Consequently, additional protocols will need to be developed to address rehabilitation related risks and incorporated into the management plan. It is anticipated that this work will be completed as part of the rehabilitation design process, prior to rehabilitation of any areas identified with fibrous hazards.

12.2.5 Geochemical characterisation

Acidic, metalliferous and / or saline drainage can occur as a result of mining processes. Unsaturated waste rock, low grade ore stockpiles and pit wall-rock have been identified as the most likely sources of acid and / or metalliferous drainage (AMD) in our Pilbara operations.

Rio Tinto Iron Ore has undertaken an extensive programme of geochemical testing over several years to understand the risk potential of various waste types common to mining operations in the Pilbara[49].

The most significant geochemical risk in Pilbara iron ore bodies is associated with pyrite (FeS_2), which can form sulphuric acid when exposed to oxygen and water. Pyrite is typically associated with black shale, which occurs most commonly in the Pilbara within the Mt McRae Shale, but can also be present in other geological units. Pyrite, however can also occur in lignite and siderite units and Banded Iron Formations (BIF). None of these geological units are found at Yandicoogina.

Other minerals have the potential to generate AMD risks. For example, sulphate minerals such as alunite and jarosite have the potential to generate acids. These minerals generally pose a lower geochemical risk due to self-limiting chemical processes. Some of these types of minerals are present at Yandicoogina.

Neutral mine drainage and saline drainage are characterised by pH levels of above 6. Neutral mine drainage is characterised by a sulphide concentration of more than 1,000mg/L, while saline drainage is characterised by a total dissolved salt concentration of more than 1,000mg/L. Elevated concentrations of elements of interest may be present under neutral or saline drainage conditions because:

- there was an excess of neutralization potential (NP) from in situ rock or waste rock that reacted with and consumed acid in the waters. As a result no acidic conditions are observed or ex situ downstream, or
- elements, ie antimony, arsenic, cadmium, molybdenum, selenium and zinc, remain relatively soluble under neutral pH conditions, or
- elements are released through rapid or accelerated weathering.

12.2.5.1 <u>Geochemical risk assessment</u>

Knowledge of Pilbara specific geochemical risks has been used to develop a geochemical risk assessment process[50], which:

- identifies materials commonly associated with geochemical risks (materials characterisation);
- establishes sulphur content (as in indicator of acid generation potential);

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[49] Rio Tinto Technology and Innovation (2008) Determination of Acid Rock Drainage Potential of Rio Tinto Iron Ore (WA) Waste Rock Samples (internal report). RTIO-PDE-0051613

[50] Green R, Borden RK (2011) Geochemical risk assessment process for Rio Tinto's Pilbara Ore Mines. Chapter 19. Integrated Waste Management – Volume I. Intech. http://www.intchopen.com/articles/show/title/geochemical-risk-assessment-process-for-rio-tinto-s-pilbara-iron-ore-mines

- undertakes static testing of materials to identify materials with AMD potential (eg acid base accounting); and
- undertakes kinetic testing of materials identified as having AMD potential.

The process produces an estimate of the amount of potentially reactive material types per block of material mined. This information is used within the mine planning process to evaluate the potential tonnage of materials with differing levels of geochemical risk, and thereby implement the appropriate management approach in accordance with the Iron Ore (WA) Mineral Waste Management Work Practice and the Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan[51].

The SCARD Management Plan describes the process for ongoing assessment of mineral waste to identify potential acid forming (PAF) material and storage procedures for PAF to manage environmental risk and minimise environmental impact. The SCARD Management Plan also outlines activities to manage safety and health risks and accountabilities associated with PAF.

The geochemical risk assessment process is initially undertaken during project development as part of exploration, is continued through the study phases and is undertaken regularly during active mining. The results are used to modify the mine design to avoid potentially geochemically reactive material, where possible, and ensure appropriate siting, scheduling and cover management of potentially reactive material.

12.2.5.2 Geochemical test results

At Yandicoogina, static tests have been conducted on all waste types, with more comprehensive sequential leach and kinetic tests undertaken on materials with uncertain test results or may pose significant geochemical risk[52] [53] [54] [55]. The sequential leach and kinetic testing regimes also included samples of materials which were identified as low risk in order to confirm that this is indeed the case. All tests were conducted in accordance with the *Global Acid Rock Drainage (GARD) Guide*[56].

In summary, elevated sulphur concentrations have been found in some mineral waste samples in the Marillana Creek catchment, from the alluvium, weathered channel alluvial material and to a less extent the Welli Wolli formation. However, the total sulphur concentration of the 99th percentile of all sampled processed ore and waste at Yandicoogina is less than 0.02%, suggesting the overall acid rock drainage risk is low to nil.

In a comparison of the geochemistry of all waste and ore lithologies against the crustal abundance index, materials from various deposits were found to be enriched in iron, arsenic and tin. Groundwater contamination with arsenic is considered to be unlikely, based on historical groundwater assessments at the Yandicoogina operations and experience from similar deposits in the Pilbara. Tin is similarly unlikely to mobilise into the groundwater and cause any environmental concern.

Sequential extraction test work was completed to confirm these assumptions. The work demonstrated that these trace elements are incorporated in the crystalline iron oxides and silicates which reduce the potential for the minerals to be released. Where low sulphur and organic carbon were present, however, the potential for contaminant release under slightly alkaline and saline environments exists. The release of contaminants is

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[51] Rio Tinto Iron Ore (2011) Spontaneous Combustion and ARD (SCARD) Management Plan for Operations, December 2011, RTIO-HSE-0010872.

[52] SRK (2012), RTS058 Yandi Project: Geochemical Test work on Low Sulfur Samples (RTIO-PDE-0099036)

[53] SRK (2012), RTS058 Yandi Project: Geochemical Test work on Low Sulfur Samples – Supplemental Samples (RTIO-PDE-0103854).

[54] Lee, S (2012), Yandi Geochemical Characterisation summary, (RTIO-PDE-0109618).

[55] SRK (2013), RTS058 Yandi Project: Geochemical Test work on low sulfur samples – supplemental leach testing, prepared for Rio Tinto Iron Ore, RTS058, September 2013. (RTIO-PDE-0110708).

[56] International Network for Acid Prevention (INAP) (2011) Global Acid Rock Drainage Guide, February 2011.

limited due to the combined effects of sorption and low mineral solubility under neutral pH conditions.

Leach tests[57] conducted on waste rock and waste fines presented circum-neutral pH values between 6.5 to 8.5 and EC values of around 650µS/cm for waste rock and 70µS/cm for waste fines, regardless of test conditions.

Readily detectable elements within the waste rock included the major elements Ca, Mg, Na, K, Cl, Si and SO4 and the trace elements Al, B, Ba, F, Fe, Sr and Zn. The highest concentrations of elements were recorded in the low contact ratio leach tests. The majority of the elements were source term limited, such that low masses were present in the samples and would be completely dissolve during the test. The test work also indicated that elements Al, Ba, F and Si may be solubility controlled.

The characteristics of the waste fines materials are similar to the waste rock, with the exception that low contact ratio leach tests contained low but detectable concentrations of Cd, Cr, Cu, Pb, Mn and Ni. These elements were not detected in the 2:1 L:S leach.

Selenium, a non-metallic chalcogen, has also been identified by the EPA as an element of concern in some Pilbara iron ore lithologies. Studies in the JSW and Oxbow deposits found that selenium does not occur at elevated concentrations compared with background materials. Gardiner (2003)[58] reported dissolved selenium concentrations of up to 2.94 µg/L in pre-mining groundwater measurements within the Yandicoogina CID aquifer. These concentrations are below the ANZECC/ARMCANZ Guidelines[59] for selenium trigger values for freshwater aquatic ecosystems (trigger value <5 µg/L for protection of 99% of species) [60].

Iron mineralogies are often associated with low mobility of metalliferous and other elements. Iron oxy-hydroxides have high sorption capacities for arsenic and selenium[61] [62], and consequently these materials have been used around the world for treating water enriched in these elements (via adsorption to the hydrated iron hydroxide surface). The overall risk posed by selenium release to the surface environment from mineral wastes is likely to be negligible. The oxidation state of the iron-rich lithologies would prevent major chemical change from mining and storage activities[63].

Results from the geochemical test work have been used to inform the ongoing prediction and evaluation of post-closure water quality, presented in Section 13.4 *Post-closure water predictions*.

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[57] SRK (2013), RTS058 Yandi Project: Geochemical Test work on low sulfur samples – supplemental leach testing, prepared for Rio Tinto Iron Ore, RTS058, September 2013 (RTIO-PDE-0110708).

[58] Gardiner SJ (2003) Impacts of mining and mine closure on water quality and the nature of the shallow aquifer, Yandi iron ore mine, Master of Science Thesis, Curtin University of Technology, Perth.

[59] ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, Canberra.

[60] ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, Canberra.

[61] Zhang W, Singh P, Paling E & Delides S (2004) Arsenic removal from contaminated water by natural iron ores, *Minerals Engineering*, Vol. 17, pp: 517-524

[62] Rovira M, Gimenez J, Martınez M, Martınez-Llad X, de Pablo J, Martı V & Duro L (2008) Sorption of selenium(IV) and selenium(VI) onto natural iron oxides: Goethite and hematite, *Journal of Hazardous Materials*, Vol. 150, pp:279–284

[63] Watkins R (2011) Environmental status of selenium (Se) in the Pilbara region of Western Australia – potential risk from iron ore mining, Western Australian School of Mines - Curtin University, Report prepared for Rio Tinto Iron Ore, Perth. RTIO-PDE-0103857

12.3 Landform design

Rio Tinto Iron Ore aims to create landforms that are safe and stable, considered aesthetically compatible with the surrounding landscape, supportive of native vegetation, and are non-polluting. As discussed below, there are several processes employed during operations and as part of the detailed rehabilitation design that are used to achieve these aims.

12.3.1 Waste dump design

In the semi-arid Pilbara climate, vegetation is unlikely to provide significant benefit for landform stability. Instead stability will be largely controlled by the nature of the surface materials.[64] Rio Tinto Iron Ore has performed extensive monitoring and landform evolution modelling of mineral waste types encountered at its Pilbara operations to determine erodibility characteristics[65], including inter-rill erodibility, rill erodibility, critical shear for rill initiation and effective hydraulic conductivity.

These landform evolution studies have led to the development of the Rio Tinto Iron Ore (WA) Landform Design Guidelines[66], which outline a process for developing waste dump designs that take into account both the specific mineral wastes present in each dump, and the climatic conditions present at the site. The guidance aims for waste dumps external to mine voids on closure to have slopes with a predicted average erosion rate (averaged over the entire slope length) of <5 t/ha/y, together with a predicted maximum erosion rate at any point on the slope of <10 t/ha/y, such that rilling, and consequently gullying potential will be minimised.

The Landform Design Guidelines are used at every stage of the mine planning process and consider:

- 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;
- final landform slope criteria (lift height, slope angle, minimum berm width);
- supplementary measures eg surface treatment for dispersive materials; and
- shaping of options for the top of the waste dump.

The latest update to the Landform Design Guidelines was released in 2012 following a comprehensive literature review and a two year erodibility project[67], which involved materials testing and erosion modelling. The study highlighted that design criteria for stable landforms differs depending on the geological origin of the mineral wastes generated. As such, the parameters used to design each waste dump constructed must be considered individually.

Other improvements to the Landform Design Guidelines included options for berm/bench and concave slope combinations, and prescribed lift heights, batter angles, berm widths and berm back slope angles based on individual site material properties and local climate conditions.

Following the Landform Design Guidelines, the selected mineral waste design criterions for landforms at Yandicoogina are summarised in Table 7. Usually the Landform Design Guidelines are applied only to waste dumps located external to the pit. This is because waste dumps located inside mine voids may not be subject to rehabilitation and landform stability requirements. At Yandicoogina, waste dumps located inside the pit will, in some locations, merge with the topography (and therefore creek flows and / or surface water

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[64] Landloch Pty Ltd (2012) Final Landform Design Criteria for Use During Mine Planning, Prepared for Rio Tinto Iron Ore Western Australia, February 2012. RTIO-HSE-0159989

[65] The definition for erodibility is aligned with Flanagan, D.C., and Livingston, S.J. (1995). Water Erosion Prediction Project (WEPP) Version 95.7 User Summary. In (Flanagan and Livingston, editors) 'WEPP user summary', NSERL Report No 11, July 1995.

[66] Rio Tinto Iron Ore (WA) Landform Design Guidelines, RTIO-HSE-0015708.

[67] Landloch Pty Ltd (2012) Final Landform Design Criteria for Use During Mine Planning, Prepared for Rio Tinto Iron Ore Western Australia, February 2012. RTIO-HSE-0159989

runoff from) outside the pit, while in other locations the waste dumps will form the edge of new pit lakes. Consequently landform design of the in pit waste dumps will be required to ensure the landform remains stable, manages flood water appropriately and supports the creation of self-sustaining ecosystems.

Table 7: Rehabilitation landform design.

Waste dump	Slope angle (degrees)	Lift height (m)	Berm width (m)	Back slope angle (degrees)	Comments
In pit final slopes	20	5	10	5	Additional erosion protection may be required for surfaces at lake fringe
Ex-pit final slopes	20	5	10	5	Waste expected to be returned to pit. In case of unexpected closure, external waste dumps may be left.

12.3.2 Other design considerations

During mining, variations in material type, mine sequencing, area availability and emerging environment factors can constrain the landform design. If during the rehabilitation design process, it is identified that a safe and stable landform cannot be achieved through land shaping alone, additional management techniques are employed. Some of the techniques considered to improve the landform design are discussed below.

When the characteristics of material on the sides or top of a constructed landform suggest that erosion could occur at an undesirable rate, and it is not possible to achieve a lower slope angle, desired erosion rates may be achieved by adding a layer of more competent or rocky material to the outside of the landform. The required material competency is determined from the landform design guidelines, according to slope angle and material characteristic recommendations.

The wrap (when placed on the sides) or cap (when placed on the top) is blended into the surface using deep ripping techniques, before soil layers are applied. This technique is particularly useful to control erosion across areas where small creeks or notable catchment runoff flows onto and across mineral waste or highly disturbed areas.

At Yandicoogina, competent material caps may be used on the waste fines storage facility, on sections of the waste dumps that form the pit lake fringe and / or for small, localised control of surface water into the pit lakes. The specific requirements will be assessed during the rehabilitation design(as part of progressive rehabilitation or at decommissioning, as appropriate).

Store and release covers are a common management tool used to reduce infiltration into mineral wastes; for example if the water could react with the geology to create water quality issues (ie mobilisation of salt) or if the passage of the water could create physical instability (ie tunnelling through dissolution).

The cover is comprised of compacted materials, usually shaped to prevent incident rainfall from leaving the area. During dry periods, water stored in the cover is removed through evaporation and plant transpiration processes, and returned to the atmosphere. With the extreme rainfall events experienced in the Pilbara it is challenging to design a store and release cover that inhibits all infiltration. Thus, in most situations, the covers in the Pilbara simply limit and thereby slow or delay impacts from infiltration.

Store and release covers for the purpose of reducing infiltration are unlikely to be used at Yandicoogina, as no infiltration related issues have been identified. However, store and release covers may be used in select areas to increase the retention of water near the surface. Soil profiles are not re-established as part of the rehabilitation process, and as a result the new landforms may not have the same ability to store water for plant use. A store and release cover provides a simple mechanism for increasing plant available moisture, to improve vegetation vigour and subsequently has the potential to accelerate organic carbon accumulation in the new landforms.

12.3.3 Waterway design

In addition to the landform design, waterways design and restoration techniques will be employed to ensure water moves across the final landform and other rehabilitated areas in a safe and sensitive manner.

During operations, the Rio Tinto Iron Ore Pilbara Surface Water Management Strategy[68] advocates for the maintenance of natural flows systems, to minimise impacts to the downstream environment and reduce closure legacy issues. The physical design and construction of surface water management structures is guided by the Rio Tinto Environmental Design Principles for Permanent Facilities[69]. Key waterway design guidelines that are used to inform the design include:

- AUSTROADS (1994) Waterway Design: a Guide to the Hydraulic Design of Bridges, Culverts and Floodways.
- Institution of Engineers, Australia (2001) Australian Rainfall and Runoff, Editor-in-chief D.H. Pilgrim, Revised Edition 2001, Barton, ACT.
- Water and Rivers Commission (2000 onwards) Water Notes series, Water and Rivers Commission, Western Australia.
- Water and Rivers Commission (2003) River Restoration Manual, Water and Rivers Commission, Western Australia.

12.3.3.1 Waterway implementation activities

The majority of the final landform waterway designs will be undertaken as part of decommissioning activities. The designs will consider downstream environmental water demands, erosion and sediment transport and cultural requirements. However preliminary design activities have commenced to reinstate Phil's Creek and for the Marillana - JSW creek crossing.

Reinstatement of Phil's Creek will be undertaken in two stages. During operations an initial land bridge-style structure will be used to convey water, as close as possible to its original position, to Marillana Creek. This design[70] will facilitate earth settlement in the land bridge while accommodating assorted mining activities including dewatering and general mine access. During decommissioning (or sooner if possible) the size and strength of the land bridge will be increased using mineral waste from other deposits to strengthen the structure, in consideration of the requirements for a walk away design solution, prior to allowing the groundwater table in this area to recover.

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[68] Rio Tinto Iron Ore (2011) Rio Tinto Iron Ore Pilbara surface water management strategy, May 2011, RTIO-PDE-0053914.

[69] Rio Tinto Iron Ore (2011) DC-N001 Environmental Design Principles for Permanent Facilities, May 2011. RTIO-HSE-0036704

[70] Detailed design for the Phil's Creek landbridge is currently in production and will be presented int eh next closure plan update.

12.3.4 Erosion monitoring

Due to the short term intensive rainfall in the Pilbara, unstable landforms tend to quickly unravel and collapse, creating landslips (ie on pit walls), or demonstrate significant rill and gully erosion features (ie in waste dumps). Within the closure landform, features other than the pit walls are expected to remain stable after closure.

Landform stability is usually defined by its erosion rates, through the presence of erosion features. Erosion monitoring is undertaken in accordance with the Rio Tinto Iron Ore Rehabilitation Monitoring Procedure[71]. The monitoring involves the examination of transects for the number of rills and gullies and their width and depth. These measurements are compared over time to determine if the landform has "stabilised".

A landform is considered to be stable once the erosion rates are within the accepted completion criteria range. For example, if rill and gully geometry does not negatively impact vegetation establishment and growth or proves to be self repairing over time it is considered stable. If a landform fails to stabilize, further management and / or physical intervention may be applied.

Completion criteria to define a stable landform have yet to be established for Yandicoogina (as discussed in Section 24 *Completion criteria*), mainly because few of the landforms currently on site are representative of the closure landform. Following the implementation of progressive rehabilitation and subsequent monitoring of erosion rates and features, the data and performance of the landforms will be assessed and discussed with stakeholders to define completion criteria appropriate to define stability.

12.4 Soil

Soil across the Hamersley Range is typically skeletal, shallow and stony, having been derived in situ or deposited as colluvium and alluvium pediments on valley floors. Most soils have low fertility and are slightly acidic, becoming more fertile and alkaline across the valley floor.

12.4.1 Soil management

The availability of topsoil significantly improves the potential for rehabilitation success. The Rio Tinto Iron Ore (WA) Soil Resource Management Procedure[72] provides guidance on soil collection and appropriate management. The procedure aims to maximise topsoil recovery and retain soil viability and productivity, to improve future success of rehabilitation programmes.

TheSoil Resource Management Procedure prescribes that a minimum of 200mm[73] of topsoil should be collected whenever new ground is disturbed, where local topography and geology allow. Up to 600mm of subsoil is also collected where geology permits. 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 bank and mychorrhizal fungi properties of topsoil. The shallow Pilbara soils make it challenging to recover sufficient top soil to dress all new landforms and disturbed areas. Thus subsoil is regularly used as a substitute for topsoil after topsoil stockpiles are exhausted.

Topsoil stripping is conducted prior to the wet season when the soil seed bank is at its optimum (most plants have recently flowered and set seeds). Topsoil is handled only when dry to prevent compaction, a breakdown of soil structure, seed deterioration and composting of organic matter.

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[71] Rio Tinto Iron Ore group (2007) IEMS Procedure – Erosion Monitoring. RTIO-HSE-0011605.

[72] Rio Tinto Iron Ore (2011) Soil Resource Management Procedure, December 2011, RTIO-HSE-0011596.

[73] Soil (combined topsoil and subsoil) for above ground linear infrastructure including rail, powerlines and roads, outside the boundary of the mine site is cleared to a depth of at least 200 mm, such that there is sufficient soil available rehabilitation.

Prior to collection of topsoil, surface vegetation is collected and stockpiled separately, as it may supply additional seeds and organic matter to the soil. Larger trees and shrubs are pushed to a separate stockpile and either crushed to reduce volume for handling or kept for use in rehabilitation habitats.

The soil is stored in dedicated signed stockpiles, with topsoil stored in stockpiles of no more than 2m height. The stockpiles are located outside drainage lines and areas prone to flooding. Natural revegetation of the stockpiles is encouraged, through the application of seed where necessary, and kept free of weeds. Monitoring of soil stockpiles for weed control and erosion is undertaken regularly, with weekly to monthly informal inspections and formal annual inspections, to ensure long-term viability of the storage area.

12.4.2 Soil inventory

Rio Tinto Iron Ore undertakes regular reconciliations of available soil (topsoil and subsoil) volumes at all sites. During rehabilitation, it is assumed soil will be spread to a depth of 200mm over all disturbed areas and landforms created outside the mine voids. At Yandicoogina soil allocation is also required to assist in establishing vegetation on pit backfill areas that will be above the recovered groundwater table.

The 2013 soil stockpile and planned disturbance reconciliation is summarised in Table 8.

Table 8: Soil stockpile volumes and deficit (as of 2013).

Material Type		Volume (Mm^3)
Existing stockpiled soil[74] (recovered from JC and JSE)		3.47
Top soil recovered	*1.12*	
Subsoil recovered	*2.33*	
Planned (future) soil recovery (JSW, Oxbow, Billiards South only)		20.63
Anticipated topsoil recovery	*4.13*	
Anticipated subsoil recovery	*16.50*	
Volume required for rehabilitation (disturbance area[75] x 200mm)		4.83
Soil balance (stockpile + planned recovery – rehabilitation requirement)		19.27 surplus

It is noted that the extent to which soil stockpiles can be created can be limited by the envelope of land approved for disturbance within the lease boundary. The life of mine planning activities have included the future stockpile requirements and topsoil will be preferentially used during operations to support progressive rehabilitation activities.

Figure 4: Top soil stockpile at Yandicoogina, 2013.

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[74] Volume refers to stockpiles of topsoil, subsoil and topsoil/subsoil mixtures.

[75] The disturbance area requiring soil application is assumed to be the total disturbance footprint at the end of the mine life minus pit areas that do not require rehabilitation.

12.4.3 Alternative growth media

In 2010 Rio Tinto Iron Ore commissioned a study into use of mine mineral wastes as an alternative rehabilitation growth medium[76]. The study reviewed soil and mineral waste characteristics from select Pilbara mining operations, to identify mineral waste and material combinations for use as a topsoil substitute or supplement.

The study showed plant-available nutrients held within the mineral wastes, although variable, was characteristically low and comparable to natural soils in the region. The majority of the mineral wastes 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 mineral wastes were also comparable to that of the benchmark topsoil materials.

In general, Pilbara mineral wastes were non-saline and non-sodic, with no sample presenting above the 15% threshold for exchangeable sodium percentage (ESP), the indicator of high sodicity. The soil structure of mineral wastes were relatively stable, with only slight or no dispersion upon re-moulding, indicating a relatively stable structure that is not easily degraded, and were not prone to hardsetting. However, estimated plant-available water content of the mineral wastes ranged significantly, from <3% to >25%, compared to local topsoil estimates of between 10% and 14%.

The study concluded that, in general, mineral wastes characteristics are within the range exhibited by local topsoil and rehabilitated soils, and therefore provide a suitable growth medium. Although alternative growth media is not anticipated to be required to assist the closure of Yandicoogina, the outcomes from such studies conducted at other Rio Tinto operations, aimed at understanding plant performance in mineral waste, will be used to inform rehabilitation strategies at Yandicoogina where applicable.

12.5 Contaminated sites

Rio Tinto Iron Ore manages contaminated sites in accordance with a Contaminated Sites Management Plan (CSMP)[77], and relevant contaminated sites and environmental legislation. The CSMP outlines how Rio Tinto Iron Ore will manage all potentially contaminated sites, on a site-by site basis. It provides for internal management, whilst also adhering to relevant regulatory requirements. The CSMP applies to all Rio Tinto Iron Ore facilities and assets, including mine sites, exploration / evaluation projects, port and rail facilities and pastoral stations.

A preliminary site investigation was carried out to establish potential sources of contamination resulting from the current and historical site activities. The main sources of contamination present at Yandicoogina today are at the hydrocarbon (mainly diesel) storage / handling facilities and fuel pumps facilities. Other potential sources of contamination include vehicle wash-down and maintenance facilities, waste oil handling facilities, liquid waste storage facilities, ammonium nitrate and fuel oil, equipment laydown, landfill, wastewater treatment and land farm facilities.

Site closure will undoubtedly involve a change in land use, as such; the significance of any site contamination may change. A contaminated sites assessment will therefore be undertaken prior to closure, and specific plans developed, as part of the decommissioning process, to remove or manage contamination where appropriate.

13. Water

13.1 Pre-mining water conditions

13.1.1 Surface hydrology

As shown in Figure 3, Yandicoogina is located near the intersection of Marillana Creek and Weeli Wolli Creek. The deposits of Junction Central, Junction South West and

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[76] Welker, L. and O'Keefe, T. (2010) Evaluation of mine mineral wastes as alternative rehabilitation growth medium. Prepared by Outback Ecology Services for Rio Tinto Iron Ore, December 2010. RTIO-HSE-0109961

[77] ERM (2007) Contaminated Sites Management Plan, January 2007, RTIO-HSE-0035253.

Oxbow are located adjacent to Marillana Creek. Junction South East straddles the catchment divide, bound by Marillana Creek to the north and Weeli Wolli Creek to the south, and the proposed expansion deposits of Billiards are located under and adjacent to Weeli Wolli Creek. Marillana Creek is a tributary to the Weeli Wolli Creek system, as part of the regional water catchment known as Weeli Wolli Catchment.

The Marillana Creek system has a total catchment area of 2,250km^2. The headwaters rise from the high relief areas of Hamersley Range where the Creek drains in an east and north easterly direction into the Munjina Claypan. The Claypan has an internally draining catchment area of approximately 274km^2. It is subject to periodic inundation following rainfall events and has the potential to retain surface water flows for lower flood events (≤1 in 10 year annual recurrence interval (ARI)). Water stored in the Claypan is believed to infiltrate and recharge the alluvial systems of Marillana Creek including the CID, and subsequently sustains creek bed (subsurface) flows for longer than (Pilbara) normal periods after flood events[78].

Water in excess of the basin's holding capacity flows southeast; past Flat Rocks gauging station, BHPBIO Yandi operation, Yandicoogina operation and into Weeli Wolli Creek. Named tributaries of Marillana Creek include Lamb Creek, Iowa Creek, Phil's Creek and Yandicoogina Creek.

The Weeli Wolli Creek system, excluding the Marillana Creek catchment area, has a catchment area of 1,750km^2. The headwaters rise from over 50km to the south of the Yandicoogina area and flow northwest, past the Hamersley HMS Hope Downs 1, BHPBIO Area C and Yandicoogina operations, before merging with Marillana Creek (the largest tributary).

As for most parts of the Pilbara, the normal condition for these watercourses is dry. Runoff is ephemeral, occurring only after significant and intense rainfall events. Flow depths in both Marillana and Weeli Wolli Creeks can exceed 5m with velocities through the majority of the channel ranging from 2m/s to 3.5m/s. Large stream flows are generally associated with rain bearing depressions or high intensity cyclonic rainfall that brings heavy rain over a large areas of the catchment.

The flows terminate in Fortescue Valley, north of the Hamersley Range, contributing to Fortescue Marsh; an extensive, intermittent wetland.

13.1.2 Groundwater

Groundwater moves principally within two aquifer systems at Yandicoogina, namely through the CID (historical drainage) and alluvial (current drainage) aquifers (Figure 5). The CID and alluvial aquifers are inter-connected and recharged from infiltration generated by water flowing along the creeks. As a result, water quality in the CID and alluvial aquifers is relatively fresh (predominantly <600 mg/L).

The CID and alluvial aquifers are bound by the Weeli Wolli Formation basement rocks, which acts as the regional aquifer. Water moves through this regional aquifer in secondary porosity, associated with, for example, dissolution features in weathered rocks and fractures. As a result, the hydraulic conductivity of the Weeli Wolli Formation at Yandicoogina is significantly lower than the CID and alluvial aquifers and has been described as "relatively impermeable".

Hydrogeological characterisation of the area has been undertaken since mining first began in the area. Historically, characterisation has focused on the CID. Water flow (through-flow) along the CID is estimated between 1500 m^3/day and 3000m^3/day, depending on the width of the CID channel. Usually the lower through-flow rates are observed at distances furthest from the main creeks. For example, in the mined out CID at JC Hairpin area, where the CID has no direct connection to the creek alluvial system, through-flow was measured to be around 1000m^3/d. The hydraulic conductivity in the CID ranges between 3m/d and 25m/d, with an average of roughly 9m/d.

[78] Beckett, K and Cheng, S. (2010) Marillana Creek regional flow balance and catchment hydrology. Internal report RTIO-PDE-0081939, 26 May 2010.

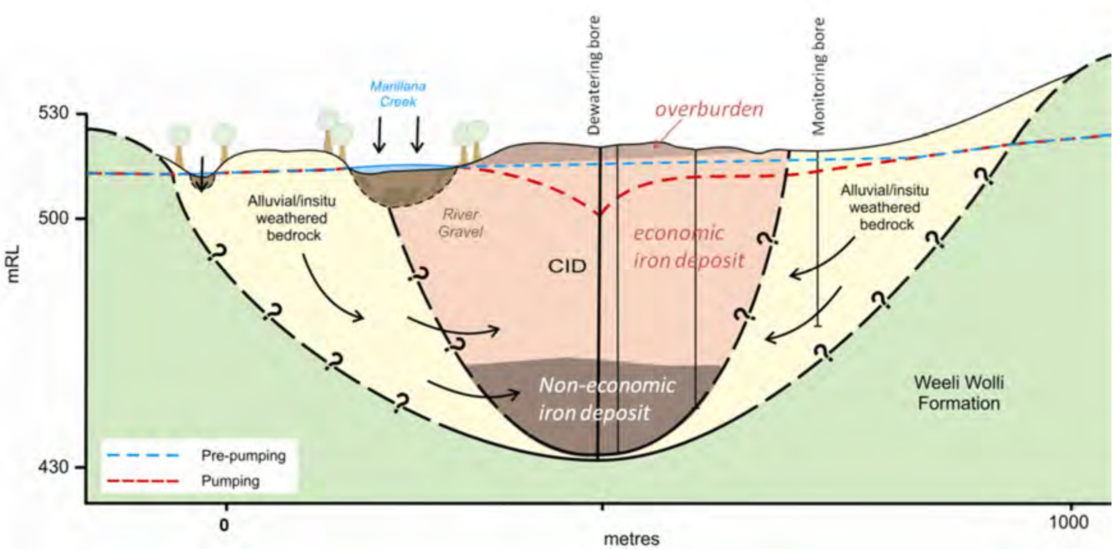

Figure 5: Schematic presentation of groundwater aquifers at Yandicoogina.

As mining operations have moved closer to the active creek systems, characterisation of the alluvial aquifer has had renewed focus. A comprehensive field campaign[79] was undertaken in 2009 to address knowledge gaps and strengthen the conceptualisation for groundwater model predictions. This work demonstrated that the alluvial aquifers, which were previously assumed to be shallow and poorly connected to the CID, consist of both unconsolidated alluvium and in situ weathered Weeli Wolli Formation bedrock. The alluvial aquifers can extend to depths similar to the CID and have a much higher hydraulic transmissivity and storage capacity than previously thought. Based on results from the field campaign, horizontal hydraulic conductivity of the alluvial aquifers has been revised to 5 m/day to 10m/day in the upper alluvium and creek bed gravels[80].

The pre-mining groundwater contours are illustrated in Figure 6. The groundwater table is located around 2m below the surface of Marillana Creek. This translates to a depth of 20m to 30m below the surface in areas of mine away from the creek system in JC. Along the length of the CID, from Oxbow to Billiards, groundwater levels changed by around 100m. This represents a groundwater gradient of 0.002 or a 2m decrease in groundwater level for every kilometre along the CID.

The gradient is relatively uniform along the length of the CID, suggesting the CID has a relatively uniform width with no barriers to subsurface flow. It was noted, however, that in the JC Hairpin area, where the CID bends around on itself, the low through-flow rates may indicate a "bottleneck" which could have caused groundwater levels to naturally back up following rainfall/recharge events. This may have led to an increase in preferential flow through the alluvial aquifer system, bypassing the current mining area, and elevating groundwater levels in the CID and alluvial aquifers in the JSW area.

The water table is observed to fluctuate considerably in response to significant rainfall events. For example, groundwater levels increase by around 10m following substantial rainfall events associated with ex-tropical cyclones Claire, Emma, Glenda and Hubert in January to April 2006, and in December 1999 as a result of rainfall Tropical Cyclone John. Over the long term, however, a noticeable trend of increasing groundwater levels has been observed across the region. At monitoring bore YM119 located in the Billiards deposit, for example, a change in average water level from 465mRL in 1991 to an almost steady state level of around 476mRL has been observed. The steady state is interpreted as the aquifer being "full"; a consequence of higher than average rainfall, more than 25

[79] RTIO (2009) Yandicoogina Hydrogeological Field Programme Report – Bore Installation and Test Pumping 2008/9, RTIO-PDE-0071209.

[80] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

percent over the short term average, between 1995 and 2006 (prior to the establishment of the Yandicoogina reinjection bore and before any influence from the Hope Downs 1 mine discharge). Since 2006, rainfall has remained high and, combined with the dewatering influences from the Yandicoogina and Hope Downs 1 operations, the aquifers in the Billiards areas remain full.

13.1.3 Water quality

Background surface water quality measurements at Yandicoogina are complicated by the discharge of groundwater to Marillana Creek from the BHPBIO Yandi operation and to Weeli Wolli Creek from Hope Downs 1 operation, both immediately upstream of the Yandicoogina. In one sampling campaign[81], the chloride concentration 800m down gradient of the BHPBIO Yandi discharge point was ~125mg/L and increased to ~150mg/L approximately 6km down gradient, towards the terminus of Marillana Creek. Further downstream, in Weeli Wolli Creek, the chloride concentration was observed to decrease to less than 100mg/L as relatively fresh discharged groundwater from the Yandicoogina and the Hope Downs 1 operations mixed with very fresh alluvial water which naturally[82] discharges to the surface.

The background quality of surface water during flood events is undefined, due to the complexity of the sampling requirements and issues around work place safety. However, methodologies to safely sample water during flood events across the Pilbara are being considered; such that samples will be taken once health, safety and environmental protocols can be met.

Within the groundwater, chloride concentration ranges from 15mg/l (in a CID sample) to a maximum of 280mg/L (in an alluvium sample). The average chloride concentration in the CID is ~120mg/L, roughly 30 percent lower than that of alluvium water. This difference is attributed to the processes of direct evaporation and evapotranspiration by native vegetation along Marillana Creek that act to concentrate salts in the upper profile of the alluvial aquifer.

Total dissolved ions (TDS) of groundwater[83] range from 100mg/l to 1,290mg/l, averaging around 550mg/l in the CID and 600mg/l in the alluvium, but without clear segregation. Groundwater from both aquifers is dominated by bicarbonate anions, contributing to pH conditions ranging from 6.7 to 8.3. Sodium constitutes a higher portion of the major cations, followed by calcium and magnesium.

No significant water quality changes have been detected in the aquifers since the start of routine water quality monitoring at Yandicoogina.

13.1.4 Ground and surface water interactions

13.1.4.1 Semi-permanent pools

Around a quarter of pools found in the Pilbara's major rivers are semi-permanent to permanent[84]. The pools are sustained by a combination of regular flooding, pool depth (storage exceeding evaporation), groundwater discharge via springs or seepage through

[81] Kirkpatrick, G and Dogramaci, S (2010) Yandicoogina Water Balance - Pre and Post Mining Hydraulics and Hydrochemistry, Internal report for Rio Tinto Iron Ore. RTIO-PDE-0073467

[82] Groundwater that expresses without assistance is called discharge. This should not be confused with water that is released into a creek to manage surplus water which is also referred to as discharge. Natural discharge occurs when the groundwater aquifer is "full", such that slight changes in topography or subsurface changes in hydraulic parametres mean that the volume of water travelling below the ground cannot be sustained, and the water is released to create surface water flows. Depending on the location and frequency of the event, these surface water flows may also be referred to as seeps or springs.

[83] Kirkpatrick, G and Dogramaci, S (2010) Yandicoogina Water Balance - Pre and Post Mining Hydraulics and Hydrochemistry, Internal report for Rio Tinto Iron Ore. RTIO-PDE-0073467

[84] Pinder, A and Leung, A (2009) Conservation status and habitat associations of aquatic invertebrates in Pilbara coastal river pools, Report to the Western Australian Department of Water from Science Division Department of Environment and Conservation, August 2009.

porous sediments, and impedance of subsurface flow by bedrock structures at the downstream ends of pools.

Some of these pools are considered fresh (salinity less than 1500mg/l) even though Pilbara evaporation rates significantly exceed rainfall. Different environmental factors naturally manage or offset evapoconcentration (the process whereby salinity increases as water is removed via evaporation) of salts in these pools, including:

- interactions with creeks and creek infiltration, such that flushing removes salts from the pools;
- high groundwater flow rates (ie springs or seeps), where the exposure time of water within the pool is reduced, eg water quickly infiltrates back into porous sediments;
- wind sheltering, by vegetation or topography, which reduces evaporation rates; and
- shading influence from trees or topography which reduce evaporation rates.

Normally, however, salinity increases between flood events, until the pool is completely dry; leaving salts in the base of pool. These salts are subsequently flushed from the pools with each flood event, but can successively contribute to pool salinity prior to a flushing event.

Pools that sustain fresher water qualities (for example, are of stock drinking water quality, up to 4000mg/l) are usually associated with groundwater springs and seeps. These fresher pools provide an important ecological function, especially through periods of drought[85]. In these fresher pools, the groundwater discharge rates usually exceed the evaporation rates and the pools are positioned in the landscape such that the pools maintain a connection to a creek and / or a creek alluvial groundwater aquifer (eg within the floodplain). This connection enables salty water and sediments to be flushed from the pool, to be replaced by fresh surface water or fresher groundwater. For this reason, pools with this type of connection to groundwater systems can be considered groundwater dependant ecosystems[86]. These type of pools are noted to occur upstream (eg Weeli Wolli Spring) of Yandicoogina, but have not been identified downstream or within the mine area.

13.1.4.2 Groundwater recharge

As discussed previously, the CID and alluvial aquifers at Yandicoogina are strongly connected to the surface water systems, with most of the groundwater recharge resulting from creek flow events. Recent studies[87] have estimated that the volume of recharge generated by one large flood event over a 25km length of Marillana Creek is equivalent to approximately 16GL of water and can be as high as 30GL depending on the duration of the event. As a result of this strong connection to the creek system, unlike other mining operations in the Pilbara, the groundwater table could theoretically recover to 90 percent of its original level in as few as 10 to 20 years.

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[85] Pinder, A and Leung, A (2009) Conservation status and habitat associations of aquatic invertebrates in Pilbara coastal river pools, Report to the Western Australian Department of Water from Science Division Department of Environment and Conservation, August 2009.

[86] Boulton, A. and Hancock, P.J. (2006). Rivers as groundwater-dependent ecosystems: a review of degrees of dependency, riverine processes and management implications. Australian Journal of Botany 54: 133-144.

[87] Kirkpatrick, G and Dogramaci, S (2010) Yandicoogina Water Balance - Pre and Post Mining Hydraulics and Hydrochemistry, Internal report for Rio Tinto Iron Ore. RTIO-PDE-0073467

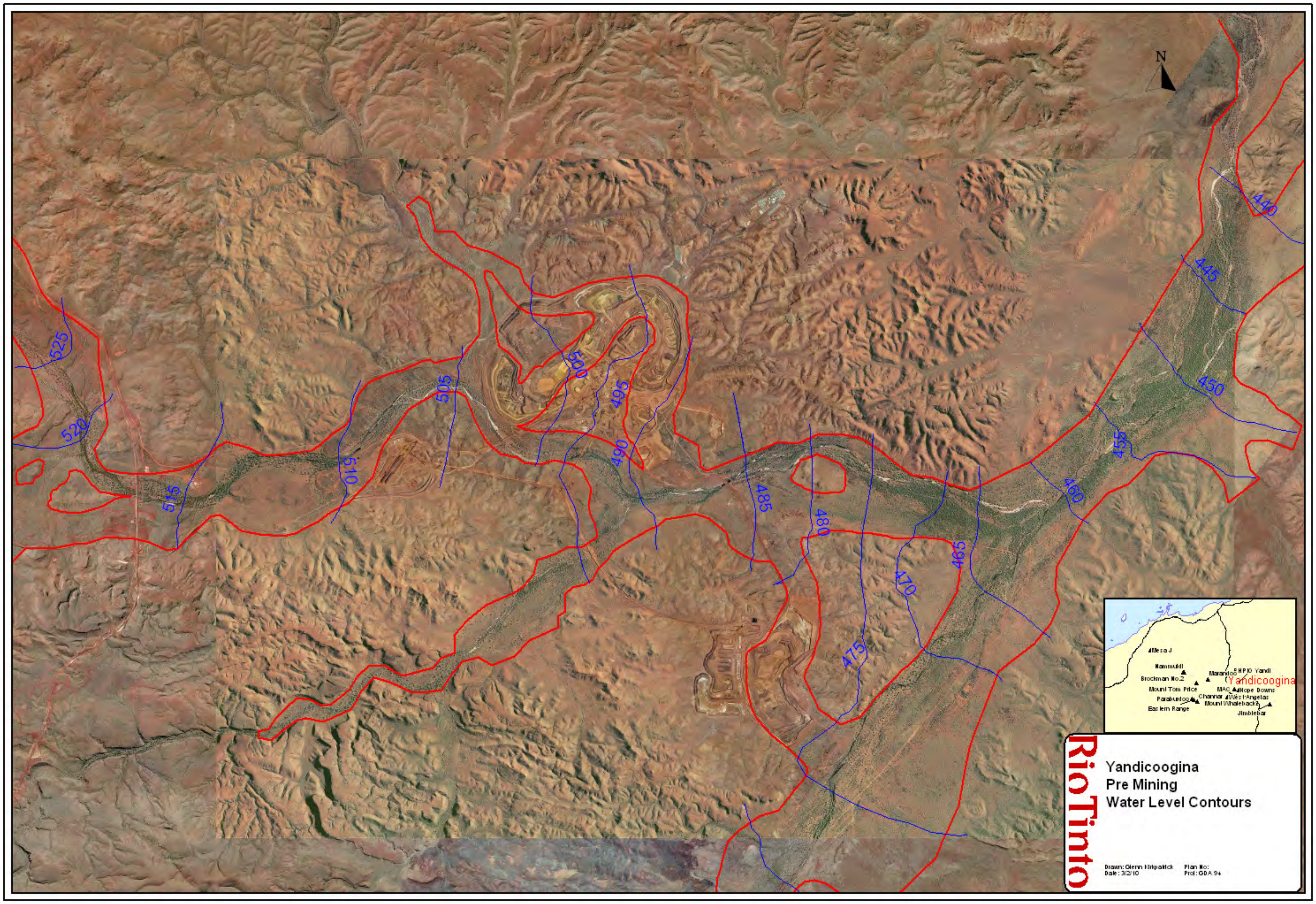

Figure 6: Groundwater pre-mining contour map.

13.2 Environmental and social values of water

13.2.1 Local environmental significance

Creek systems in the Yandicoogina area offer deeper soil types (alluvium), with capacity to store water in between rainfall events. This stored soil water is used to sustain plant growth through dry periods. Some of the larger tree species have root systems that enable access to water stored deep within the alluvium, and in some cases are able to access the groundwater table on an ongoing or transient basis. The key tree species are *Eucalyptus victrix* (Coolibah), *Eucalyptus camaldulensis* (River Red Gum) and *Melaleuca argentea* (Silver Cadjeput).

The paperbark species *Melaleuca argentea* occurs in areas of shallow groundwater and is regarded as being dependent on groundwater to meet its ecological water requirements[88][89] *Eucalyptus camaldulensis* and *E. victrix* occur extensively along Marillana and Weeli Wolli Creeks. These species are known to use a range of mechanisms to regulate their water use in response to changes to water availability, such as: stomatal control[90], cell-wall elastic adjustment and osmotic adjustment[91], leaf area equilibration[92], and self thinning[93]. These adaptations and the ability to extract water variably through deep tap roots or shallow lateral roots, depending on relative water availability, make the Eucalypt species relatively resilient to water table fluctuations; although they will still exhibit stress when soil water content goes above or below an optimal level.

Riparian vegetation along Marillana and Weeli Wolli Creeks is considered locally significant, due to the relatively limited extent of this vegetation type compared with other locally occurring vegetation types. Riparian vegetation also provides important ecological services, including:

- the provision of structural habitat elements, such as tree hollows;
- the protection of creek banks from erosion;
- protection of water quality through sediment trapping and nutrient stripping, and
- transfer of subterranean water and nutrients to the surface environment by some of the dominant tree species.

The Yandicoogina Environmental Management Plan[94] has been implemented during operations (in accordance with Ministerial Statement 914 Conditions 7 and 8) to ensure adequate protection of the waterways and associated riparian vegetation outside the mine impacted areas. Management of the remnant riparian vegetation will continue as part of closure (as discussed in Section 14.3 *Vegetation*).

There are currently no permanent surface water bodies present in the Yandicoogina area. As discussed in Section 13.3 *Water systems after closure*, it is expected that through the act of mining at Yandicoogina, pit lakes will be created. The creation of pit lakes will represent a departure from the pre-mining environment. The nearest permanent water

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[88] Graham J (2001) The root hydraulic architecture of *Melaleuca argentea'*, Honours Thesis, Department of Botany, University of Western Australia, Perth

[89] O'Grady AP, Eamus D, Cook PG & Lamontagne S (2005) Comparative water use by the riparian trees *Melaleuca argentea* and *Corymbia bella* in the wet–dry tropics of northern Australia, *Tree Physiology*, vol. 26, pp: 219–228

[90] For example White DA, Turner NC & Galbraith JH (2000) Leaf water relations and stomatal behaviour of four allopatric Eucalyptus species planted in Mediterranean southwestern Australia, *Tree Physiol* , vol. 20, pp: 1157-1165

[91] For example Lemcoff JH, Guarnaschelli AB, Garau AM & Prystupa P (2002) Elastic and osmotic adjustments in rooted cuttings of several clones of *Eucalyptus camaldulensis* Dehnh. from southeastern Australia after a drought, *Flora - Morphology, Distribution, Functional Ecology of Plants*, vol 97, pp: 134-14

[92] For example O'Grady AP, Cook PG, Eamus D, Duguid A, Wischusen JDH, Fass T & Worldege D (2009) Convergence of tree water use within an arid-zone woodland, *Oecologia*, vol. 160, pp: 643-655

[93] Horner GJ., Baker PJ, Macnally R., Cunningham SC, Thomson JR & Hamilton (2009) Mortality of developing floodplain forests subjected to a drying climate and water extraction, *Global Change Biology*, vol. 15, pp: 2176–2186

[94] Rio Tinto Iron Ore (2013) Yandicoogina Environmental Management Plan. RTIO-HSE- 0183435

bodies are located 10km upstream (Weeli Wolli Springs) and 40km downstream (Fortescue Marsh). These water bodies present dramatic differences in water quality, with the former being fresh and the latter ranging from sub-potable to hypersaline (depending on the length of time since last rainfall). Both water bodies are capable of supporting a variety of fauna, including fish, birds, tortoises and frogs[95]. The area is therefore capable of sustaining natural ecosystems in and around water bodies of varying salinity.

13.2.2 Regional environmental significance

Downstream of Yandicoogina, the Fortescue Marsh area has important conservation values[96] and has been recognised by the Western Australian Department of Parks and Wildlife as a Priority Ecological Community[97] (PEC) Priority 1. The marsh is rich in plant and animal species of high conservation value and is part of an ancient and complex array of alluvial aquifers and groundwater systems. It is sustained by floodwater from the upper Fortescue River catchment[98], of which the Weeli Wolli catchment comprises around half the source catchment, and local rainfall. Regular flooding of the fringing vegetation around the wetland is required to flush salts from the soil into the underlying groundwater table. This flushing is necessary to periodically reduce the stress on the samphire and halophytic vegetation[99], providing the ecosystem with a period of rejuvenation.

Upstream of Yandicoogina, the Weeli Wolli Spring riparian woodland and forest associations (approximately 15km upstream from the Marillana and Weeli Wolli Creek confluence) have also been identified as a PEC (Priority 1).

The operation and closure plans are not expected to directly impact the Fortescue Marsh or Weeli Wolli Spring communities; however, the cumulative effect of mining in the region (ie Yandicoogina and other mining operations) may alter water movement and / or water quality. This could indirectly affect the environmental and / or social values at these locations.

This closure plan does not address the cumulative effect of the wider regional mining activities on the above named water sensitive areas or springs. Instead, the potential for cumulative impacts is noted and efforts have been made to design a post-closure landform that will minimise potential detrimental outcomes, as discussed in Section 20 *Post-closure landform*.

13.2.3 Cultural significance

Water has high significance for regional Indigenous communities[100]. Water is a highly valued resource in the Pilbara. The views represented by the Traditional Owners of the Yandicoogina area are consistent with those of other Indigenous people of the Pilbara and regions across Australia. A recently commissioned report by Rio Tinto explains,

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[95] FMG (2006) Fortescue Marshes Management Plan, October 2006, available at http://www.fmgl.com.au/IRM/Company/ShowPage.aspx?CPID=1524

[96] Environmental Protection Authority (2013) Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area, Advice of the Environmental Protection Authority to the Minister for Environment under Section 16(e) of the Environmental Protection Act 1986, Report 1484, July 2013.

[97] Priority Ecological Communities (PECs) are poorly understood ecological communities, which potentially have high conservation values and may be subject to threatening processes. They are classified as either priority 1, 2 or 3; ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status. It is noted that areas of Fortescue Marsh will change to conservation tenure following the renewal of Western Australian pastoral leases in 2015.

[98] Skrzypek G., Dogramaci S., Grierson P.F. (2013) Geochemical and hydrological processes controlling groundwater salinity of a large inland wetland of northwest Australia. *Chemical Geology* 357: 164–177. RTIO-HSE-0198428

[99] Huxtable, D. (2013) Perspectives on ecological water requirements for plant communities of the Fortescue Marsh, in Proceedings of the Fortescue Marsh workshop, 26 March 2013.

[100] Rumley & Barber (2004) We Used to Get Our Water Free – Identification and Protection of Aboriginal and Cultural Values of the Pilbara Region, April 2004, Study report prepared for the Water & Rivers Commission

'…*that in Indigenous belief systems water is perceived as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Waters sources are derived from the actions of mythic beings during the Dreaming and are the most important features in the Pilbara cultural landscape. Sustaining and protecting country, including the relationships Traditional Owners have with particular places, was found to be the primary obligation for people*'.[101]

The major named creeks in and around Yandicoogina: Marillana, Yandicoogina, Weeli Wolli and Phil's Creeks, have all been identified as areas with high cultural significance. Cultural values are associated with camping, ceremonies and other cultural activities. Although no specific cultural or mythological information relating to water has been identified during heritage surveys completed to date at Yandicoogina, linkages with creation beings and the sustaining influence of water on the environment and adjacent water systems is a recurring theme during discussions of the creeks and springs in the region.

13.3 Water systems after closure

13.3.1 Changes to flood frequency

The creation of mine voids and slow, inevitable collapse of incised diversion structures used to control surface water at Yandicoogina will cause small creeks and local hillside runoff to be captured in the mine voids. Removal of small volumes of water, when considered in isolation, is unlikely to change the flow dynamics of the larger creek systems. Thus after closure, the frequency of large flood events in Marillana Creek is not anticipated to change.

However, it was recognised that the cumulative effect of terminating small runoff and flows as a consequence of mining activities across the Marillana Creek catchment could alter the flood regime; and that these changes could have a significant impact on riparian communities adjacent to Yandicoogina. Thus the cumulative effect of mining could compromise Rio Tinto's ability to comply with commitments to manage these riparian communities.

A simple study[102] was conducted in 2010 to quantify the potential magnitude of changes to flood frequency in Marillana Creek. The study assumed a worst case scenario by assuming all local tributaries that flow over the mapped CID were terminated. These conditions align roughly with the proposed, externally released BHPIO Yandi[103] closure strategy and closure options presented by Rio Tinto for the 2011 public environmental review of Yandicoogina.

The results showed that at the terminus of Marillana Creek the maximum capacity of water held without overtopping the creek banks (bank full) would reduce from a 10 year average recurrence interval (ARI) to a 20 year ARI. This means that in the future there will only be a five percent chance of overbank flooding occurring in any year, instead of a 10 percent chance. This flood regime change would affect sections of the creek otherwise unaffected by mining activities that support flood plain ecologies, such as *Eucalyptus camaldulensis* (River Red Gum), by reducing the volume of water stored in the floodplain alluvial soils.

There are a number of reasons why closure strategies involve termination or capture of surface water flows. The principal reason is to manage groundwater quality; and the diversion of runoff and syphoning of a proportion of flood water has been referenced, for example, as a water management solution to "flush" salts into the groundwater system, to reduce salinity in pit lakes.

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[101] Barber & Jackson (2010) Water and Indigenous People in the Pilbara: A Preliminary Study Funded by Rio Tinto Iron Ore, September 2010, CSIRO

[102] Beckett, K and Cheng, S. (2010) Marillana Creek regional flow balance and catchment hydrology. Internal report RTIO-PDE-0072519, 26 May 2010.

[103] BHP Billiton (2004) Marillana Creek (Yandi) Mine : decommissioning and final rehabilitation plan, January 2004

There are few avenues available at present to further pursue the discussion of cumulative effects and impacts of mining on the Weeli Wolli Catchment. However, new systems for managing cumulative effects are expected to be developed by regulators in Western Australia following the release of the new Western Australia Government Water Resources Management legislation[104].

13.3.2 Discharge impacts

Dewatering discharge undertaken during operations extends the duration of creek flow within the naturally ephemeral Yandicoogina creek systems. This activity has created water logged areas and permanent pools within the Marillana and Weeli Wolli Creeks. As mining activities draw to a close, the volume of discharge will taper then cease at the end of mining, returning the creeks to their pre-existing ephemeral regime. Water will not be artificially sustained to the creeks after the cessation of mining.

During the operating period, as water discharge is reduced, the health and / or vigour of riparian vegetation may change. During operations, these changes will be managed and monitored in accordance with the Yandicoogina Environmental Management Plan[105].

From our current understanding and observations, riparian vegetation is expected to achieve a new equilibrium without human assistance. If monitoring of the vegetation health during operations suggests a different outcome, contingency plans will be developed as part of the Decommissioning Study to assist riparian recovery.

13.3.3 Groundwater dewatering impacts

To enable mining to occur at Yandicoogina, groundwater levels in the CID and linked alluvial aquifers have been suppressed over a long period of time (decades in some locations). While mining activities leave the wider regional groundwater system intact, vegetation communities within the groundwater ‘cone of depression’ (the area where groundwater table is depressed due to groundwater abstraction during mining) are impacted and vegetation death is anticipated[106]. Note, during operations, the management and communication of these impacts to stakeholders are addressed through the Yandicoogina Environmental Management Plan.

It is now understood that large flood events can rapidly recharge depleted groundwater aquifers[107], such that groundwater systems can substantially recover in as little as 10 years once dewatering stops. However the degree and rate at which groundwater recovers beneath an individual tree is difficult to predict. As with the management of discharge impacts, riparian vegetation is expected to achieve a new equilibrium without human assistance. If monitoring of the vegetation health during operations suggests a different outcome, contingency plans will be developed as part of the Decommissioning Study to assist riparian recovery.

13.3.4 Groundwater through flow

The act of mining does not remove the entire CID. Once the economic ore is removed an unmineralised section of the aquifer left intact. The unmineralised section is a permeable block around 10m to 15m thick[108]. It is estimated that the in situ unmineralised CID is capable of maintaining a groundwater flow rate of 10m/day.

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[104] http://www.water.wa.gov.au/Future+water/Water+reform/default.aspx

[105] Rio Tinto Iron Ore (2013) Yandicoogina Environmental Management Plan. RTIO-HSE- 0183435.

[106] Rio Tinto (2011) Yandicoogina Junction South West and Oxbow Iron Ore Project, Public Environmental Review Prepared by MWH and Equinox Environmental for Rio Tinto, September 2011.

[107] Kirkpatrick, G and Dogramaci, S (2010) Yandicoogina Water Balance - Pre and Post Mining Hydraulics and Hydrochemistry, Internal report for Rio Tinto Iron Ore. RTIO-PDE-0073467

[108] Liquid Earth (2002) HI Yandi: Phil's Creek and Hairpin Dewatering Borefield Installation Program 2002. Prepared for Hamersley Iron Pty. Ltd. September 2002. GDSR 4397

Towards the surface, in pit mineral waste, waste fines cells and lakes will form new aquifers. The hydraulic conductivity through these new aquifers will differ from the original CID characteristics, with in-pit waste expected to have convey groundwater at a rate of around 15m/d and <1m/d for the fine cells.

The arrangement of in pit waste, waste fines cells, lakes and the subsequent interactions between creek alluvial aquifers and these new aquifers will influence groundwater table recovery. These interactions have been investigated as part of the landform design models, presented below.

13.3.5 Landform designs to minimise regional water impacts

Lakes will form within the mine voids at Yandicoogina because there is not enough mineral waste generated by the mining process to backfill the voids to above the groundwater recovery levels.

In consideration of how topography can influence water systems, six different landform combinations, using mineral waste generated through mining to create landforms and control water movement, were investigated at Yandicoogina. Each closure scenario investigated[109] was selected because it influenced the surface and ground water systems differently, and had the potential to achieve different environmental and social closure outcomes.

The six scenarios investigated were:
1. No backfill (all voids become lakes);
2. Backfill to pre-mining water table (material would be mined, removing adjacent hills to achieve this scenario);
3. Maintaining creek flows (with lakes);
4. Multiple small, deep lakes (Weeli Wolli Creek captured);
5. One permanent lake (large lake captures Weeli Wolli Creek); and
6. Continuous channel (large lake in palaeo valley, all creeks captured).

These scenarios, presented and illustrated in Appendix D, provide conceptual guidance as to the potential closure outcomes. Any of the six scenarios could be adopted at the current stage of mining. Scenario 3, to maintain creek flows, was considered by Rio Tinto to provide the optimal closure outcome for the Yandicoogina area, based on the currently proposed life of mine plan (including development of the yet to be approved Billiards deposits).

However, it is recognised that the mine plan may change in the future, for example, if new ore deposits are identified or if restrictions to the mine plan occur (ie for environmental or heritage reasons). Rio Tinto will continue to evaluate the impact of mine plan changes on closure outcomes, and this could result in a need to modify the closure landform in the future.

13.3.5.1 Scenario 3 Maintaining creek flows after closure

The “maintaining creek flows” scenario prioritises the use of available mineral waste to stabilise the pit walls, strengthen flood bunds and thereby preserves the creek systems as far as practicable. No attempt to suppress the groundwater table is made. Instead deep lakes are encouraged to form, and excess mineral waste not required to support the creek system is placed to reduce the surface area of the lakes, rather than reduce the depth of the lake.

Mineral waste priority locations were identified (from high to low) to minimise the potential for pit walls to collapse and to increase resilience to large flood events:
- Phils Creek reconstruction. Phils Creek is removed as part of the JSW pit development. Additional mineral waste would be used to strengthen the land bridge (constructed during operations) by increasing the buttressing either side of the land bridge. This

[109] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

configuration would minimise the potential for pit walls to collapse and increase resilience to large flood events.

- Marillana Creek between the JSW A and C areas. The area where Marillana Creek divides the JSW –A (southern) deposit from the JSW-C (northern) deposit restricts surface water flows between two flood bunds. Once the ore is removed, the bridge of CID ore and alluvium that remains under Marillana Creek has the potential to collapse into the void. Mineral waste would be used here to strengthen the pit walls and, leaving the flood bund in place, strengthen the flood bund. This configuration would increase resilience to large flood events.
- JSW area A adjacent to Marillana Creek. This pit wall is also located in the floodplain. Mineral waste would be used here to strengthen the pit walls and again, leaving the flood bund in place, strengthen the flood bund. This configuration would increase resilience to large flood events.
- JSE waste fines cover. Mineral waste is placed over the JSE waste fines cells to prevent the creation of a lake. This would prevent the permanent drawdown of the groundwater table under Marillana and Weeli Wolli Creek adjacent to the JSE deposit.
- Billiards southern expansion. The Billiards expansion intersects the Weeli Wolli Creek floodplain and could potentially mine through Weeli Wolli Creek. The long pit wall parallel to the creek has a high potential to fail. The mineral waste estimated to be generated from mining the northern portion of the Billiards deposit would allow the entire southern portion of void to be backfilled to surface to reinstate a floodplain.

In this scenario lakes will form in the Oxbow, JSW, JC and Billiards areas.

Modelling suggests the groundwater table would recover to approximately pre-mining levels in spite of the creation of several lakes. This situation evolves due to several different water interactions.

At Oxbow, the lake would behave as sink and water quality would deteriorate over time as a consequence. However, recharge from local runoff (terminating in the lake) would sustain the water levels around the pre-mining level. By behaving as a sink, salts would be prevented from interacting with the downstream alluvial and lake systems.

The JSW lakes would have a strong connection to the alluvial aquifers beneath Marillana Creek and would be rapidly recharged with the fresh alluvial waters. The surface area of the lakes would be relatively small in relation to the through flow rates, enabling the water to stay relatively fresh.

The JC lake would behave as a sink. However, because the lake is fed via water travelling through the CID from the JSW area, the salt content would be relatively low and the lake would take longer to become saline than Oxbow. The water level at JC would not recover to pre-mining level and a cone of depression would extend from JC under Marillana Creek into the JSE area.

The cone of depression at JC would cause the water flow direction to reverse through the JSE area, when compared to the pre-mining flow direction. This would pull the fresh groundwater in the Weeli Wolli aquifers through the JSE area, achieving approximately the pre-mining water levels.

Downstream of the JC cone of depression in Marillana Creek, the alluvial aquifer would be rapidly recharged from the surface water flows. This would sustain the pre-mining water table, in this sensitive riparian area, at the pre-mining water quality.

In the southern backfilled portion of the Billiards expansion area water levels and water quality would be returned to pre-mining conditions. Around the Billiards lake a small cone of depression may form during periods of prolonged dry weather. However, because this lake would receive all flows from Weeli Wolli Creek, the water levels would fluctuate with rainfall and overtop following large flood events (possibly every two to three years or so).

Further detailed study is now required to refine the landform design for Scenario 3 and verify the modelling predictions. Some of these studies have commenced, and the outcomes to date are discussed separately in Section 13.4 *Post-closure water* *predictions*. A discussion on wider closure outcomes associated with this preferred post-closure landform is presented in Section 20 *Post-closure landform*.

13.3.6 Effects of evaporation on water quality

Conceptual water balance models[110] indicated that some landform configurations create highly saline lake waters. Very conservative geochemical modelling[111] was undertaken to understand the effects of trace element leaching from backfill materials and evaporation. The model used measured groundwater quality parameters from Yandicoogina area (highest values ever recorded in any literature), assumed an evaporation rate of 90 percent in an open system (reflecting final salinity concentration in excess of 10,000mg/l) and only allowed hydroxide and carbonates to precipitate.

The geochemical model results indicate the groundwater is supersaturated with respect to carbon dioxide (CO_2). Thus degassing of CO_2 was modelled to occur as the groundwater equilibrates with the atmosphere and mixes with pore waters from backfill materials. Degassing of CO_2 increases the pH of the system from ~7.4 to ~8.6. Equilibrium with the atmosphere and the increase in pH resulted in the precipitation of minerals including calcite and ferrihydrite.

Evaporation of the resulting model fluid caused an increase in the saturation states of many minerals, and resulting precipitates including ferrihydrite, calcite, sepiolite, manganite, tenorite and smithsonite. Subsequent reactions modelled included increased precipitation, element depletion and further degassing of CO_2 due to evapoconcentration, leading to a further reduction in pH and additional precipitation.

Sorption / desorption processes were not considered as part of this modelling. It is recognised, however, that if high pH (alkaline) conditions develop, elements that are present as sorbed species in minerals such as hematite or goethite, but currently below detection limits, could mobilise. Elements of concern that could be mobilised under alkaline conditions include arsenic, selenium and antimony. Alkaline conditions may also mobilise amphoteric elements such as aluminium, which would be otherwise fixed in the system as gibbsite or other minerals.

It is important to note that mineral precipitation predicted by modelling may be reversible in the field if flushing with neutral or slightly acidic water occurs, for example from a rain event or from surface water runoff. Thus, remobilisation of solutes such aluminium, iron, manganese, copper and zinc could occur during rain events. Desorption on the other hand, may not be reversible. Once arsenic, selenium or antimony are mobilised, they may remain in solution even after rain events.

Physical modelling (ie evaporation trials) will be undertaken to validate the input parameters before further geochemical modelling of lake specific conditions is undertaken.

13.4 Post-closure water predictions

As discussed, conceptual water modelling has been used extensively to guide selection of the preferred closure strategy - to maintain creek flows. The following studies detail the local spatial and temporal variations in water levels, flows and quality at specific locations. The detailed information will be used to inform rehabilitation plans and other closure management requirements.

Detailed predictions of the post-closure water conditions will continue to be developed over time, and will be required in order to evaluate the post-mining environmental impacts. It should be noted, due to the complexity of the creek, groundwater and lake interactions at Yandicoogina, existing computer programmes struggle to model how water will move and the quality change at spatial and temporal scales that enable

[110] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

[111] Lazo-Skold, C. and Lee, S. (2013) Assessment of Yandicoogina water quality at closure. Technical memorandum, 5 August 2013. RTIO-PDE-0113542.

environmental impacts, especially the effects on groundwater dependent ecosystems, to be conclusively resolved. This issue is currently managed by modelling each location in isolation.

13.4.1 Regional groundwater recovery model

Following the landform design requirements, as described in Section 12.3 *Landform design*, a conceptual closure landform was designed for Yandicoogina (Figure 18). This design was undertaken in conjunction with the life of mine planning process, in order to optimise mineral waste movement. (For further discussion please refer to Section 20 *Post-closure landform*). A groundwater recovery model was subsequently generated for the post-closure landform.

This latest groundwater recovery model, created in the computer package Modflow-Surfact, considered the interaction of surface water flows, groundwater aquifers and lake storage and utilises the latest surface water flow predictions for the Marillana and Weeli Wolli Creek catchment areas and rainfall predictions for the region[112]. Figure 7 shows the expected groundwater recovery levels. In general, with the exception of JC lake, water tables recover roughly to or above pre-mining levels. These results confirm that the closure strategy, to maintain creek flow, will deliver the desired outcome and suggest that, post-closure, water availability within the creek systems will largely return to pre-mining conditions.

The lake at JC will act a sink, with water lost from the lake via evaporation and potentially through minor leakage to the regional aquifer. The cone of groundwater depression sustained by the lake system will extend for about a kilometre from the southern edge of the lake, drawing the water table down by 1m to 2m, within the observed, seasonal groundwater variation, for a kilometre of Marillana Creek[113]. (Note the extent of the depressed groundwater is similar in extent to the existing mine dewatering cone of depression, although substantially shallower.)

The model showed that, without intervention, the groundwater in areas adjacent to the major creeks would recover quickest (ie JSW could recover in around 10 years after dewatering stops) while lakes located furthest away from the major creek will take the longest to reach its new equilibrium (ie JC lake could take 40 years to stabilise).

Groundwater conditions through the Billiards area will be resolved once field data on the performance of the groundwater aquifers is available.

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[112] Cheng, S. (2013) Weeli Wolli Creek hydrology and floodplain assessment – Yandicoogina Billiard South Order of Magnitude Study. Water Resource Evaluation / Projects & Development report 17 December 2013, RTIO-PDE-0117748

[113] Commensurate with impact Zone 2a as defined within the Report and recommendations of the Environmental Protection Authority, Yandicoogina Iron Ore Project - Expansion to include Junction South West and Oxbow Deposits, Report 1448 August 2012.

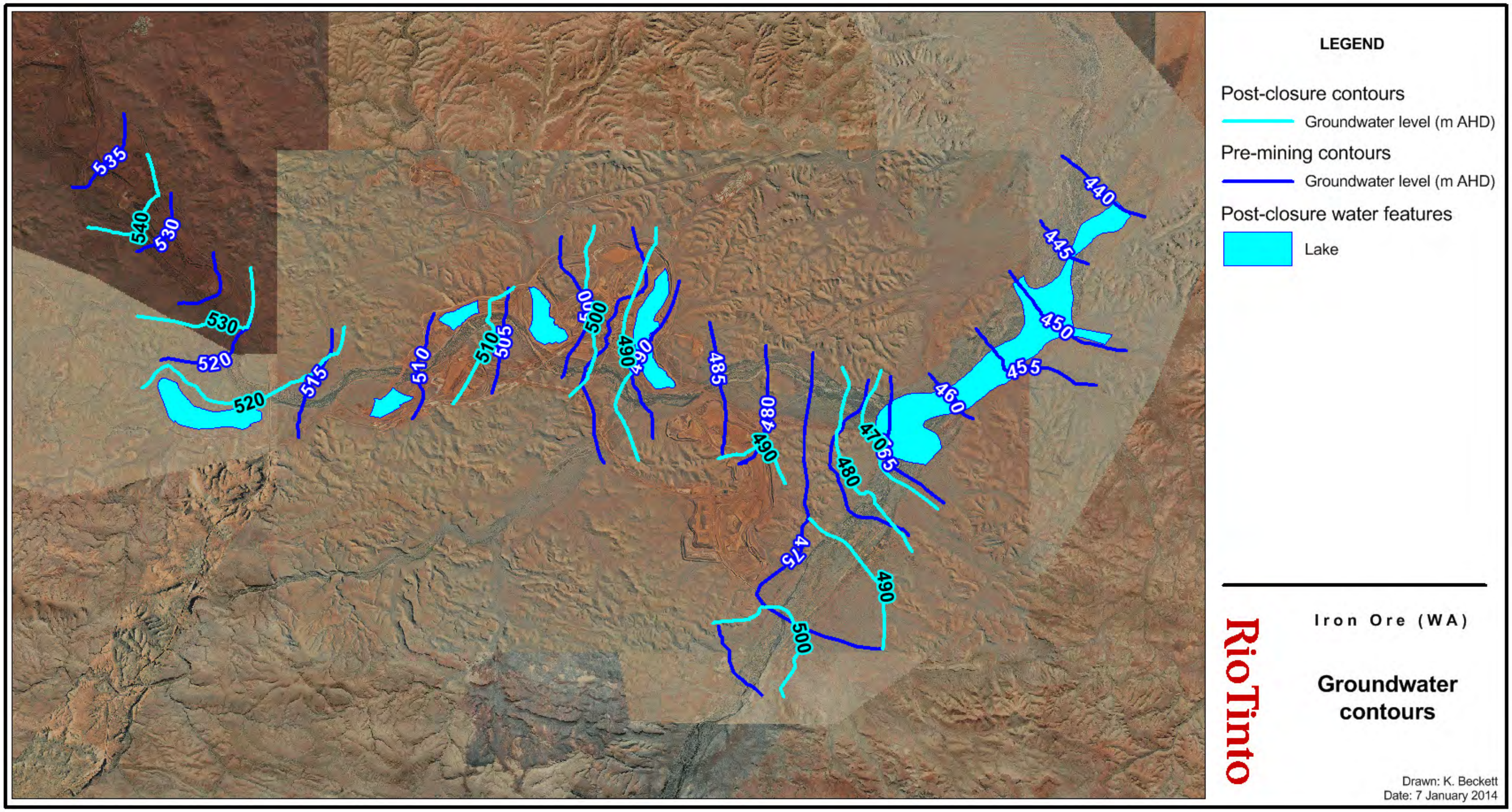

Figure 7: Groundwater recovery contour map

13.4.1.1 Enhanced groundwater recovery

During operations, the groundwater table is suppressed within all pits until rehabilitation and closure activities have been completed, in order to maintain a safe working environment within the mine voids. This could mean that dewatering could occur across a large proportion of the entire site, including exhausted pits, for many decades to come. An opportunity to reduce the dewatering requirements through large, progressive rehabilitation campaigns has been identified[114] and will be investigated over the next few years, to ensure the solution does not sterilise future resources. By reducing the dewatering requirements the groundwater table will recover earlier than the groundwater recovery model predictions.

Furthermore, given the long mine life estimated for the Yandicoogina deposits, it may be possible to utilise surplus water generated from active mine areas to enhance groundwater recovery. For the most part, this could be achieved through the creation of pit lakes, by discharging surplus water into the landscaped mine voids, whereby the water will dissipate into waste material located within the pits and eventually link up with the in situ groundwater aquifers.

Further investigations, modelling and stakeholder engagement will be undertaken to understand if enhanced groundwater recovery may be pursued without compromising safety, the environmental or social values in the region.

13.4.2 Oxbow lake

A simple water balance model[115] was developed for Oxbow lake to characterise salinity and water levels. The model used the same parameters as employed in the groundwater recovery model: groundwater, surface water flows from the oxbow catchment and climate sequences to calibrate the water balance, then simulated alternate evaporation and rainfall sequences through a Monte Carlo process to determine salinity and water levels. This modelling approach enabled detailed daily and monthly variability, ie temporal peaks in water levels created by minor flood events, to be resolved which cannot be achieved using the groundwater recovery model alone. As with the groundwater recovery model, this model used the latest information available, such that the results supersede previous water level and quality predictions for Oxbow.

The water balance results aligned with the groundwater model predictions, estimating that water levels would recover to around 514mRL (±1m with 25% certainty), approximating the pre-mining groundwater level. This water level was sustained by a combination of groundwater, surface water and rainfall inflows. For example, nearly half of the water presenting in the lake each year was due to groundwater inflows, another 30 percent was due to runoff from the catchment above the lake and the remainder was from direct rainfall. The water level never reached the top of the pit and it was found that the lake never received sufficient water so as to over top the pit wall.

Although the lake levels reached approximate pre-mining levels, the additional detail provided by the water balance revealed the lake was most likely to behave as a sink, contrary to the conclusions presented in the 2012 conceptual modelling[116].

The detailed outputs from the new Oxbow water balance model suggest that groundwater levels in the adjacent Marillana Creek alluvial aquifer will be slightly higher than Oxbow lake, which although subject to flooding is also subject to continual evaporation. This balance will prevent water from Oxbow lake from flowing back into the Marillana Creek alluvial aquifer and is likely to terminate longitudinal flow down the CID, in favour of infiltration from the overlying Marillana Creek alluvials. As a consequence, salts, delivered through the CID groundwater system (via the BHPBIO Yandi mine), and were

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[114] Beckett, K. (2013) Closure and water strategy synergies at Yandicoogina, considerations for the Billiards South order of magnitude study, internal memorandum, 30 May 2013. RTIO-HSE-0201688

[115] Murray, E. (2013) Oxbow Pit Lake – Stochastic salinity and water level conditions post closure. Internal memo, 12 November 2013. RTIO-PDE-0116562

[116] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

predicted to build up in the lake in perpetuity. When inflow salinity was set at 1100mg/l[117], after 300 years the salinity was predicted to exceed 10,000mg/l.

It was observed as part of the water balance modelling that, due to the coarse grid cell size required to run the groundwater model, the groundwater model over-estimates the storage capacity of Oxbow's lake by roughly 30 percent. A separate water balance was subsequently run, using the same input parameters, to quantify the sensitivity of the lake water levels and salinity to the geometry of the void.

With a smaller mine void, a more accurate reflections of the mine void Rio Tinto are expected to build, the water level recovered to a higher level, 528mRL (±1m with 25% certainty), due to the smaller lake surface area and associated lower annual evaporative volume. If the water levels recover to 528mRL, it is possible for the lake to overtop and for water from the lake to return to Marillana Creek. Under these conditions the salinity was predicted to stabilise at 2,700mg/L after 2000 years, remaining fresh (below 1,500mg/l) for the first 500 years.

The large difference in water salinities and water levels resolved in these two models show that the water balance in this location is very sensitive to the closure landform design. At present, the void modelled water balance for Oxbow has not considered how the adjacent tenure holder, BHPB, plan to develop the CID adjacent to Oxbow[118]. But it would be reasonable to assume that development of the adjacent tenure CID would result in the creation of another pit lake. Consequently, the annual evaporative losses are more likely to increase, reflecting the modelling outcomes from the larger mine void – the development of highly saline (sink) lake that is not connected (downstream) to Marillana Creek or the associated Marillana Creek alluvial aquifer. On this basis, further management planning will assume saline conditions evolve, until future modelling is able to demonstrate otherwise.

13.4.3 Junction South East ecological water balance

Conceptual water modelling[119] suggested the JSE void would act as groundwater sink if the groundwater table was exposed. As a result, a highly saline lake could develop in JSE, which could generate a substantial groundwater cone of depression that could extend under both Marilliana and Weeli Wolli Creeks. As discussed in several previous closure plans, this outcome is not preferred but may be expected when mineral waste is not available to backfill the pit to above the water table and when mining of adjacent hills for suitable backfill material is equally undesirable.

However, when development of the Billiards expansion areas is considered, a substantial volume of waste fines materials will be generated and deposited into the JSE mine void. The waste fines materials enable an alternative closure outcome to be developed, where the JSE mine void is backfilled to suppress the groundwater table, thereby improving the closure outcomes for Yandicoogina. This preferred, alternative outcome has been adopted in the development of the conceptual closure landform design.

In the conceptual closure landform design the waste fines cells are proposed to be capped with sufficient mineral waste so as to prevent the formation of a permanent lake. However, as discussed, the volume of mineral waste available is limited. To ensure the

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[117] This value is the estimated groundwater salinity at Oxbow as a result of mining activities at BHPB Yandi, as published in BHP Billiton (2004) Marillana Creek (Yandi) Mine: decommissioning and final rehabilitation plan, January 2004.

[118] Rio Tinto is not privy to the proposed mine development activities or strategies of BHPBIO, which would constitute the release of commercially sensitive information to a competitor, and could breach antitrust laws. A legal framework has yet to be identified that will enable the exchange of commercially sensitive information between Rio Tinto and its competitors. As a consequence, Rio Tinto is not in a position to resolve cumulative catchment impacts that are sensitive to mine development strategies ie final landform designs.

[119] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

conceptual closure landform could be achieved, a study was undertaken[120] to determine the minimum volume of material and associate landform configuration required to prevent a lake forming in the JSE void for more than 30 days on average each year[121].

The study used a three layer water balance model to mimic potential water conditions at JSE. The model used inputs from surface water runoff from the adjacent catchments and rainfall, and removed water via evaporation and evapotranspiration. The simple water balance model was also calibrated to the groundwater behaviour exhibited by the regional groundwater model, such that groundwater moved into and out of the aquifers created by the waste fines cells and backfilled mineral waste. Three layers were used in the model to track water movement: ponding on the surface, the water content of the cap and the water content of the remaining waste fines cells / general backfilled mineral waste.

Figure 8 illustrates the required capping depth required to suppress the water table as resolved from the model. With this configuration it was found that the periphery of the waste fines cell, constructed from mineral waste, would not require additional backfill and therefore should be available for rehabilitation once the cell was completed and access along the cell wall was no longer required (eg three sides of the cell may be available for rehabilitation while the waste fines cell is drying).

The landform configuration within the cells would result in water cumulatively cascading, from cell to cell, from south to north, where the water would eventually accumulate to create a temporary pool in the northern most cells. Infiltration from these temporary pools could have an advantage of locally increasing groundwater recharge above the cone of depression created by the JC lake; which, in turn, could reduce the magnitude of the cone of depression and any potential, associated impacts within Marillana Creek.

Further discussion on the use of the model results to inform the rehabilitation strategy is provided in Section 14.5 *Progressive rehabilitation activities*. A similar understanding of the water balance and water availability conditions likely to evolve within the closure landform will be developed for other locations, where required, to assist rehabilitation planning activities.

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[120] RPS (2013) Yandicoogina JSE pit landform water balance. Report number 1167E/E5/009c Prepared for Rio Tinto, November 2013. RTIO-HSE-0208317

[121] The 30 day trigger was arbitrarily selected to represent the difference between a temporary pool (the desired outcome) and an ephemeral lake (the undesired outcome).

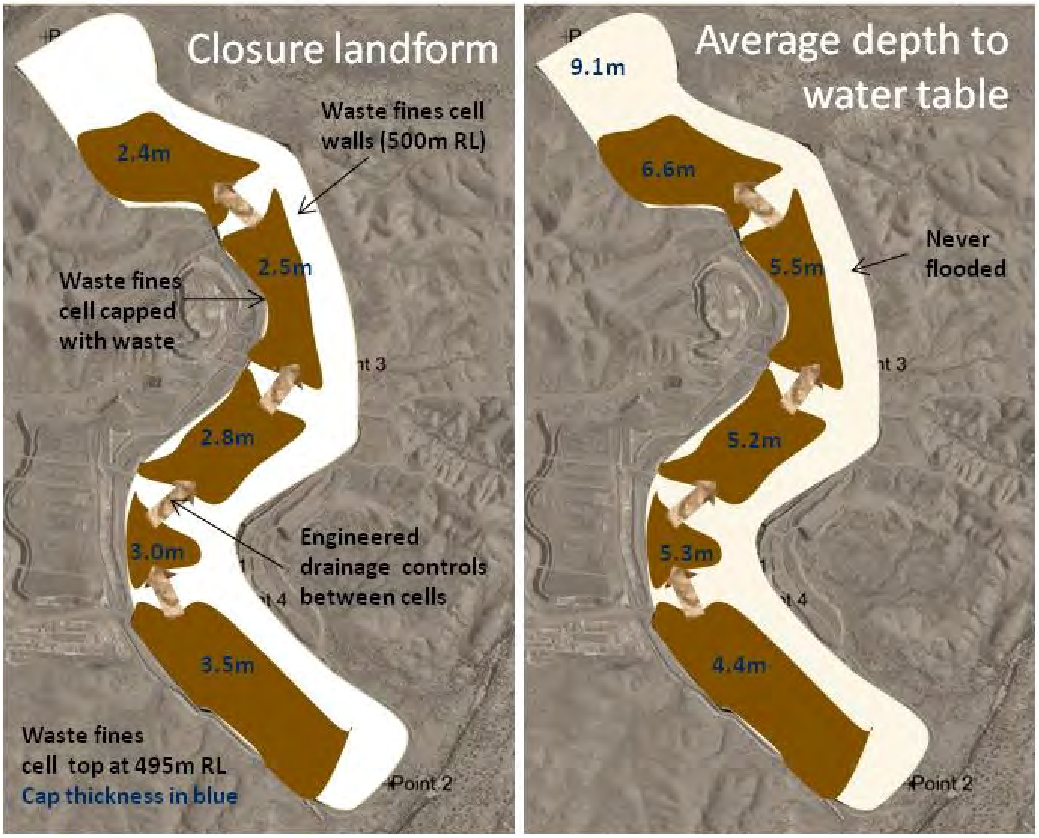

Figure 8: Junction South East landform design requirements to suppress water table.

14. Biodiversity

Rio Tinto Iron Ore undertakes regular surveys at established reference sites throughout the life of its mines to ascertain temporal differences in vegetation composition and faunal distribution in reference sites across the Pilbara.

At Yandicoogina, baseline surveys were undertaken prior to mining, and have been published as part of the public environmental reviews (PER)[122]. This data has been used to identify biodiversity / ecosystem values of relevance to the closure of Yandicoogina.

The operation is not expected to impact the conservation status of any flora or fauna species, populations or fauna habitat. This includes changes to fauna and flora abundance, species diversity, geographic distribution and / or productivity at species or ecosystem levels. Thus no ecosystem restoration activities are planned as part of the rehabilitation activities at Yandicoogina. However, opportunities to reintroduce species and / or habitats of biodiversity value will be sought, as appropriate, during rehabilitation implementation.

14.1 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. Similarly, the consequence of mining may be strategically assessed through an understanding of the relative magnitude of habitat loss, linkage between habitats and / or the anticipated changes as a consequence on introducing of new habitat.

[122] Rio Tinto (2011) Yandicoogina Junction South West and Oxbow Iron Ore Project, Public Environmental Review Prepared by MWH and Equinox Environmental for Rio Tinto, September 2011.

Six broad habitats types have been identified across the Yandicoogina area. These habitats include ridge, gullies, slopes, plains, drainage lines and creeks, that are likely to have existed prior to mining, and one disturbed habitat type as a consequence of current mining activities. Characteristics of these habitat types are provided in Table 9.

Of the habitat types, only the creek habitat is of high value due to the diversity of microhabitats and potential to support conservation significant fauna species. Drainage line and gully habitats are considered to have moderate habitat value due to the number of fauna that may utilise the area, while slopes, plain and ridges have low value. Cleared and disturbed areas provide little food, shelter, water or any other life essentials. As a consequence cleared habitat has little to no habitat value.

The six pre-mining habitat types will be present in the local area after closure. This includes areas of moderate and high habitat value adjacent to the mining activities, which may experience little to no disturbance as a result of mining or closure related activities.

However, some areas of Yandicoogina will be substantially changed compared to the pre-mining conditions as a consequence of mining activities. These changes, such as the creation of pits and generation of mineral waste, make it difficult and / or inappropriate to restore the original vegetation assemblage or habitat across most of the disturbed land. Understanding the habitats in the local area provides a source of knowledge and guidance as to alternate, sympathetic options for rehabilitation. As a consequence, rehabilitation outcomes may mimic the broad characteristics of an existing habitat or, by virtue of the mining landform legacy, introduce new types of habitat.

New habitats that are likely to be introduced to Yandicoogina at closure include:

- Rehabilitated land. Native and self-sustaining vegetation community with species selected to survive in, for example, the nutrient- and carbon- poor substrate created by the mineral waste.
- Terminal basin. Revegetated areas designed to accommodate periodic, sustained flooding as well as periods of drought. As few vegetation species are capable of withstanding the extreme conditions, species diversity within and coverage across the habitat may be low.
- Pit lakes. Water that accumulates within a mine void. No rehabilitation or re-vegetation is undertaken and, due to the minimal volume of substrate present, little vegetation is anticipated to establish naturally. Water quality is unreliable.
- Wetland. Lakes developed within mine voids from recovery of the groundwater table and / or capture of surface water flows, with water quality suitable for stock water requirements. Wetland habitat is differentiated from pit lake habitat by the (planned) presence of vegetation and quality of water.
- Cleared land. Areas of the mine lacking substrate that cannot be safely accessed, for which no effort is made to establish vegetation or stabilise the landform.

Table 9: Habitats considered in closure planning.

Habitat	Description
Hill habitats	
Ridge	Hills, ridges, plateaux remnants 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*, Bloodwood *Corymbia hamersleyana*, Kanji *Acacia inaequilatera* and/or *Hakea chordophylla* over moderately dense spinifex, predominantly *Triodia* aff. *basedowii*, with some *T. wiseana* on slopes. Rocky, sheltered ridges and breakaways provide a suite of specialist plants or species more typical of lowlands. This habitat is characterised by a low diversity of microhabitats. In general there are few to no logs, little woody debris, and very few hollows in trees. The shallow soil is often hard and unsuitable for burrowing fauna. Although the exposed bedrock can provide a few niche habitats in the form of cracks and crevices. This habitat zone will be present in undisturbed areas around the mine and may evolve around the edge of the disturbed mine area, especially where the pit shell intersects local hills. However this habitat type will not be restored or rehabilitated as part of the closure plan.
Gullies	Small gullies in upper hills with small, stony creeks. Under natural conditions gully habitats are only marginally different from the community that happened to surround them. Usually species poor, with occasional eucalypts over *Triodia* aff. *basedowii* and *T. wiseana*. This habitat creates a diverse array of microhabitats. 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 around the mine. However this habitat type will not be restored or rehabilitated as part of the closure plan.
Valley habitats	
Slopes	Stony lower slopes with quaternary colluvium and situated below the surrounding hill systems. Under natural conditions major soil types include red loamy earths and red shallow loams. Vegetation is characterised by hard and soft spinifex grasslands and scattered mulga (*Acacia aneura*) shrublands, as seen in the western half of the Oxbow area and in the JSW-A area pre-mining. This habitat is characterised by a low diversity of microhabitats with few logs and woody debris, and very few tree hollows. The soil is usually hard and unsuitable for burrowing fauna. The Western Pebble-mouse traditionally inhabits this habitat zone as it creates its Pebble mounds on the rocky scree. This habitat zone will be present in undisturbed areas outside of the mine. Opportunities for successful rehabilitation of this habitat are limited.
Plains	Undulating, low stony plains and alluvial flats. Under natural conditions soils vary from relatively deep, stony, skeletal red clay loams on low undulating plains to deep red clay loam soils with massive clay substrates on Mulga flats. Vegetation is characterised by *Corymbia hamersleyana* over sparse mixed shrubs and various species of spinifex. Alluvial soils may also support Mulga *Acacia aneura* and other Acacia communities over a moderately rich assemblage of shrubs, herbs and tussock grasses. Spinifex is less conspicuous in this community than most other habitats; however *Triodia wiseana* and *T. pungens* are frequently present. This habitat type contains limited microhabitats with the dominant Acacia species providing no tree hollows, few logs, limited leaf litter and sparse vegetation.

Habitat	Description
	This habitat zone will be present in undisturbed areas outside of the mine and has the most potential for successful rehabilitation, for example in low disturbance areas where top soil is available and the substrate has not been disturbed.
Drainage habitats	
Drainage line	A linear habitat that begins at the top of hills and runs to the surrounding plains, or encompasses small tributaries that eventually flow into larger river and creek habitat types. Vegetation composition is usually similar to the neighbouring habitat but with increase vigour and density due to sustained, elevated soil moisture following rainfall events. Drainage line habitat act as wildlife corridors that help flora and some fauna disperse across the landscape. There is a moderate diversity of microhabitats with some logs, debris, occasional tree hollows and isolated pods of soft soils. Surface water is more likely to persist in this habitat after it has evaporated elsewhere, providing a refuge for fauna. This habitat zone will be present in undisturbed areas outside of the mine. It is likely that rehabilitation of some disturbed drainage line habitat will be required coincident with, or as part of, local drainage controls. It is possible that drainage line habitat could be introduced coincident to surface water runoff controls in the closure landform.
Creeks	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 a mixture of woodlands (including River Red Gum *Eucalyptus camaldulensis*, Coolibah *E. victrix* and other tree species), shrublands and hummock grasslands, including riverine fringing vegetation of grasslands and herbs. Spinifex was comparatively sparse in drainage lines, and usually comprised *Triodia pungens* or *T. longiceps*. 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 will be rehabilitated, unless the landform has been substantially changed and the land is no longer expected to function as a creek habitat. Creek habitat may also be introduced where the closure landform creates conditions where creek habitat is the most suitable outcome, ie where the water table will be consistently close to surface or where new floodplains are created.
Disturbed / introduced habitats	
Cleared	Areas where vegetation and soil has been removed from the area for the purpose of mining and related activities. No effort has / will be made to establish vegetation or stabilise the landform. This habitat type is expected to have limited opportunity for fauna re-colonisation due to the lack of vegetation, substrate or shelter. This habitat zone will develop in some highly disturbed areas without substrate suitable for plant growth, such as pit benches, and areas of the mine that cannot be safely accessed.
Rehabilitated	Land that has been disturbed for the purpose of mining and has subsequently been landscaped and vegetated to establish a natural, self-sustaining ecosystem. Vegetation community characteristics differ from pre-mining conditions and surrounding pre-mining habitats due to the substantially altered landforms, water availability and substrate. This habitat type contains limited opportunity for fauna re-colonisation as it contains few to no tree hollows or logs, limited leaf litter and sparse vegetation.

Habitat	Description
	This habitat zone will be introduced as part of the rehabilitation of most of the disturbed areas that are external to the mine voids.
Terminal basin	Land that due to its shape captures and holds surface water runoff. The landform shape facilities the settling of silts and sediments, often creating a claypan or hardpan over time. Vegetation communities are designed to accommodate periodic, sustained flooding as well as periods of drought. As few vegetation species are capable of withstanding the extreme conditions, species diversity within and coverage across the habitat may be low. This habitat type contains limited opportunity for fauna re-colonisation as it contains few to no tree hollows or logs, limited leaf litter and sparse vegetation. This habitat zone will be introduced in selected areas, as part of the surface water management within the closure landform, primarily to control erosion of mineral waste.
Pit lake	A water body created through the process of mining below the water table and / or through creeks. No effort has / will be made to establish vegetation or stabilise the landform. This habitat may attract fauna and is susceptible to weeds. Water quality may vary over time, and could become unpalatable or hazardous over time. This habitat zone will be introduced in controlled locations, where the environmental impact is acceptable.
Wetland	Habitat created through the process of mining below the water table and / or through creeks when mine voids are rehabilitated to function as a lake system. The water body is readily accessible to fauna and humans, and the quality of the water is anticipated to be suitable for the proposed function of the lake. Water may or may not be introduced to the area to establish an initial lake area. The fringe of the lake may or may not be vegetated, dependent upon the proposed function of the lake, closure landform conditions and rate of lake water development. Aquatic fauna and aquatic fauna habitat are not anticipated to be included in the rehabilitation process, but may be introduced over time through natural recovery processes. Over time, and following the development and / or recovery of fringing vegetation the area is expected to create a fauna refuge area. This habitat zone will be introduced in nominated locations, where closure conditions are favourable.

14.2 Fauna

14.2.1 Priority fauna

The following species have been identified as present at or near Yandicoogina[123] and have biodiversity value because of their rare and / or threatened status:

- Northern Quoll (*Dasyurus hallucatus*) (Declared Schedule 1 [rare or likely to become extinct], and also Federally listed as Endangered),
- Pilbara Olive Python (*Liasis olivaceus barroni*) (Declared Schedule 1 in Western Australia, and also Federally listed as Vulnerable),
- Peregrine Falcon (*Falco peregrinus*) (Declared Schedule 4 [otherwise protected fauna] in Western Australia),
- Australian Bustard (*Ardeotis australis*) (Priority 4 [WA]),
- Grey Falcon (*Falco hypoleucos*) (Priority 4 [WA]),
- Bush Stone-curlew (*Burhinus grallarius*) (Priority 4 [WA]),
- Rainbow Bee-eater (*Merops ornatus*) (Priority 4 [WA]),
- Star Finch (*Neochmia ruficauda subclarescens*) (Priority 4 [WA]), and,
- Western Pebble-mound Mouse (*Pseudomys chapman*) (Priority 4 [WA]).

[123] Biota (2004) Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey, December 2004, report prepared for Hamersley Iron Pty Ltd, RTIO-HSE-0057590

Re-introduction of fauna is not considered as part of this closure plan. Instead, natural migration of fauna species into rehabilitated land is encouraged by creating habitats with similar composition to pre-mining communities in appropriate locations and with consideration of the post-closure soil and landforms design. Habitat elements that are considered as part of the closure landform design include:

- vegetation known to provide preferred food or shelter preference;
- retaining and replacing woody debris;
- rapid generation and retention of leaf litter using small-scale topography (eg furrows created from ripping);
- introducing or leaving rocky features such as oversized waste burden or scree slopes;
- creating greater depths of friable soil (or suitable mineral wastes) for burrowing fauna;
- preserving connectivity with unmined areas, and maintaining the quality of these habitats; and
- managing feral predators and herbivores across both reference and rehabilitated areas.

Ridges, outcropping, caves and gorges represent preferred habitat (Hill habitat) for the Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and Pilbara Olive Python (*Liasis olivaceus barroni*).[124] Hill habitat will remain post-closure in areas adjacent to current mining activity and may be suitable for colonisation. However, no habitat reconstruction or artificial micro-habitats construction to support colonisation of these species is proposed as part of this closure plan. Similarly, no speciality habitat requirements have been identified for the carnivorous Peregrine Falcon (*Falco peregrinus*) or the Grey Falcon (*Falco hypoleucos*), which range across habitats in search of food.

Australian Bustard (*Ardeotis australis*), Rainbow Bee-eater (*Merops ornatus*) and Star Finch (*Neochmia ruficauda subclarescens*) prefer tussock grassland, Triodia hummock grassland, grassy woodland, and low shrublands, associated with Valley habitats. While the Bush Stone-curlew (*Burhinus grallarius*) prefers open woodland, edges of forest and riparian zones, associated with Drainage habitats. The introduced rehabilitated habitat zone may have characteristics similar to those preferred by these avifauna species, and therefore has the potential to provide habitat for these species.

14.2.2 Subterranean fauna

Subterranean fauna are animals that inhabit underground habitats and include:

- stygofauna - obligate, groundwater dwelling aquatic fauna, and
- troglofauna - obligate, subterranean dwelling fauna occurring in the unsaturated profile above the water table.

Stygofauna and troglofauna are known to occur in a range of habitats in the Pilbara region, but can potentially have restricted distributions based on their evolutionary history and specialised habitat requirements.

The CID at Yandicoogina does not provide ideal troglofauna habitat due to frequent inundation during periods of heavy rainfall. Three potentially troglobitic species have been collected, none of which are endemic to the area.

At least 150 species of stygofauna have been recorded in the Pilbara[125] with 500–550 taxa[126] estimated to remain undescribed. Prior to 2011, 15 new (undescribed) taxa, currently only known to be present beneath Marrillana and Weeli Wolli Creeks, had been identified. For this reason, subterranean fauna habitat is considered to have biodiversity value.

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[124] Young, M. and Parsons, B (2012) Baseline Terrestrial Fauna Assessment of Pilbara Rehabilitation Areas. Prepared by Outback Ecology Services for Rio Tinto Iron Ore, March 2012. RTIO-HSE-0134168

[125] Eberhard SM, Halse SA, Scanlon MD, Cocking JS & Barron HJ 2005, „Assessment and conservation of aquatic life in the subsurface of the Pilbara region, Western Australia", *Proceedings of the Symposium on World Subterranean Biodiversity*, Universté Claude Bernard Lyon, November 2005.

[126] Eberhard SM, Halse SA, Scanlon MD, Cocking JS & Barron HJ 2009, „Exploring the relationship between sampling efficiency and short-range endemism for groundwater fauna in the Pilbara region, Western Australia", *Freshwater Biology*, vol. 54, pp: 885–901.

A subterranean fauna management plan[127] was implemented at Yandicoogina to address possible direct and indirect impacts to subterranean fauna affected by mining. The plan included regular sampling and morphological analysis, identification of species whose long-term survival is at risk and procedures to avoid or minimise the impacts on these species, and analysis of physical environmental (habitat) data.

Work, completed in accordance with the plan, demonstrated that the taxonomic composition of the stygobitic fauna recorded at Yandicoogina remained similar over multiple recording campaigns[128]. These results suggest that an abundant and diverse stygal community remains within the aquifers of the Yandicoogina creek systems, years after the commencement of the dewatering at the operation, and shows that impacts to subterranean fauna are localised to the immediate mine areas. Consequently, targeted creation of stygofauna habitat is not considered to be required for the closure of this site.

Closure and post-closure impacts to the stygofauna populations may arise as a consequence of predicted changes to groundwater quality (salinity and / or pH). The potential response of remnant stygofauna populations at Yandicoogina to potentially altered groundwater conditions is currently unknown; although stygal communities are known to be present in the brackish water condition of the Fortescue Marsh[129].

The potential impacts to subterranean fauna are currently monitored and managed through the Yandicoogina Environmental Management Plan[130].

14.2.3 Common species

Common fauna species that are considered to be important indicators of rehabilitation success, and therefore have biodiversity value, include:

- micro-organisms brought into rehabilitated areas within respread topsoils;
- invertebrates, especially ants and parasitic wasps; and
- vertebrates.

Invertebrates have a major role in the success of rehabilitation efforts because they facilitate a variety of ecosystem processes, such as litter decomposition and nutrient cycling, herbivory, seed dispersal, soil aeration and drainage, pollination and provision of a source of food for vertebrate predators. Invertebrates can be encouraged by providing areas of thick, widespread litter cover over part of the area, logs and standing dead wood.

Vertebrates are usually the last to recolonise, once complex vegetation assemblages and invertebrate prey are established[131].

14.2.4 Feral animals

Feral carnivores (eg 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.

Feral herbivores (eg 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

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[127] Pilbara Iron Pty Ltd (2006) Yandicoogina JSE Subterranean Fauna Management Plan. Prepared by Biota Environmental Sciences Pty Ltd, August 2006. RTIO-HSE-0017212

[128] Biota (2010) Yandicoogina Subterranean Fauna Assessment Phases I – V, unpublished report prepared for Rio Tinto Pty Ltd, September 2010, and Yandicoogina Stygofauna Assessment: 2010 Addendum, February 2011, Biota Environmental Sciences, Perth. RTIO-HSE-0101408

[129] Bennelongia (2010) Christmas Creek Project Water Management Scheme: Stygofauna Assessment, prepared for Fortescue Metals Group Ltd, Report 2010/96, September 2010.

[130] Rio Tinto Iron Ore (2013) Yandicoogina Environmental Management Plan. RTIO-HSE- 0183435.

[131] Thompson, G. G. and Thompson, S. A. (2006) Small vertebrate colonisers of mine site rehabilitated waste dumps in the Goldfields of Western Australia. In Proceedings of the First International Seminar on Mine Closure. Perth, Australia.

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 low-on effect to native fauna species that rely on this vegetation for food and shelter.

Feral animals will continue to be managed in accordance with the Yandicoogina Feral Animal Management Plan[132] during closure. The Feral Animal Management Plan conforms to Ministerial Statement 914 and meets current national guidelines, ie Codes of Practice for the humane control of invasive species published by the Department of Environment.

14.3 Vegetation

14.3.1 Priority flora

The following Declared Rare Flora (DRF) and Priority flora have been identified at or near the Yandicoogina operations[133][134] and have biodiversity value because of their rare and / or threaten status:

- *Lepidium catapycnon* (DRF [WA] & Vulnerable [Commonwealth]),
- *Rhodanthe frenchii* (Priority 2),
- *Sida* species Barlee Range (Priority 3),
- *Themeda* species Hamersley Station (Priority 3),
- *Rhychosia bungarensis* (Priority 3),
- *Rostellularia adscendens* var. *latifolia* (Priority 3), and
- *Goodenia nuda* (Priority 4).

Figure 9: Lepidium catapycnon (Photo from the DPaW Florabase website)

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

- habitat preference (preference for drainage lines, gullies, calcretes or other habitat not suitable or similar to those likely to be present in the rehabilitation landscapes);
- abundance – very few populations or small populations from which to source seed;
- difficult taxonomy / unresolved taxonomy issues and thus status of species highly uncertain; and / or
- growth form – eg. short lived annual species with preference for growth under woodland canopies;

Other issues include the availability of seed at the time when rehabilitation occurs and seed dormancy.

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[132] Rio Tinto (2011) Yandicoogina feral animal management plan. RTIO-HSEE-0187214

[133] Biota (2013) Yandi Additional Areas Vegetation and Flora Level 2 Assessment. Prepared for Rio Tinto Pty Ltd, January 2013. RTIO-HSE-0175488

[134] Note that this list only captures species that have been observed in the current and future proposed disturbance areas around the Yandicoogina operation. Also note that historic survey reports list other Priority species are being present in the study area: these were listed by the DEC as Priority species at the time of survey, but have subsequently been removed from the schedules.

In consideration of these issues, only three species from the DRF and Priority list above have been identified that could be considered in future rehabilitation programmes at Yandicoogina:

- *Lepidium catapycnon* in hill habitat rehabilitation;
- *Sida* species Barlee Range in valley floor habitat rehabilitation; and
- *Themeda* species Hamersley Station in valley floor habitat rehabilitation.

Lepidiums are members of the mustard family, and other members of the genus are known as peppercresses, pepperweeds or pepperworts. The Hamersley Lepidium (*Lepidium catapycnon*) is a short lived perennial herb or shrub up to 40cm high (Figure 9) normally associated with break of slope topography in hill habitats. It is also listed as Vulnerable by the Federal Government[135]. Research undertaken into rehabilitation of the *Lepidium catapycnon*[136] found that the use of the growth hormone gibberellic acid enabled germination rates approaching 90 percent in the laboratory and concluded that good germination results are likely to be possible in the field. Test and transplant work for this species is ongoing; however, the availability of seed and habitat requirements may limit the re-introduction of this species at Yandicoogina.

Inclusion of *Sida* species Barlee Range in rehabilitation is currently limited due to seed collections issues and potential seed dormancy, but is otherwise expected to be suitable for inclusion in the rehabilitated habitat zone seed mix.

Themeda species Hamersley Station has a preference for heavy, clay soils. This restricts potential use of this species to areas with a high soil fine fraction. These conditions may develop in the closure landform at the waste fines cell areas. However, conditions will need to be verified in the field, after landform shaping, to confirm suitability for rehabilitation purposes.

14.3.2 Riparian vegetation

Riparian areas supports a range of species not typically recorded in other habitats. Phreatophytes, for example, are plants that constantly have their roots in touch with water, drawing from surface water, saturated groundwater aquifers and / or the capillary fringe above the saturated zone. In the ephemeral creek systems of the Pilbara, phreatophytes such as *Melaleuca argentea* (Silver Cadjeput or Paperbark) access groundwater recharged from flood events and / or regional groundwater.

All sites of permanent water (whether saline or fresh) are considered significant refuges for fauna during years with below average rainfall[137]. With direct disturbance to phreatophytes expected as a consequence of dewatering and more general threats from cattle and weeds, all water-related habitats are generally considered to be ecosystems at risk, and thereby considered to have biodiversity value at a sub-bioregion scale.

As discussed in Section 13.2 *Environmental and social values of water*, management undertaken during operations[138] is expected to preserve environmental, social and biodiversity values of the riparian vegetation. Disturbed riparian vegetation will be rehabilitated to similar pre-mining habitat if the function of the land post-mining is still preserved. For example, creek crossings will be rehabilitated to creek habitat. Conversely, creek habitat removed to create a pit void may be rehabilitated to a different post-closure habitat.

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[135] Department of Environment Water Heritage and Arts, Approved Conservation Advice for: Lepidium catapycnon (Hamersley Lepidium), December 2008 http://www.environment.gov.au/biodiversity/threatened/species/pubs/9397-conservation-advice.pdf

[136] Department of Conservation and Land Management (now DEC), The germination requirements of seeds of the rare Hamersley *Lepidium catapycnon* (Brassicaceae), February 2000, report to BHP Iron Ore Pty Ltd.

[137] Biota (2012). Koodaideri project, targeted fauna survey. Report for Rio Tinto Iron Ore by Biota Environmental Sciences. February 2012.

[138] Rio Tinto Iron Ore (2013) Yandicoogina Environmental Management Plan. RTIO-HSE- 0183435.

14.4 Revegetation

Revegetation is the final implementation stage of the rehabilitation process. (Implementation procedures for rehabilitation are discussed in Closure implementation Section 28 *Progressive closure activities*.) Rehabilitation, including revegetation, is conducted in accordance with the Rio Tinto Iron Ore's Rehabilitation handbook[139].

Revegetation is currently accomplished by using seed. Revegetation activities, including the 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.

14.4.1 Seed management

Monitoring has shown that in small disturbed areas adjacent to existing vegetation or in areas where fresh topsoil can be utilised (eg borrow pits) appropriate species general 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 very small 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.

Seed mixes for rehabilitation are preferentially of local provenance. Specific seed mixes are 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 plant, if and when identified through ongoing consultation with Traditional Owners.

Rio Tinto Iron Ore purchases seeds on an annual basis from commercial seed suppliers, with emphasis on ensuring that there are appropriate local provenance seeds available for rehabilitation of each of its sites. Seeds are stored in a purpose-built facility at the Rio Tinto Iron Ore Dampier port facility, or off-site at facilities owned and managed by third parties.

14.4.2 Weed management

The Yandicoogina Weed Monitoring Plan[140] defines procedures to identify, control and eradicate target weeds and monitor weed control measures to minimise the spread of weed species, prevent the introduction of new weeds and control and/or eradicate both noxious and environmental weeds in the mine area.

All weed species that have been identified at Yandicoogina are considered common weeds in the region[141]. Buffel grass (*Cenchrus ciliaris*) was widespread and abundant prior to mining as a result of pastoral activities[142]. The remaining species generally occurred as scattered individuals or in isolated patches. Mesic habitats such as

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[139] Rio Tinto Iron Ore, *Rehabilitation Handbook,* RTIO-HSE-0011608

[140] Astron (2013) Yandicoogina Iron Ore Project Weed Monitoring Plan. Prepared for Rio Tinto Iron Ore, September 2013. RTIO-HSE-0188629

[141] Two recording of Sisymbrium irio (London rocket) is an exception and appears to be a new record for the Pilbara region. Biota (2004)

[142] Biota Environmental Sciences (Biota) (2004). Yandi Expansion Vegetation and Flora Survey. Unpublished report prepared for Hamersley Iron Pty Ltd, December 2004.

creeklines and floodplains are particularly susceptible to weed invasion, and comprise the main areas around the mine supporting significant weed infestations.

Weed eradication programmes target weeds of high concern, specifically *Acetosa vesicaria* (Ruby dock), *Aerva javanica* (kapok bush), *Cenchrus ciliaris* (buffel grass), *Malvastrum americanum* (spiked malvastrum), *Ricinus communis* (castor oil plant), *Setaria verticillata* (whorled pigeon grass) and *Vachellia farnesiana* (mimosa bush).

Weed assessment is undertaken on a biennial basis. Targeted weed mapping is undertaken following significant rainfall events, during the period from February to June. Weed hygiene activities are also employed for vehicle and earthmoving machines to minimise the distribution of weeds.

14.4.3 Monitoring procedures

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

The Rio Tinto Iron Ore Rehabilitation Monitoring Procedure[143] details the monitoring methodology for recording and assessing vegetation development, fauna re-colonisation / habitat development and erosion. The procedure also ensures monitoring is carried out in a safe, efficient manner across all Rio Tinto Iron Ore Pilbara operations.

Habitat characteristics are 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 is also recorded.

The current monitoring programme includes:
- 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; and
- presence of weeds, and species.

Transects are also reviewed as a whole to record:
- number of logs (>10cm diametre and >30cm long);
- number of rocks (>15cm diametre);
- presence of scat;
- presence of ants,;
- general animal sighting (including tracks, burrows and nests);
- flowering and fruiting species;
- extent of grazing; and
- if burnt since last monitoring.

Monitoring of rehabilitation and reference sites is scheduled annually for the first three years after establishment, biennially from years five to nine and (approximately) triennially thereafter, until the completion criteria is achieved.

Analysis of the trends observed at rehabilitation sites over time and in comparison to reference sites is being studied to develop an understanding of rehabilitation quality and successional processes in our rehabilitation.

[143] Rio Tinto Iron Ore (2013) Iron Ore (WA) Rehabilitation monitoring procedure. RTIO-HSE-0010757

14.4.4 Reference sites

Key characteristics of reference transects [144] established to assist in the assessment of rehabilitation success are presented in Table 10.

Table 10: Yandicoogina reference site vegetation statistics (2009).

	Lower slopes / flat	Midslopes	Upper slopes / hilltops
Bare ground (%)	20.8 ± 4.2 (std error)	10.8 ± 2.1 (std error)	12.1 ± 2.5 (std error)
Live plant density (plants/m^2)	Range 2.3 – 2.6	Range 2.6 – 6.0	Range 4.2 – 10.9
Foliage cover (%)	Range 27.3 – 31.9	Range 32.1 – 33.2	Range 18.7 – 29.0
Species richness (per m^2)	Range 0.7 – 1.1	Range 0.4 – 1.0	Range 0.5 – 0.85
Dominant plants (average alive plants/m^2)	Perennial grasses (1.65) Shrubs (0.6) Perennial herbs (0.2)	Perennial grasses (3.5) Shrubs (0.2) Perennial herbs (0.04)	Perennial grasses (5.8) Sedge (2.0) Shrubs (0.1)
Dominant plants (alive % foliage cover)	Perennial grasses (21.4) Shrubs (5.8) Trees (2.0)	Perennial grasses (26.6) Shrubs (4.5) Trees (1.5)	Perennial grasses (23.0) Shrubs (1.9) Trees (0.2) Sedge (0.1)

Figure 10: Example of existing ridge habitat from C1 transect on hill tops (Matiske 2009).
Hummock grassland of *Triodia wiseana* with *Eucalyptus leucophloia* and *Senna glutinosa* subsp. *pruinosa*.

[144] Mattiske Consulting Pty Ltd, Rio Tinto Iron Ore (2009) Yandicoogina Revegetation Reference Sites, July 2009, RTIO-HSE-0098922, summary statement September 2009, RTIO-HSE-0076334.

Figure 11: Example of existing slope habitat from C6 transect on mid slopes (Matiske 2009).
Hummock grassland of *Triodia basedowii* and *Triodia wiseana* with *Eucalyptus gamophylla* and Acacia spp.

Figure 12: Example of existing plain habitat from C5 transect on low slopes (Matiske 2009).
Hummock grassland of *Triodia pungens* with *Eucalyptus gamophylla*, *Corymbia hamersleyana*, *Hakea lorea*, and Acacia sp.

14.5 Progressive rehabilitation activities

14.5.1 Borrow pits

Borrow pits associated with the railway at Yandicoogina were rehabilitated in the second half of 1998. Rehabilitation monitoring commenced in 1999 and continues today. Monitoring results[145] suggest that vegetation communities, in general, are similar to that of reference sites (Figure 13), while classification analysis showed there was no clear difference between the rehabilitated and reference sites in terms of their overall species composition.

Burning has occurred in both control sites and rehabilitation areas. The density and numbers of species present at control sites was observed to change after burning, often resulting in significant increases in plant species and resulting increased vegetation cover and diversity. However, analysis suggests rehabilitated sites do not respond to burning in the same manner, such that burning of rehabilitated sites does not result in long-term differences in vegetation composition.

[145] Rio Tinto Iron Ore (2010) Yandi Borrow Pit Rehabilitation Monitoring Report 2010. Prepared by Pilbara Mining Operations, September 2010.

Figure 13: Comparison of reference site 434 (left) and rehabilitated borrow pit area 434 (right) in 2013, 15 years after rehabilitation.

Figure 14 illustrates the difference in rehabilitation performance five years and 12 years after rehabilitation. After 12 years a small number of species present in reference sites have yet to be recorded in rehabilitation areas or are present only in lower numbers. However, there is a trend to gradual increase in species diversity. For example, in 2007, 20 species were recorded in reference sites that were not present in rehabilitation areas. By 2010 the number of species not identified in rehabilitation areas had reduced to 10, two of which were only recorded as a single plant across all reference sites.

Species found to be present in rehabilitated borrow pits at densities lower than in their reference sites comprise *Acacia aneura, Acacia dictyophleba*, *Acacia atkinsiana*, *Triodia pungens* and *Triodia wiseana*. Reasons for the lower abundance of some species in rehabilitation may include influence of fires, different densities prior to clearing and topsoil handling techniques.

Figure 14: Borrow Pit 417, with *Triodia* ground cover and *Acacia ancistrocarpa* and *A. atkinsiana* upper storey in 2003 (left) five years after rehabilitation, and in 2010 (right) 12 years after rehabilitation was completed.

It is recognised, however, that it will be more challenging to achieve the same, consistent revegetation growth across the mine area at closure due to the different closure landform shape, top soil deficit and potential deterioration of the stockpiled top soil with age.

14.5.2 Drainage shadow

Drainage shadow monitoring on Hamersley Iron's Yandicoogina railway commenced in 1998 and was completed in 2004. The monitoring program[146] was designed to assess whether construction and operation of the railway had any indirect impact on the survival and health of Mulga, *Acacia aneura*. It was postulated that downslope impacts in the drainage shadow area might occur, with limited upslope impacts due to flooding also considered.

[146] Environmental Management and Research Consultants (2004) Yandicoogina Railway Drainage Shadow Monitoring 1999 - 2004, Prepared for Hamersley Iron Pty Ltd, December 2004.

The results showed that although numbers of all mulga age classes and dead mature mulga appeared to be higher in some upslope transects, over time there was no clear statistically significant difference between the upslope and downslope transects.

14.5.3 Water interaction planning for rehabilitation

As discussed in Section 14.1 *Habitat*, the closure landform is expected to introduce habitats that differ significantly from the pre-mining conditions due to changes in water conditions. Consequently integrated landform design and water management will be a critical component for the successful rehabilitation of Yandicoogina.

As presented in Section 13.4 *Post-closure water predictions*, a water balance model[147] has been used to guide the basic landform design requirements for the JSE void (Figure 8). The water balance model was subsequently used to predict the water conditions that would evolve through the area.

The results, presented in Figure 15, show that water availability will vary spatially and with depth. Some areas will experience prolonged water logging after heavy rains, but will otherwise need to survive on little to no water (receiving only incident rainfall). At the other extreme, in other areas groundwater will be constantly near to the surface, providing access to water through prolonged droughts. As a result, the revegetation strategy for JSE will need to consider species that suit different habitats for different areas of the landform.

Figure 16 represents the initial planning for the rehabilitation strategy at JSE. This plan will continue to evolve as more information is developed for the site. As the JSE area remains active until the end of the mine life, the detailed rehabilitation plan for JSE is not expected to be completed during the Decommissioning Study (eg waterway design to covey water between cells). However the rehabilitation strategy will be used to guide progressive rehabilitation as opportunities arise.

[147] RPS (2013) Yandicoogina JSE pit landform water balance. Report number 1167E/E5/009a Prepared for Rio Tinto, November 2013. RTIO-HSE-0208317

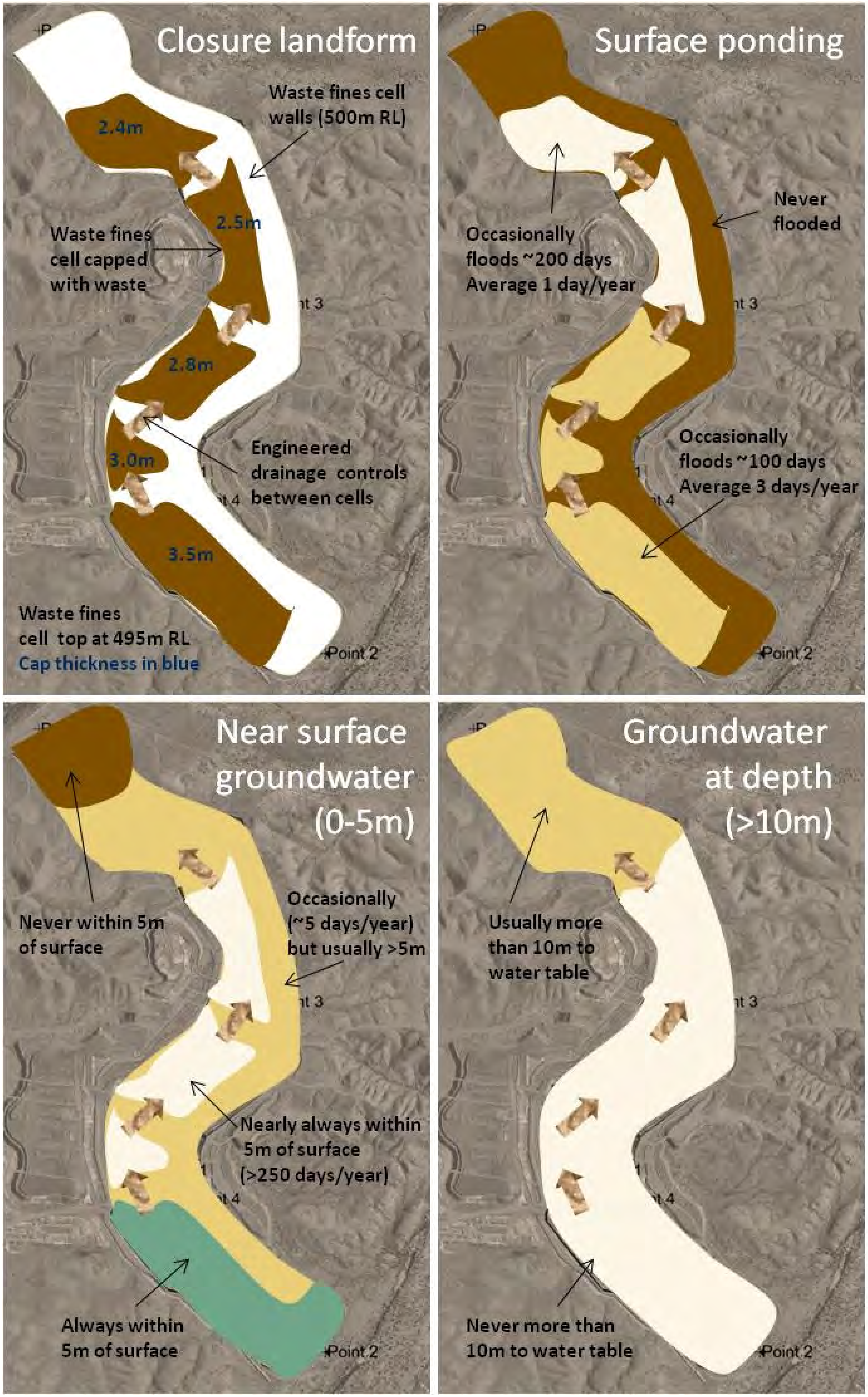

Figure 15: Water conditions anticipated to occur in the JSE closure landform.

Figure 16: Rehabilitation strategy for the JSE closure landform.

15. Social factors

Note some social data used to inform closure decisions is gathered in confidence. This information remains confidential to Rio Tinto and the representative bodies, management committees and members of the relative interest groups. This information cannot be disclosed to any other person or organisation without the written permission of all of these groups with the exception of State and Commonwealth agencies (eg Department of Indigenous Affairs [DIA], EPA, DMP) for the purposes of demonstrating compliance with various regulatory and other requirements. Similarly some cultural heritage values information is not available to the general public and is unable to be released.

15.1 Cultural heritage management

Rio Tinto recognises and respects the significance of Australia's cultural heritage, and in particular the cultural heritage of Aboriginal people who have traditional ownership of, or cultural connections to, the land on which Rio Tinto businesses operate. Rio Tinto businesses take all reasonable and practicable measures to prevent harm to cultural heritage sites. Where this is not possible, businesses will take steps to minimise or mitigate impacts and ensure required statutory approvals are obtained.

Rio Tinto Iron Ore employ a Cultural Heritage Management System (CHMS)[148] to ensure appropriate protection and management of Aboriginal heritage through engagement with Aboriginal Traditional Owners throughout the mine life, including closure.

The Rio Tinto Iron Ore Approvals Coordination System is used to regulate ground disturbance activities. This process ensures that significant Aboriginal and environmental sites are not disturbed without authorisation, triggers further surveys for areas where existing information may have insufficient detail and ensures conditions are met prior to work commencing.

Consultation with Traditional Owners is conducted on a regular basis in accordance with Agreements that have been negotiated (or are in the process of being negotiated) with the various groups impacted by Rio Tinto Iron Ore operations. Life of Mine consultation sessions are conducted on a quarterly basis, and include closure as an agenda item when appropriate. The outcomes of these sessions inform the development of closure strategies, and are fully documented using the CHMS.

Consultation will be sustained throughout the decommissioning and closure phases of the mine life to ensure cultural heritage is managed appropriately.

15.1.1 Relevant Aboriginal groups

According to early anthropological studies, the Yandicoogina mining area is located at the confluence of territories of three Aboriginal language groups: Banjima (Pandjima, Panyjima)[149], Nyiyaparli (Naibali, Nyiyaparli) and Palyku (Bailgu). The current representation of Traditional Owner boundaries is reflected in the Native Title Claim boundaries lodged with the National Native Title Tribunal[150]. The boundaries of the claims were revised in 2011 when MIB and IB claim groups became Banjima and the reminaing Innawonga area became known as Yinhawangka. According to these claims (which are still to be determined by the Federal Court), the Yandicoogina mine is located on the traditional country of the Banjima and Nyiyaparli peoples. Native Title claim areas are shown in Figure 17.

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[148] Rio Tinto (2011) Cultural heritage management standard for Australian businesses. Internal publication. http://www.riotinto.com/documents/Cultural_Heritage_Management_standard_ Australian_businesses_2011_2014.pdf

[149] Multiple spellings apply to many Aboriginal groups in accordance with variations to how they are anglicised. The first name mentioned is in current use, with common alternatives provided in brackets. Note that the primary names used in this closure study report differ from those used by McDonald (AHIS report ID 20435).

[150] National Native Title Tribunal Register of Native Title Claims and Determinations

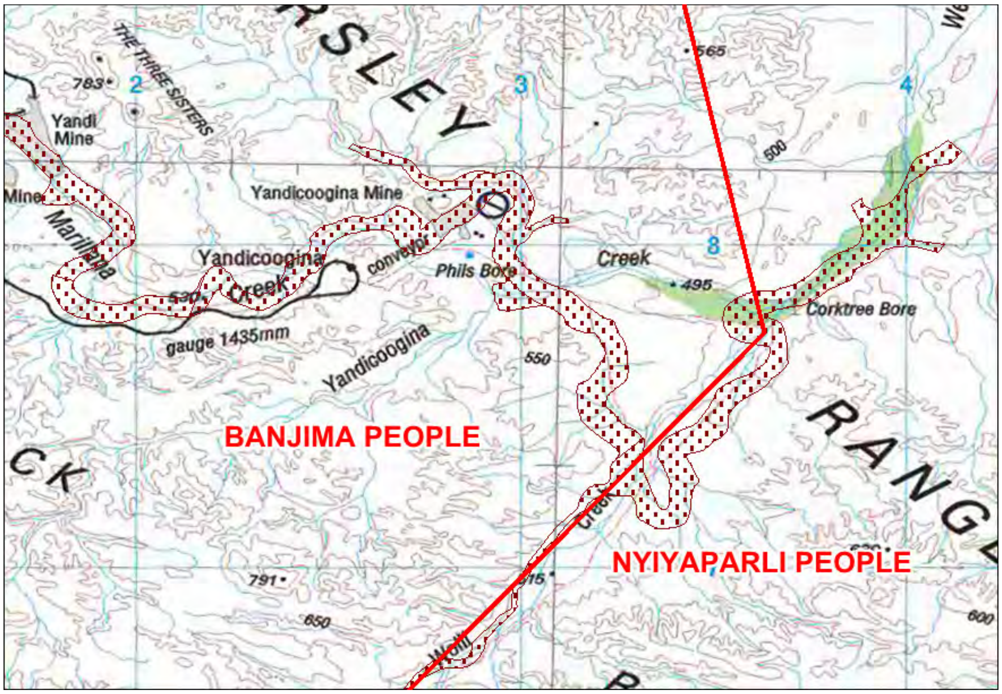

Figure 17: Native Title boundaries.

In the past, these groups lived a hunter-gatherer-fisher lifestyle throughout the central Pilbara. Evidence suggests they often lived together, intermarried, and met for ceremonies.

Anthropologists have discussed the Aboriginal groups in the area as belonging to a "central Pilbara culture block," sharing an understanding of cultural norms, laws, and customs[151]. Relationships between these groups are organised through the 'skin system,' which crosses language boundaries and dictates much of the social structure for Central Pilbara Aboriginal society.

The geographical boundaries of the these Aboriginal groups cannot be distinguished by linguistics alone, and any attempt to define group boundaries through linguistic groupings is potentially problematic (i.e. Tindale 1974). Research in the Central Pilbara demonstrates that Indigenous identification with traditional lands or 'country' is more attributed to broader kin groups than to language groups[152]. Boundaries are also dynamic and will have changed over time.

Yandicoogina mine is nominally considered to be on Banjima territory, with Nyiyaparli land commencing to the east of Weeli Wolli Creek. However, these boundaries are fluid, and the area is considered to straddle country of importance to both groups[153].

The Paylku people as documented by Tindale (1974) are more generally identified with the Fortescue Marsh area to the north of Yandicoogina than with Yandicoogina itself, although there is some evidence of historic connection. They have close ties to the Nyiyaparli people and have met frequently with them. The Paylku people (as a separate group to Nyiyaparli) have not been prominent in Yandicoogina agreement negotiations.

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[151] Day, B (2004) Report on the ethnographic survey at possible burial site P02175, Yandi Village Walk trail and Billiards Drilling Project at Weeli Wolli Creek, Yandicoogina. A report for Hamersley Iron Pty Ltd and Gumala Aboriginal Corporation.

[152] Clarke, C & Smith, M (1982) Yandicoogina Prospect WA: A Survey for Aboriginal Sites (Final Report) – A Survey of Temporary Reserves 5259, 5603-4, 6685 and 6696 for CSR, A report for CSR.

[153] Elizabeth McDonald (2004) Report of Archaeological Site Inspections and Ethnographic Consultation, 2003/2004 Yandicoogina Evaluation Drilling Programme and Mine Expansion Yandicoogina, Pilbara, Western Australia (AHIS report ID 20435)

Aside from Banjima and Nyiyaparli, a third group was heavily involved in development of the Yandicoogina Land Use Agreement: the Yinhawangka (Innawonga) (more commonly associated with the Paraburdoo area). Banjima, Nyiyaparli and Yinhawangka people are closely linked and share a common language (Banjima)[154].

In March 1997, the Nyiyaparli, Banjima and Yinhawangka peoples signed the historical Yandi Land Use Agreement with Hamersley Iron Pty Ltd (a wholly-owned subsidiary of Rio Tinto). Gumala Aboriginal Corporation was created in 1996 to represent the collective interests of the Traditional Owners in the negotiations with Hamersley Iron and to develop and sign the Agreement.[155]

15.1.2 Ethnographic and archaeological values

Extensive archaeological and ethnographic surveys[156] have been undertaken within the Yandicoogina locality, principally in association with mining activities in the area[157]. These reports help Rio Tinto to understand the heritage values of the Yandicoogina area.

Numerous Aboriginal archaeological sites have been recorded: including artefact scatters, quarries, skeletal material / burial, rock shelters, engraving sites and scarred trees. These sites range from low to high archaeological and cultural significance[158][159].

A number of ethnographic sites have also been identified in the Yandicoogina locality, most significantly in connection with Marillana Creek and Weeli-Wolli Creek. The creek systems are recognised to have important associations with camping, ceremonies and cultural activities[160]. A heritage exclusion zone is currently in force around Weeli-Wolli Creek, Marillana Creek and Phil's Creek, although it is noted that part of the planned and / or proposed mining activities occur within this exclusion zone. Rio Tinto Iron Ore is required to consult with Traditional Owners prior to any disturbance within this exclusion zone and engage them in the Approvals process. It should also be noted that any long-term alteration to the regional water regime is likely to be of high cultural significance. Consultation to date has not, however, identified any specific conflicts or issues associated with Yandicoogina closure options.

It is important to note that these studies are primarily location specific (eg for a specific project expansion area, or the clearing of a defined area); and Traditional Owner representatives participating in surveys offer cultural information on a need-to-know basis. Accordingly, Traditional Owner identification of archaeological and ethnographic significance may not encompass areas or values beyond the defined location.

To date, consultation regarding closure has been at a broad options level and as such the main concerns raised by the Traditional Owners related to changes to the cultural

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[154] Clive Senior, *The Yandi Story (1998)*, internal RTIO report not available for external distribution

[155] http://www.gumala.com.au/ accessed 12 August 2013

[156] Key information contained in this Section is available in open reports upon request. The information contained within these reports is confidential to Rio Tinto Iron Ore (RTIO) and the representative bodies, management committees and members of the Gumala Aboriginal Corporation (GAC), Martu Idja Banyjima, Innawonga Banjima and Nyiyaparli claim groups and must not be disclosed to any other person or organisation without the written permission of the all of these groups with the following exceptions: State and Commonwealth agencies (e.g. The Department of IndigenousAboriginal Affairs, the Department of EnvironmentMines and Conservation, the Department of Industry and Resources, the Department of Environment and Water ResourcesPetroleum) for the purposes of demonstrating compliance with various State and Commonwealth regulatory and other requirements.

[157] Davis, Yit & Burke (2009) Yandicoogina Cultural Heritage Management Plan, RTIO Internal document.

[158] Davis, Yit & Burke (2009) Yandicoogina Cultural Heritage Management Plan, RTIO Internal document.

[159] Government of Western Australia, Department of Aboriginal Affairs, Aboriginal heritage inquiry system. Registered Aboriginal Sites http://maps.dia.wa.gov.au/AHIS2/ accessed 16 August 2013.

[160] For example, see Chapter 6 of the 2008 Federal Native Title Report, *Indigenous Peoples and Water*, at http://www.hreoc.gov.au/social_Justice/nt_report/ntreport08/index.html. RTIO is currently undertaking a study to provide a better understanding of the cultural significance of water with respect to its operations in the Pilbara.

landscape as a whole, rather than any site-specific concerns. Topics under discussion with Traditional Owners and their representatives include:

- Preservation of remaining ecosystems and protection for creek banks,
- Lake water quality,
- Ongoing importance of ethnographic and archaeological surveys,
- Role of Gumala Aboriginal Corporation in closure planning,
- Importance of including elders and young people in consultation,
- Management of artefacts at closure,
- Potential community use of site infrastructure after closure, and
- Access through and around the mine and into the lake areas.

Traditional Owners have suggested during consultation that pit lakes have the potential to improve the local landscape, but only if the water is of a suitable quality to support natural ecosystems.

At closure, repatriation of cultural artefacts to the Yandicoogina area is anticipated, and thus sustained access to the agreed repatriation sites will be developed through the consultation process and included in the closure landform design.

15.2 Profile of local community

15.2.1 Workforce

Yandicoogina is a remote mine site that operates on a 100 percent FIFO (Fly-in, Fly-out) worker basis.

Around 500 to 600 personnel (employees and contractors) work at Yandicoogina to sustain the current production tonnage; although it is noted that the tonnage could reduce substantially in the decade prior to closure. The majority of the FIFO personnel are based in Perth and around 10 percent commuting from Busselton, a regional town in the south west of Western Australia.

Service providers are largely flown directly to the site, although it is possible that local service providers may be utilised from time to time. Closure of Yandicoogina is not anticipated to impact on local service providers.

15.2.2 Local towns

The nearest town, Newman, is located 90km south-east of Yandicoogina. Newman is ostensibly linked to BHPBIO operations in the area (particularly the Mt Newman mine which is located on the outskirts of the town). Yandicoogina mine has negligible interaction with Newman or any other local towns.

The small town of Nullagine, located 130 km northeast of Yandicoogina, has a high proportion of Aboriginal residents, and has participated in work programmes aimed at improving employment opportunities, including opportunities at Yandicoogina. The status of these programmes and the impact on the local employment profile will be reviewed with greater detail as the site approaches closure.

15.2.3 Community values

No significant non-Indigenous cultural heritage values have been identified for Yandicoogina through the consultation and research activities undertaken to date. It is recognised that locations along Weeli Wolli Creek are opportunistically accessed by the general public for camping, fishing and other associated recreation activities.

Stakeholder consultation

'Stakeholders' include external and internal stakeholders who are likely to affect, be affected by or have an interest in mine closure planning and outcomes[161].

Rio Tinto Iron Ore aims to develop strong and credible relationships with all stakeholders; consulting internally and externally to increase levels of input and ownership in the closure planning process.

16. Key stakeholders

Key stakeholders have been identified through Rio Tinto's ongoing mining experience in the Pilbara region, as well as through discussion with the Office of the Environmental Protection Authority (OEPA). Table 11 lists the key stakeholders identified for this project. This list is dynamic and will evolve over time.

Table 11: Yandicoogina key stakeholders

Category	Stakeholder
Commonwealth Government	Department of Environment, Water, Heritage and the Arts
State Government	Department of State Development (DSD) Department of Indigenous Affairs (DIA) Department of Mines and Petroleum (DMP) Office of the Environmental Protection Authority (OEPA) Department of Parks and Wildlife (DPaW) Department of Environment Regulation (DER) Department of Water (DOW) Department of Regional Development and Lands (RDL) Department of Agriculture Department of Transport (DoT) Main Roads Western Australia (MRWA)
Local Government	Pilbara Regional Council Shire of Ashburton East Pilbara Shire
Non-Government	Gumala Aboriginal Corporation (GAC) Fortescue Metal Group (FMG) Iron Ore Holdings (IOH) BHP Billiton Iron Ore (BHPBIO) Brockman Mining Limited Mineral Resources Hancock Prospecting Pastoral Lands Board RTIO shareholders

[161] Department of Mines & Petroleum and Office of the Environmental Protection Authority (2011) Guidelines for Preparing Mine Closure Plans, June 2011, http://www.dmp.wa.gov.au/documents/Mine_Closure(2).pdf.

Category	Stakeholder
Community	Banjima people Nyiyaparli people Yinhawangka (formerly Innawonga) people Marillana Pastoral Station Township of Nullagine
Internal	Rio Tinto Iron Ore employees and contractors

17. Stakeholder consultation process

17.1 Consultation purpose and principles

Stakeholder consultation is undertaken to ensure all stakeholders have their interests considered during closure planning. Rio Tinto Iron Ore has established processes and protocols for consultation with each of its key stakeholders. This work expands on the principles established by Rio Tinto's approach to Communities and Social Performance[162], guided by Rio Tinto's global code of conduct *The way we work*[163]. 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 used by Rio Tinto Iron Ore 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
- wherever practical, work with communities to manage the potential impacts of mine closure.

The focus for discussion on closure will change over the mine life. Examples of the focal areas for discussion are illustrated below.

- Prior to the commencement of operations and during expansion phases
  - Stakeholder identification and stakeholder mapping.
  - Closure issues centric 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.
  - Discuss closure landform design options.
  - Communicate outcomes of studies undertaken to improve the closure knowledge base and close knowledge gaps.
  - Communicate proposed changes to the closure plan.

- In the lead up to closure (development of decommissioning plan)
  - Final completion criteria consensus.
  - Future use of infrastructure post-closure.
  - Commence workforce communication strategy.

- Post-closure
  - Communicate general site conditions.
  - Progress against completion criteria.

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162 Rio Tinto (2007) Communities policy, September 2007. Rio Tinto (2011) Communities standard, January 2011. http://www.riotinto.com/sustainabledevelopment2011/social/communities.html

163 Rio Tinto (2009) The way we work. http://www.riotinto.com/sustainabledevelopment2011/social/communities.html

17.2 Consultation strategy

Closure consultation is usually conducted within a broader Rio Tinto Iron Ore operation centric or regional consultation framework, as a component of Rio Tinto Iron Ore's ongoing consultation forums.

During mine expansion phases, closure consultation is conducted as part of the environmental approvals process[164] to resolve closure objectives, issues and closure strategies. The environmental impact assessment process then provides any member with the public with the opportunity to comment on all aspects of the expansion, including closure.

Consultation with Traditional Owners is regularly undertaken through the liaison forums, established under the terms of Indigenous Land Use Agreements with relevant groups.

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.

17.3 Engagement register

Closure consultation for Yandicoogina has been undertaken as part of environmental approvals processes and throughout the life of the mine. At the current stage of project development consultation has focused on describing the site and its associated closure issues, and discussing closure objectives.

Table 12 summarises topics that have been raised with or raised by stakeholders with respect to closure and the general opinion expressed.

Note Table 12 does not record presentations provided to stakeholders as part of general Rio Tinto Iron Ore operation consultations where closure planning is presented if the audience has not been actively engaged in closure discussions.

[164] For more information on the environmental approval process please refer to the Environmental Protection Authority (EPA) website http://www.epa.wa.gov.au/

Table 12: Stakeholder engagement (communications) register

Date(s)	Title of communication	
Stakeholders	**Outcomes**	**Related actions**
1996	Junction Central environmental approvals	
EPA public process, public submissions from: Conservation Council, Dept Aboriginal Affairs, Dept Conservation & Land Management, Dept Minerals & Energy, Dept Resources Development	The main closure concerns identified by stakeholders were: • salinity of any remaining pit voids; and • aquifer rebound, and vegetation stress caused by depressed groundwater levels. A commitment was made to develop a decommissioning plan at least 2 years prior to closure: the EPA considered this to be insufficient, and imposed a condition requiring the plan to be developed within 5 years of commissioning.	Commitment to develop a decommissioning plan at least 5 years prior to closure was adopted.
1998	Agreement on key environmental criteria	
Department of Environment, Water & Rivers Commission	Closure performance criteria agreed as part of the 1998 closure planning process. Agreed criteria were: • maintain beneficial use (stock watering) water quality in Weeli Wolli braided area; • limit extent and intensity of impact of drawdown on creek and phreatophytic vegetation to within 1 to 2 km of the pit; and • limit the potential for saline development of in-pit water to less than 15,000mg/L.	These criteria were re-affirmed in the 2003 closure plan update and approved by the DEC in 2005. Note, the FMG Nyidinghu project is now located within the Weeli Wolli braided area. The potential mining influence on this location suggests the Weeli Wolli braided area is no longer a suitable measurement location.
2005	Junction South East environmental approvals	
EPA public process. Consultation was undertaken in preparation of Environmental Protection Statement with: Environmental Protection Authority, Dept Environment, Dept Conservation & Land Management, Conservation Council, Wildflower Society, Gumala Aboriginal Corporation, BHP Billiton Iron Ore, Hope Downs Management Services.	Closure related issues raised by stakeholders related to the following issues: • Salinity of mine void lakes; • Surveys and rehabilitation plans for 'Backfill Hill' prior to mining for backfill material; • Mechanisms for development of completion criteria; • Undertaking closure planning as a component of operational mine planning; • Minimisation of the time between mining and rehabilitation. The final proposal approved by the EPA included the following closure strategy (developed after stakeholder consultation, and not questioned during the public appeal period): "*Use out of pit waste dumps and ROM pad, plus additional mined fill, to backfill the final pit void to at least 490mRL. Rehabilitation of backfilled material to commence once final landforms are constructed and stable.*"	A closure plan was submitted in 2008 to comply with the commitment to revise the 2003 Closure Plan to include JSE within 12 months of commissioning.

Date(s)	Title of communication	
Stakeholders	**Outcomes**	**Related actions**
2010	Junction South West and Oxbow expansion	
Office of the Environmental Protection Authority, Department Environment & Conservation, Department of Water, Department of Mines & Petroleum	Several meetings were held with Government agencies concurrent with Junction South West and Oxbow expansion proposal, including a one day workshop 28 May 2010 where closure objectives and options were discussed. Departmental officers agreed that it may be appropriate to review existing objectives, but indicated that such decisions would need to be made by the OEPA. Efforts to engage discussion with the OEPA during the course of the study were unsuccessful. A formal letter was sent to the OEPA on 18 June 2010[165], with no response. DMP officers suggested that an objective be included that relates to erosion management. Departmental officers agreed that the existing closure strategy (partial backfill) is likely to be inappropriate, but indicated that formal endorsement of alternative strategies would need to be made by the OEPA. Departmental officers did not endorse any particular alternative closure strategy on the basis that further information is required to enable reasonable assessment. However; there was some qualified support for the 'channel' and 'pit void' options.	An indicative completion criteria relating to landform stability has been included in the closure plan.
Gumala Aboriginal Corporation	Half day workshop 24 March 2010 to discuss ethnographic values relevant to closure, to introduce closure options, and obtain feedback on options[166]; and Attendance at the Gumala elders meeting 20 August 2010 to discuss issues specific to the 'channel final landform configuration' (the preferred landform scenario presented in this study report). Concerns were initially raised that the final landform would be different to the pre-mining landscape. No specific ethnographic values that may affect closure planning were identified in the discussions. It was clear at this stage that the Traditional Owners did not wish to provide definitive answers regarding the project, as the options discussed were at a broader strategic level. With respect to the channel configuration, the following issues were identified: • Any standing water should be of suitable quality to maintain a functional	Concerns raised by Gumala have been discussed in the closure plan. Engagement with Traditional Owners is proposed to continue via the regular GAC Monitoring and Liaison Meetings

[165] Correspondence to Office of the Environmental Protection Authority dated 18 June 2010, RTIO-CR-0022848

[166] Workshop outcomes are documented in memo RTIO-CR-0024696. The summary of outcomes was also forwarded to Gumala Aboriginal Corporation on 26 March 2010

Date(s)	Title of communication	
Stakeholders	**Outcomes**	**Related actions**
	ecosystem; • The channel should be constructed in such a manner that enables egress to people or animals that enter; • Heritage surveys conducted to date are not sufficient to identify impacts. Surveys of additionally impacted areas would be required; • Consideration should be given to maintaining access from one side of the channel to the other; and • Further discussions will be required with Traditional Owners when more specific closure plan details have been established.	
2013	Traditional Owner liaison meetings	
Gumala Aboriginal Corporation	At the June 2013 Yandicoogina Land Use Agreement Monitoring and Liaison Committee an overview of the mine closure process was presented to the GAC board members. It was agreed at the meeting to form a sub-committee / working group to address issues relating to closure and land management. The terms of reference for the sub-committee / working group are yet to be resolved.	Rio Tinto subsequently (October 2013) met with the Gumala Aboriginal Corporation Lore and Culture Committee to discuss participation of Elders in the closure working group. A decision on Elder's participation and representation is still pending.

Post-mining land use and closure objectives

18. Land use

18.1 Historical land use

The Pilbara is classified as an Extensive Land Use Zone[167]. Primary land uses include cattle grazing, exploration and mining, and Aboriginal and conservation reserves.

Traditional Owner activities at Yandicoogina were and continue to be closely linked to the creek systems, where the creeks provide important associations to camping, ceremonies and other cultural activities.

18.2 Options for post-mining land use

Options for post-mining land use are limited in the Pilbara region, with mining and pastoralism the only industries that have historically proven viable. Inland regions are sparsely populated, with the largest inland towns (such as Tom Price, Paraburdoo and Newman) established specifically to support the mining industry. Beneficial uses for the mining area (eg recreation or aquaculture) that might have potential in areas supported with a higher population base are unlikely to be viable.

However, the mining methods for iron ore used at Yandicoogina do not generate significant volumes of mineral waste compared to the amount iron ore removed. As a consequence there is insufficient mineral waste volume available to backfill the mine voids to surface or even to successfully stabilise all of the pit walls. As a result, the mine voids are unlikely to be successfully rehabilitated to enable historic pastoral activities, sheep (wool) and cattle production, to occur within their footprint. Similarly, the highly erodible mineral waste backfill areas are unlikely to withstand significant cattle traffic even after self sustaining ecosystems are established. Other locations disturbed by the mine activities may be compatible with pastoral activities following decommissioning.

Consequently, a return to pastoral activity is not considered a viable post-closure land-use for the entire mine area. Alternative land use options will continue to be investigated throughout the mine life, in consultation with local communities and Traditional Owners. Some examples of the alternative options for consideration include non-pastoral native vegetation, recreation / camping grounds for Traditional Owners and / or public use and fauna refuge (due to the permanent water supply).

Until an alternate land use is agreed, the closure and rehabilitation strategy will focus on the following, to ensure the system remains compatible with general Pilbara land uses:

- create landforms that are stable for access by humans and native fauna;
- ensure water systems support existing riparian vegetation and are compatible with the natural system dynamics; and
- establish ecosystems with similar biodiversity and cultural heritage values as surrounding reference sites.

19. Closure objectives

The goal of mine closure at Yandicoogina is to relinquish the site to the Government. This goal will be achieved once the government and community agree that the condition of the site is compatible with an agreed post-mining land use.

19.1 Rio Tinto's vision for closure in the Pilbara

Rio Tinto operates a number of mines in the northwest region of Western Australia. At all of these operations, closure planning is guided by sustainable development principles, in view of Rio Tinto's social obligations and commitments to minimise adverse impacts on

[167] National Land and Water Resources Audit, 2001.

the human and natural environment, and provide a legacy which makes a positive contribution to sustainable development.

These vision statements reflect a broad range of closure issues relevant to all Rio Tinto operations in the Pilbara, and drive the development of local and regional closure strategies and plans for effective closure management:

- Preserve, protect and manage the cultural heritage values of the area in cooperation with the Traditional Owners and other stakeholders.
- Develop and implement strategies for closure which consider the implications on local communities.
- Achieve completion criteria which have been developed with stakeholders and agreed with Government;
- Develop landforms that are safe and stable and compatible with the surrounding environment and post-mining land use.
- Achieve environmental outcomes that are compatible with the surrounding environment.
- Implement a workforce strategy which addresses the impacts of closure on employees and contractors.
- Achieve successful closure in a cost effective manner.

19.2 Yandicoogina closure objectives

The following closure objectives (Table 13) describe the long term closure outcomes that Rio Tinto and stakeholders in the Yandicoogina operation have agreed are appropriate for the site and reflect aspects of the closure plan that are essential to achieving closure success.

Over time the definition and expectations associated with closure objectives has changed. After discussion and feedback from regulators and the community, the closure objectives for Yandicoogina have been altered from those presented in previous closure plans. The closure objectives preserve the intent from previous closure plans, but reflect the requirements of closure objectives as described by the *Guidelines for Preparing Mine Closure Plans*[168].

Table 13: Yandicoogina closure objectives

	Objective
1	Rehabilitated landforms are stable and designed to manage floodwater appropriately
2	The environmental and cultural heritage values associated with creek flows and function are maintained post-closure
3	Environmental values of Fortescue Marsh are not compromised
3	Water quality within pit lakes support natural ecosystems and are compatible with post-mining land use
4	Alluvial groundwater systems support remnant phreatophytic vegetation
5	Final landforms are rehabilitated to be compatible with post-mining land use
6	Public safety hazards have been addressed

Completion criteria, described in Section 24, define how the successful execution of these objectives will be assessed to facilitate relinquishment.

[168] Department of Mines & Petroleum and Office of the Environmental Protection Authority (2011) Guidelines for Preparing Mine Closure Plans, June 2011, http://www.dmp.wa.gov.au/documents/Mine_Closure(2).pdf.

Proposed landform at relinquishment

20. Post-closure landform

Through the decommissioning and rehabilitation process, the post-mining landform is reshaped to create the closure landform. When the wider environment is considered, including interactions with neighbouring hills and creeks, the area is referred to as the post-closure landform.

The preferred closure scenario, established in this closure plan and discussed in Section 13.3.5 *Landform designs to minimise regional water impacts*, to maintain surface water flows along the major creeks provide a strategic basis for the design of the closure landform. The intention of the design was to prioritise the use of available mineral waste to stabilise the pit walls, strengthen flood bunds and thereby preserves the creek systems as far as practicable.

The landform design for Yandicoogina, presented in Figure 18, followed sustainable development principles and established management practices (as discussed in Section 12 *Land*), considered different stakeholder / environment needs and the post-closure land-use options. Key drivers for the design of this post-closure landform were, in order of priority:

- safe, stable, non-polluting landforms;
- preservation of creek ecosystems, including riparian habitat;
- minimum impact to surface water flow paths, volumes and levels;
- achieving the lowest lake water salinity, preferably stock drinking water quality (4000mg/l) or lower; and
- minimum rehandle of mineral waste.

The post-closure landform will continue to evolve as the mine develops and as closure related studies identify new issues, conflicts and solutions.

In previous closure plans, for example, preserving groundwater quality was perceived to be the most important issue. To achieve stock drinking water qualities or better in post-closure pit lakes, options were investigated that diverted flood events into the pit voids. This had the effect of reducing the magnitude of flood events downstream, if not terminating flooding all together.

In 2012 it was discovered[169] that the Fortescue Marsh is a surface water dependent system which relies on flood events from its contributing creeks, including Marillana Creek and Weeli Wolli Creek, to stimulate the freshening sequence of its saline lake water and alleviate stress in the fringing vegetation. With this understanding, preservation of the flood regimes of the local creeks is now viewed as more important than the preservation of groundwater quality. Thus the post-closure landform has been modified to accommodate the evolving knowledge and understanding of the neighbouring ecosystems and their ecosystem services.

[169] Skrzypek G, Dogramaci S, Grierson PF (2013) Geochemical and hydrological processes controlling groundwater salinity of a large inland wetland of northwest Australia. Chemical Geology 357 (2013) p164-177.

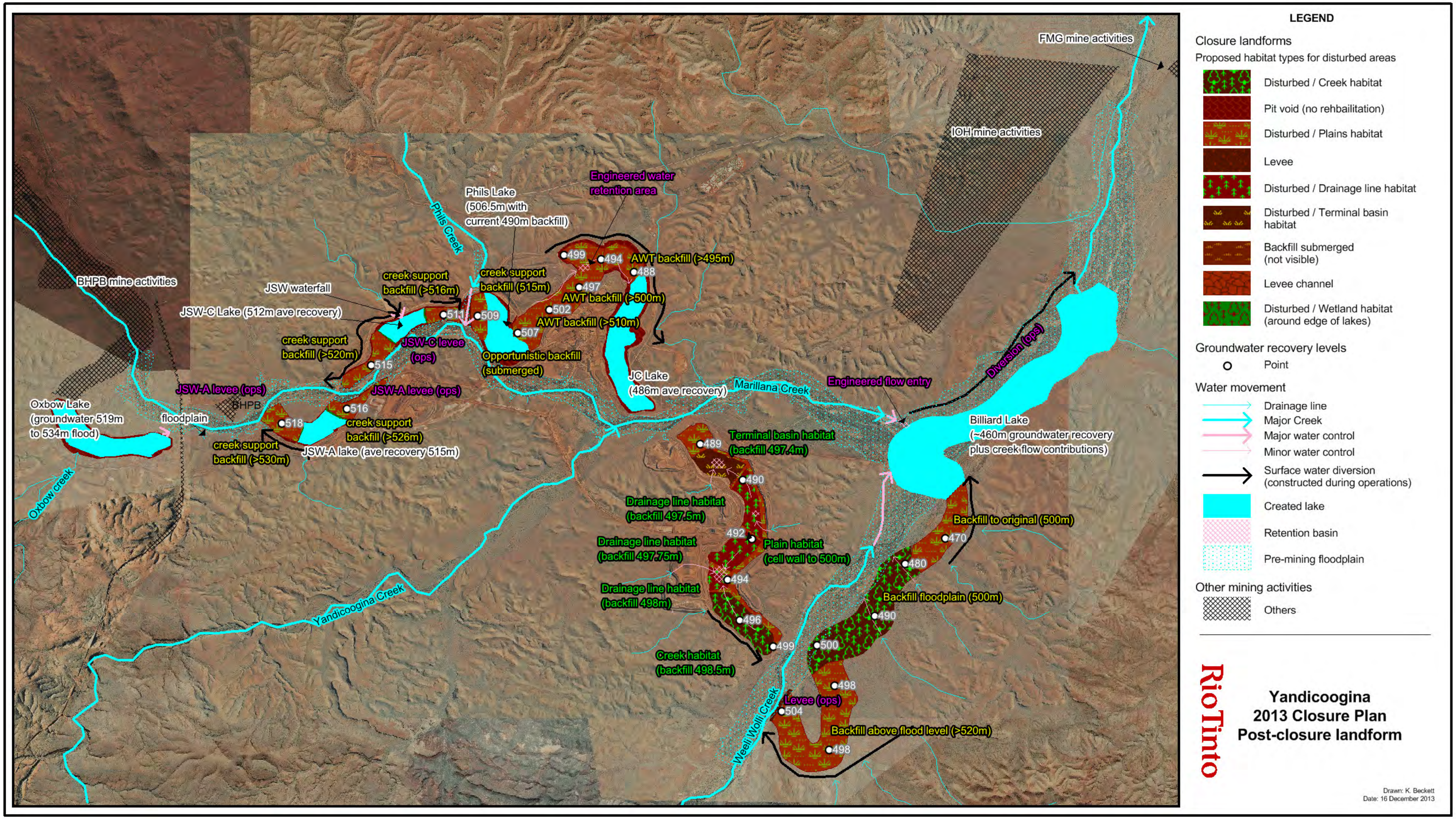

Figure 18: Post-closure landform.

20.1 Landform stability

Key characteristics to achieving landform stability in the post-closure landform include:

- Introduction of mineral waste buttresses to support pit walls located adjacent to creeks, as illustrated in Figure 19. These areas of the pit are backfilled to the same height as the land adjacent to the creek.
  - Where mining intersects the flood plain on Marillana Creek the levee is left in place and material is backfilled to the height of the levee. Note the Marillana Creek levees will not be removed at closure. However, there is insufficient material available to backfill the length of the JSW-C deposit, resulting in a pit lake towards the centre of JSW-C deposit.
  - In Weeli Wolli Creek, this approach includes a preference to backfill to reinstate the floodplain wherever sufficient capping material and mineral waste exists.
- Rehabilitation and landscaping of in pit waste dumps. The in pit waste dumps will form two of the four sides of each pit lake. Landscaping of the waste dumps incorporating waterway design techniques will be required to help stabilise the edge of the lakes and to ensure runoff from the in pit catchments and neighbouring hills is conveyed to the lake areas with the minimum of erosion.
- Construction of engineering solutions at points where creek flows enters and exits the pit lake in Weeli Wolli Creek.
- Construction of engineering solution at Phil's Creek land bridge, which accommodates land subsidence and groundwater through flow.

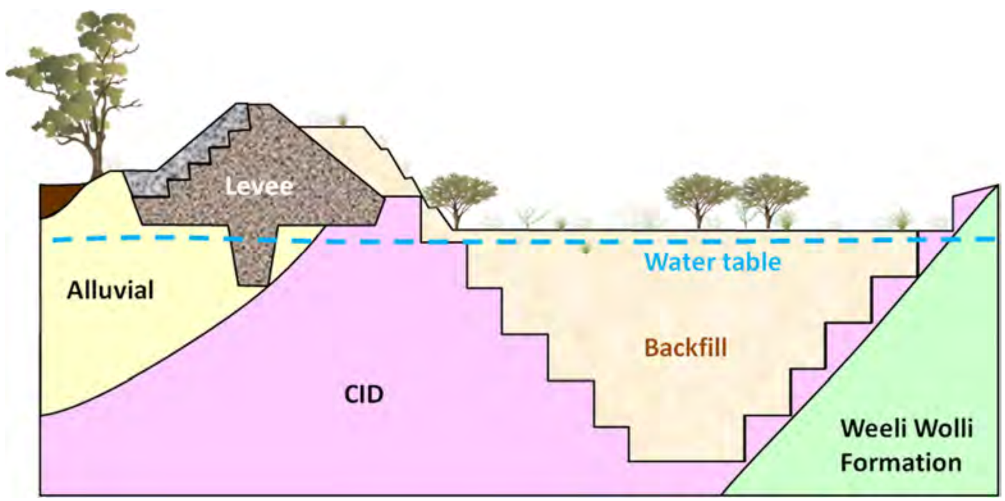

Figure 19: Schematic representation of backfill supporting the pit wall adjacent to a creek.

20.2 Preservation of creek ecosystems, including riparian habitat

Actions integrated into the closure landform design to preserve the creek ecosystems include:

- Minimising disturbance of the existing creek systems.
- Limiting interaction between the existing creek systems and the former mine area.
  - Where creeks systems interact with the former mine area, engineering controls are required to control erosion.
- Modifying the landform to increase groundwater recovery levels and improve groundwater quality
  - Modelling suggests water levels from Oxbow to the west of JC lake will recover to (approximately) pre-mining levels.
  - By creating a pit lake in JC which acts as the lowest groundwater level, modelling suggests water will be drawn from the Weeli Wolli Creek aquifer into the Marillana Creek aquifer. This will prevent saline water from moving through the alluvial aquifers downstream of the JC – JSE crossing, thereby improving groundwater quality in the riparian community.

20.3 Impact to surface water systems

Actions integrated into the closure landform design to minimise impact to surface water include:

- Minimising disturbance of the existing creek systems.
- Limiting interaction between the existing creek systems and the former mine area.
  - Flood water is not syphoned from the creek system to "flush" pit lakes.
  - Creek systems adjacent to the creek are supported, as far as practicable, to prevent the creek from being captured by the pit lake.
  - Interactions limited to Oxbow, JSW-C (following the eventual collapse of the levee into the void at some undefined time in the future), and across the Billiards North deposit.
- Where creeks will intercept pit lakes the surface area of the lakes have been minimised, such that the smallest volume of water possible is needed to cause the lake to flood and allow surface water flows and floods to continue.
- Backfill and rehabilitation to re-establish a flood plain across of the parts of the Billiards South deposit.

20.4 Lake water quality

Actions integrated into the closure landform design to manage lake water quality include:

- Minimising lake surface areas to reduce evaporation.
- Using engineered control structures to minimise erosion where the lakes intersect creeks.
- Rehabilitation of in pit backfill areas to reduce erosion and subsequent sediment loads into the pit lakes.
- Consideration of the revegetation requirements for the lake / wetland fringe.

20.5 Rehandle of mineral waste

Actions integrated into the closure landform design to reduce the volume of mineral waste that will need to be moved (reclaimed / rehandled) during decommissioning include:

- Optimisation of the closure landform to the availability and proximity of mineral waste and its material characteristics.
- Integration and alignment of the closure plan into the Yandicoogina life of mine planning process.
- Communication of the closure plan to the Yandicoogina site personnel to improve understanding of the closure plan requirement, and to identify opportunities to reduce closure costs and improve closure outcomes.

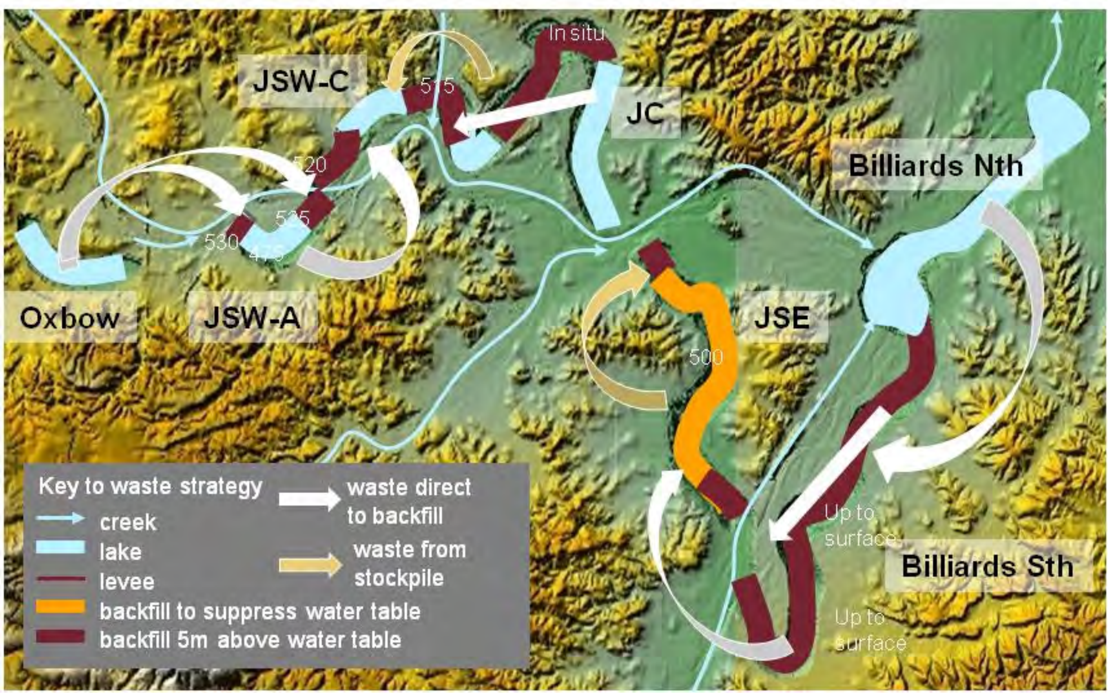

Figure 20: Yandicoogina mineral waste proposed rehandle / reclamation strategy.

21. Anticipated closure outcome

The current closure approach employs a combination of in pit backfill during the mine life and reclaiming mineral mineral waste, such as overburden alluvial material temporarily stored outside the pit, to create a closure landform. Mineral waste is preferentially placed against pit walls that are adjacent to creeks, to stabilise the walls and prevent the creek from collapsing into the void post-closure.

Areas disturbed by mining activities, including backfill areas, will be rehabilitated appropriate to the desired habitat characteristics. Surface water, ie runoff, will be managed in a manner sympathetic to that habitat. Habitat requirements for species of biodiversity value will be integrated into the rehabilitation design where appropriate.

Pit lakes have been acknowledged as permanent features of the closure landform. The closure landform has been designed to minimise the future lake surface area. This will reduce evaporation and thereby reduce groundwater / lake salinity, reduce the potential for alkaline water conditions (which lead to metal mobilisation) to develop and increase groundwater recovery levels. This is expected to lead to better groundwater conditions within the adjacent alluvial groundwater aquifers that support groundwater dependent ecosystems.

The lake fringe will be a dynamic environment due to the strong links between creek flows and the groundwater that will sustain the lakes. As the creeks flood, water is expected to move quickly through the creek bed alluvium to recharge the groundwater systems and linked lakes. The rapid recharge will cause the lake water to rise (whether the lake is located in a creek or not) flooding the lake fringe and vegetation. This type of dynamic environment is common in wetlands. Accordingly, the characteristics that define a stable landform, such as erosion rates, will differ along the lake fringe from those used to define normal rehabilitation success.

Water quality will vary from lake to another, depending on how the lakes source their water and the hydrological regimes that develop. Unfortunately, due to the complexity of the creek, existing computer programmes used to model groundwater and lake interactions struggle to accurately predict how water will move and how water quality may change, at spatial and temporal scales that enable environmental impacts, especially to the groundwater dependent ecosystems, to be conclusively resolved at this stage of planning.

Current modelling suggests groundwater levels adjacent to Oxbow to the west of JC should recover to approximate pre-mining levels, and to within 5m of pre-mining conditions at the JC lake. Both the Oxbow and JC lakes will act as sinks, that is, most of the water entering these voids will leave via evaporation. As a result, Oxbow, which will receive groundwater via the CID aquifer connected to the BHPB Yandi deposits, will become saline (over 1500mg/l) within the first 20 years after mining and continue to increase over time.

Oxbow lake is expected to trap the solutes concentrated within the CID due to upstream mining activities. Modelling suggests, instead, the groundwater in the CID downstream of Oxbow will be recharged via creek flow infiltration and the alluvial aquifers. This fresher groundwater source will be subject to ongoing evapoconcentration as it moves from JSW-A lake through to JC lake.

Mining activities will not interfere with the hydrological regime of Marillana Creek. As such the creek is expected to continue to function without assistance.

The creation of Billiards lake, within the Billiards North mine void (positioned across the current flow path of Weeli Wolli Creek), will capture small flow events, reducing the low flow (<2 year ARI) flood frequency down Weeli Wolli Creek. The impact of this reduction will need to be investigated in combination with the cumulative impacts of multiple mining companies (IOH and FMG) at the entrance to the Fortescue Valley. However, as the groundwater table is very near surface at this location, the volume of water required to cause the lake to overtop is relatively small. As a consequence the larger floods, which support the ecosystems at Fortescue Marsh, are expected to be maintained.

Identification and management of closure issues

Rio Tinto Iron Ore has undertaken an evaluation of issues that may apply to closure of the site. This section outlines how this process was conducted and its outcomes. It then documents proposed strategies for the management of key issues.

22. Closure issues

22.1 Issues identification and evaluation process

Rio Tinto Iron Ore has identified several issues that require consideration when planning for closure of its Pilbara mining operations, including:

- closure landform stability;
- acid and metalliferous drainage (AMD);
- surface water;
- pit lakes and groundwater;
- management of hazardous wastes;
- biodiversity;
- visual amenity;
- cultural heritage;
- impacts to local communities
- decontamination
- communication and consultation; and
- other issues that may be relevant at a specific site.

The process for evaluating and managing issues is as follows.

1. Identify work undertaken to understand each issue specific to the site. Review baseline studies, stakeholder consultation, learnings from work undertaken at other sites, research, impact assessment studies, etc.
2. Identify controls in place to manage each issue, including inherent controls, management plans and procedures, commitments.
3. Document the current knowledge for each issue.
4. Determine what further actions are needed to understand the issue or improve closure outcomes.
5. Update actions in the closure task register.

22.2 Evaluation and management summary

Closure issues for Yandicoogina were re-evaluated at a workshop conducted with technical and operational representatives from across the business in June and August 2013. Issues were discussed with respect to achieving the closure landform, presented in Figure 18 and discussed in Section 20 *Post-closure landform*.

The current status of closure issues for Yandicoogina are summarised in Table 14. The tasked identified to support issues are discussed in Section 23 *Closure tasks*.

The progress of the tasks will be evaluated annually, and the issues re-evaluated prior to the next closure plan update and / or following any substantial changes to the mine plan (ie due to unexpected or temporary closure, failure to gain approval to mine expansion areas).

A detailed issues identification and evaluation process will be employed during the development of the decommissioning plan to address implementation actions.

Table 14: Current status of closure issues.

Aspect	Assessment and management summary	Status
Closure landform stability	• All waste planned to be returned to mine voids • Need to stabilise new Phil's Creek landbridge and pit wall sections in / adjacent to creeks • Stability of waste on pit lake fringes unresolved	Ongoing investigations
AMD	• Low risk of acid drainage • Alkalinity increases from evapoconcentration of groundwater could affect mobilisation of trace elements in mineral waste	Ongoing investigation
Hazardous waste	• Fibrous minerals low risk for this site • No other hazardous wastes identified • Management plan in place if fibrous materials or other hazardous wastes are encountered	Managed
Water	• Surface water flow regimes influenced by post-mining landform design • Groundwater system recharged by creek flow • Pit lakes directly connected to groundwater system • Water levels and quality influenced by landform design • Cumulative impact of mining could alter outcomes • Impact to environmental and cultural heritage values unresolved	Ongoing investigations
Biodiversity	• No impact to conservation status of any flora or fauna species, populations or fauna habitat • Rehabilitation techniques for new habitats (evaporation basins and permanent deep lakes) is untested • Habitat requirements for biodiversity values not fully resolved • Need to extend invasive management strategies to address closure aspects	New and ongoing investigations
Cultural heritage	• Cultural heritage sites and values need to be maintained post-closure • Interaction and impacts of post-mining landform to / on cultural heritage values unresolved • Access through the closure landform noted, but not incorporated into design	Ongoing engagement and investigations
Visual amenity	• Visual amenity linked to and addressed through cultural heritage • Will be reassessed prior to closure	Managed
Local communities	• 100% FIFO site with minimal community impact • Will be reassessed prior to closure	Managed
Contaminated sites	• Full assessment will be undertaken as site approaches closure	Managed
Consultation	• Undertaken within a broader consultation framework, with closure-specific consultation undertaken when issues arise	Ongoing engagement

Note: Rio Tinto Iron Ore maintains integrated systems to manage environmental and social risks, and these will continue to be used until relinquishment.

23. Closure knowledge gaps

The following closure tasks have been identified for Yandicoogina. These tasks describe activities that are required to ensure successful closure of the Yandicoogina mine. The tasks include knowledge gaps where additional research, study or monitoring is required, as well as situations where standard Rio Tinto Iron Ore management practice may not address all of the hazards at the site.

The closure task list excludes activities that are part of standard operating procedures and excludes activities undertaken as a normal component of a decommissioning study. These tasks are excluded from the list as existing controls adequately manage these aspects.

23.1 Closure landform

As described in Section 12.2 *Mineral waste characterisation*, most of the mineral waste is characterised as highly erodible. The challenges associated with managing highly erodible waste are reduced by utilising, where ever possible, mined out void to store waste during operations and the return of waste to the void during closure. In addition, as discussed in Section 12.3, design recommendations for the rehabilitated landform (Table 7) have accounted for the erodibility properties of the material.

It is recognised, however, that additional erosion management, ie capping material, may be required in locations that receive surface water runoff or creek flows. Management of these aspects will be guided by waterway design principles, as discussed in Section 12.3 *Landform design*. Detailed hydrological and engineering assessment will be undertaken during the decommissioning study to design structures, sympathetic to the natural environment, to control erosion. In addition, the material inventory for the site will be expanded to identify potential capping materials for the purpose of water management.

Walking tracks will be required through the Yandicoogina area to facilitate Traditional Owner land-use requirements, eg to access to repatriated cultural artefacts. Due to the high potential for tracks to erode or cause erosion, detailed landscape design studies during the decommissioning study will be undertaken to ensure the tracks do not facilitate additional erosion of built structures.

Historically, mining at Yandicoogina has minimised interactions with creek systems. The Yandicoogina life of mine plan, on which this closure plan is based, anticipates mining activities to occur closer to and within some the flood plain of major creeks.

Investigations are currently underway to review the geotechnical stability of the geology left in situ adjacent to the creeks, to understand how to best construct mineral waste pillars / buttress that will be used to stabilise pit walls adjacent to creek systems and to return Phils Creek to its original alignment.

The closure landform recommended in this closure plan relies on the use of mineral waste generated through the mining of areas yet to be approved by Government (ie the Billiards expansion deposits) to stabilise creek systems and achieve a closure landform that minimises evapotranspiration. Contingency plans for alternative landform configurations are discussed in Section 30 *Unexpected closure.* Closure issues and tasks have not been identified for these contingency options, however, closure issues and tasks will be reviewed and investigated when there is a reasonable expectation that an alternative landform configuration will need to be enacted.

Closure landform actions for closure task list

Ref	Action	Indicative commencement
YA-5	Undertake detailed hydrological and engineering assessment to design erosion control structures	As appropriate, prior to decommissioning
YA-39	Review the geotechnical stability and design requirements for creek supporting structures	Ongoing
YA-35	Identify sources of backfill material and capping material to achieve closure landform	Ongoing
YA-36	Consider the landscape design requirements for the repatriation of cultural use into the closure landform	As appropriate, prior to decommissioning

Ref	Action	Indicative commencement
YA-9	Develop (and maintain) a progressive rehabilitation schedule.	Ongoing
YA-1	Confirm that the mine plan and schedule can deliver a closure landform that aligns with closure objectives	Ongoing

23.2 Acid and / or metalliferous drainage (AMD)

As described in Section 12.2 *Mineral waste characterisation*, studies indicate that the risk of acid rick drainage is low. However, recent investigation into the effect of evapoconcentration processes on Yandicoogina groundwater (Section 13.3 *Water systems after closure*) showed there is the potential for alkaline water conditions to affect mobilisation of trace elements.

Further investigations are required to determine if any problematic trace elements are present in natural background water and / or could be desorbed / released under future water conditions. Further studies may also be required to determine the frequency of potential water quality issues and the interaction with the local environment.

Acid and metalliferous drainage (AMD) actions for closure task list

Ref	Action	Indicative commencement
YA-29	Undertake alkaline leach tests on Yandicoogina mineral wastes	Commended 2013
YA-30	Undertake geochemical modelling with groundwater chemistry to understand additional salt loads and other pit lake water chemistry	After indicative acceptance of post-mining concept from stakeholders (~2015)

23.3 Water

The hydrology of the creeks in the Yandicoogina area is well understood, as described in Section 13.1 *Pre-mining water conditions*. Data will continue to be collected during operations to verify and improve our understanding of surface and subsurface water interactions within the creeks. Mining through Phils Creek, for example, is expected to provide an opportunity to verify the geometry of the alluvial systems used in various models, as well as providing an opportunity to validate preferential flow movement along and between layers exists within the alluvial aquifer.

The process of mining the Yandicoogina CID will not produce enough mineral waste to backfill the areas excavated below the water table. As a consequence the closure landform must incorporate pit lake(s).

As discussed in Section 13.3 *Water systems after closure*, the quality and levels of the lake and groundwater systems evolve differently under different closure landform designs; such that the recommended landform design has been selected in consideration of these properties. It is expected that the closure landform design will be refined through stakeholder feedback and in consideration of mine activities, evolving knowledge and monitoring data. Further monitoring and modelling is required to resolve the water quality evolution within the lakes and to continue to refine the groundwater model (including surface and groundwater interactions). Opportunities to enhance the recovery of the groundwater will be investigated.

The cumulative effects of mining in the Weeli Wolli catchment and the influence of climate change are poorly understood with respect to the changes to water conditions after closure. This situation is mainly driven by regional unknowns, ie what other mines will develop, when will they develop, what impact will they have on the environment and how will their changes affect water quality and quantity. Within the existing modelling, a basic assumption for increased groundwater salinity has been used as an input, based on published literature. However, this condition is not expected to accurately reflect post-mining or climate changes to water quality, and will need to be reviewed and revised as further literature becomes available.

During the modelling processes it was noted by water modelling experts that it is not possible to simultaneously model the water quality and level information using normal commercial software. This is due to the complexity of the surface water, groundwater and multiple lake interactions at Yandicoogina combined with the size of the model and (grid) resolution at which environmental impacts should be assessed. To achieve the current results an array of different water model programmes have been employed. It is anticipated that as technology improves, more advancements in water modelling software will improve modelling capabilities.

In the current closure landform, Billiards lake is the only pit lake that will capture and release flood water to the environment. As a consequence, Billiards lake has the greatest potential to influence or impact the environment downstream. (Although it is noted that proposed mining of the FMG Nyidinghu mine downstream of the operation will also substantially influence, change and / or impact the downstream environment.) Current understanding suggests the water quality will be fresh and the lake regularly flushed, preserving the flood regime to Fortescue. However, it is recognised that more detailed studies are necessary confirm the current understanding and provide more detail on local environmental outcomes and potential influences / impacts on cultural heritage value.

Water actions for closure task list

Ref	Action	Indicative commencement
YA-37	Review the behaviour of Phil's Creek during mining to understand the amount of leakage.	During mining of JSW-C deposit
YA-40	Identify opportunities to enhanced aquifer recovery	Ongoing
YA-32	Undertake drilling to develop an improved hydrogeological conceptual model that covers areas relevant to the closure plan	As appropriate, prior to decommissioning
YA-33	Undertake programme (ie drilling) to develop a better understanding of surface water and groundwater interactions	As appropriate, prior to decommissioning
YA-30	Undertake geochemical modelling with groundwater chemistry to understand additional salt loads and other pit lake water chemistry	After indicative acceptance of post-mining concept from stakeholders (~2015)
YA-31	Confirm groundwater and pit lake quality, and how the water quality will change over time.	As appropriate, prior to decommissioning
YA-34	Review the available water balance model technology to enable improved prediction of pit lake water levels	Ongoing
YA-19	Assess the impacts of seasonal flushing of channel / lake water downstream on vegetation and fauna (towards Fortescue Marsh) during periods of heavy rainfall (including floods)	Due to commence after 2017
YA-27	Consult with the traditional owner group regarding specific water values.	Due to commence after 2017

23.4 Biodiversity

The closure landform will include wide variety of habitats, ranging from cleared areas without rehabilitation inside the pit voids to backfilled and rehabilitated land above the water table and will introduce new water-related habitats to the Yandicoogina area.

Standard landform design and revegetation practices, as discussed in Section 14 *Biodiversity*, are considered sufficient to maintain an appropriate degree of biodiversity post-closure in areas that will be revegetated for non-water related habitats. However, Rio Tinto Iron Ore has limited experience in rehabilitating habitats associated with water. Research programmes and rehabilitation trials are underway and are expected to be completed prior to decommissioning to provide informed instruction for water related habitats. These studies include the influence / impact of water quality variability on the riparian and groundwater dependent species, and the impact of Billiards floodplain reconstruction and lake formation on the Weeli Wolli Creek and Fortescue Marsh ecosystems.

Similarly, as discussed in Section 14.3 *Vegetation*, studies are ongoing to integrate Priority flora species into rehabilitation programmes. Studies are also planned to address gaps with respect to the Northern Quoll and Pilbara Olive Python habitat requirements for rehabilitation programmes.

It is hypothesised that stygofauna populations may be impacted by changes to groundwater quality, as a consequence of regional mining activities and climate change. A study has been proposed to review the impact of closure of the Yandicoogina operations stygofauna populations and to identify any potential mitigation strategies that may be implemented as part of rehabilitation programmes.

As stated in Section 14.4 *Revegetation*, the invasive species management plan will also be updated prior to decommissioning to reflect the closure conditions.

Biodiversity actions for closure task list

Ref	Action	Indicative commencement
YA-13	Undertake research to improve knowledge of rehabilitation of (riparian environments) new landforms / habitats, including the best methods for restoration of Pilbara creek line habitats.	Due to commence in 2014 / 2015
YA-14	Investigate how to balance the requirement to apply topsoil on channel banks to enable vegetation establishment with short-term erosion management goals	Due to commence after 2017
YA-38	Undertake rehabilitation trials for different landform and substrate types	Due to commence after 2017
YA-15	Establish faunal reference sites, and commence monitoring faunal assemblages	Underway
YA-12	Assess impacts of closure implementation on stygofauna populations.	Underway
YA-10	Research Northern Quoll habitat requirements to enhance habitat potential in final landforms.	Due to commence in 2014 / 2015
YA-11	Research Pilbara Olive Python habitat requirements to enhance habitat potential in final landforms.	Due to commence in 2014 / 2015
YA-17	Assess the ability of pit lake water to sustain aquatic flora and fauna, and support other species	Due to commence after 2017
YA-18	Assess the impacts of closure implementation on groundwater dependent vegetation	Due to commence after 2017
YA-19	Assess the impacts of seasonal flushing of channel / lake water downstream on vegetation and fauna (towards Fortescue Marsh) during periods of heavy rainfall (including floods)	Due to commence after 2017
YA-38	Extend the invasive species management plan to address closure conditions	At decommissioning

23.5 Cultural heritage

As discussed in Section 15.1, mining activities and by extension closure actions, often occur in close proximity to areas of cultural significance to Traditional Owners.

Archaeological and ethnographic surveys continue across Yandicoogina as needed to identify and catalogue important features and salvage artefacts (where appropriate).

The extensive cultural heritage work associated with the expansion of the site has constrained engagement on closure with Traditional Owners, and it is recognised further consultation and engagement is required to ensure Traditional Owners values are respected and integrated (where appropriate) into the closure plan.

Cultural heritage actions for closure task list

Ref	Action	Indicative commencement
YA-21	Update the Yandicoogina Cultural Heritage Management Plan (to include closure strategies) and implement it as a working document.	Ongoing
YA-23	Undertake a gap analysis to identify areas requiring heritage survey and areas of significance which should be avoided and managed.	After indicative acceptance of post-mining concept from stakeholders (~2015)
YA-24	Undertake as required heritage surveys (ethnographic and archaeological) with the traditional owners.	Ongoing
YA-25	Continued consultation and information share with the traditional owner groups regarding the proposed mine closure plan, including repatriation of cultural material.	Ongoing
YA-27	Consult with the traditional owner group regarding specific water values.	Due to commence after 2017

23.6 Other stakeholders

It has been noted with regards to several aspects of closure that the cumulative effects of mining within the Weeli Wolli catchment and their respective closure landforms could have unforeseen consequences for the closure success at Yandicoogina. At present no formal, legal avenues exist to share information with mining competitors operating in the Pilbara regarding their anticipated closure outcomes and impacts on the environment. As a consequence inputs into the closure plan are limited to externally published reports generated through, for example, public environmental reviews.

Rio Tinto will continue to investigate legal processes and opportunities to share data and information on environmental matters relating to the Weeli Wolli Creek catchment with the aim of reducing closure issues and improving closure outcomes.

Other actions for closure task list

Ref	Action	Indicative commencement
YA-7	Consult with BHPBIO to ascertain compatibility of closure strategies with the BHPBIO Yandi mine and Marillana Stations (owned by BHPB)	Ongoing

Development of completion criteria

24. Completion criteria

Completion criteria are the checklist by which our stakeholders verify the site is presented in a condition suitable for relinquishment. Stakeholder feedback is sought during the mine life so that the completion criteria may be reviewed at each closure plan update, and may be refined accordingly. Stakeholder agreement on the completion criteria is negotiated as part of the decommissioning plan development (commencing 5 years prior to closure).

Rio Tinto Iron Ore recognises that the process of developing criteria needs to commence early in the planning process to enable baseline information to be collected, provide clear performance goals for progressive rehabilitation conducted during the mine's operational phase, and provide sufficient time for measurement methodologies and technologies to be developed, reviewed and agreed with stakeholders. Developing closure criteria early in the planning process also provides some contingency in the event of unplanned closure.

However, completion criteria finalised too early in the mine life may no longer be appropriate at the point of closure because:

- mine plan changes could have significant impacts on closure strategies and outcomes;
- the closure knowledge base can be expected to improve;
- stakeholders and stakeholder expectations may change; and
- environmental and social values, on both a local and regional level, may change (eg due to impacts of climate change, changes to post-mining land use etc).

For these reasons, completion criteria need to be viewed as an evolving process, and criteria developed early in the mine life should be considered indicative only. Significant changes already made to completion criteria for Yandicoogina have been associated with the formation of pit lakes, which were introduced to the closure landform design as part of 2005 JSE mine proposal.

Table 15 lists the indicative completion criteria for each Yandicoogina 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 15. 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.

The final, agreed completion criteria are expected to contain significantly greater detail than the indicative completion criteria.

24.1 Landform stability

The objective for Landform Stability is: *Rehabilitated landforms are stable and designed to manage floodwater appropriately.* Closure landforms need to remain stable through future extreme climates events and floods, be safe to humans and animals, and compatible with the post-mining land-use.

The current indicative completion criterion "e*rosion does not threaten the long term stability of the landform*" reflects a commitment to constructing and rehabilitating stable landforms. This commitment will be refined when sufficient physical field measurements from rehabilitated areas are available to review with stakeholders.

Management practices and construction activities to achieve stable landforms, including flood management and waterway design, have been integrated into the operating and closure planning processes, as described in Section 12 *Land*.

Monitoring of rill and gully frequency and gully depth and width will be undertaken on final landform designs to better understand the thresholds for landform stability. It is proposed that completion criteria success be measured via visual and measured assessment of erosion from rehabilitated areas for comparison of trends.

A few rehabilitated structures will be located within floodplains of the major creek systems. Erosion modelling to demonstrate the performance of these structures is proposed to be used as a measure of completion criteria success.

24.2 Water features

Three water related objectives have been agreed at Yandicoogina, highlighting the importance of water management to Yandicoogina and the wider Weeli Wolli catchment. The first objective is: *The environmental and cultural heritage values associated with creek flows and function are maintained post-closure*, taking into account any changes that may naturally occur as a result of climate change.

To achieve this objective, flow and flood events along the Weeli Wolli, Yandicoogina and Marillana creek systems and into the Fortescue Marsh must continue at a level, frequency and quality that ensures retention of ecological function and continued provision of areas for camping, ceremonies and other cultural activities. However, it is recognised that the impact of cumulative mining activities outside of the Yandicoogina operation and climate change may inadvertently alter the creek systems beyond its current function, and these changes will define new flow and flood event "normal" conditions.

The current indicative completion criterion "s*urface water remains at a level and quality that ensures retention of ecological function and cultural value*" reflects a generic commitment to the management of creek systems. This criterion will be refined following stakeholder engagement on the final landform design, which will influence the final creek system alignment, flow frequency and quality characteristics.

Section 13 *Water* identifies the environmental and cultural heritage values related to creek systems that have been identified at Yandicoogina and the proposed management processes. Creek system (riparian zone) restoration and stabilisation has been integrated into the operating and closure planning processes, as described in Section 12 *Land* and will be addressed in detail during progressive rehabilitation and / or decommissioning study phases.

A post-closure evaluation of surface water conditions against baseline (pre-mining) conditions and / or reference site trends over time is proposed to demonstrate the values associated with the creek systems have been maintained. The evaluation will be supported by water and weather data collected before mining, during operations and after closure, and supporting photographic evidence (where appropriate) to illustrate the preservation of environmental and cultural heritage values.

The second water related closure objective specifically addresses Fortescue Marsh: *Environmental values of Fortescue Marsh are not compromised*. Fortescue Marsh has been identified by stakeholders as a wetland area of great significance, and listing under the Ramsar Convention on Wetlands has been proposed. Recent studies have identified that maintenance of the flood regimes is a key requirement to preserving the environmental values of Fortescue Marsh, and an aspect that the closure of Yandicoogina could impact.

The current indicative completion criterion "*the frequency of large flood events is maintained at the downstream tenement boundary*" reflects a specific commitment to design a post-closure landform that conveys floodwater through to Fortescue Marsh.

Section 12 *Land* and Section 13 *Water* discuss the strategies and management that have been considered and implemented to achieve this completion criterion. Studies will continue throughout the life of the mine to verify and refine the closure landform to ensure flood conditions at the downstream tenement boundary are maintained beyond closure.

The third water related closure objective is: ***Water quality within pit lakes support natural ecosystems and are compatible with post-mining land use.*** As discussed in Section 18 *Land use*, there are a number of different post-mining land uses for the area, and each lake may have a different post-mining use depending on its proximity to gazetted roads and heritage areas, and potential environmental benefits. Until the post-mining land use is agreed, water quality within the lakes will seek to be compatible with the common surrounding land uses: cultural heritage use, native vegetation and fauna use, and pastoral use.

It is recognised that for pastoral use, water salinity should remain lower than 4500mg/L, the limit for stock drinking water quality. Regional native ecosystems in the Pilbara, however, support a wide range of water salinities from fresh <500mg/L to saline >1500mg/L and very saline (15,000mg/L). While cultural activities relate to water quality through the native, aquatic and riparian, ecosystems they support. Thus, in general, it will be possible to identify a common surrounding land uses for most water quality outcomes.

To support this lake water quality objective two completion criteria have been identified. Following agreement of the post-mining land use it is expected that only one criterion, the most appropriate to post-mining land use, will be used.

The first criterion proposed is: "*Groundwater salinity is not predicted*[170] *to exceed 2,500mg/L at the downstream tenement boundary*". This criterion has been selected to reflect conditions where downstream future beneficial use or downstream environment requirements have a higher (more important) value than the immediate lake area.

The second criterion: "*Lake salinity is not predicted to exceed 4,500mg/L or pH >X"* has been selected for use if lake water is anticipated to provide future beneficial use, ie a water supply or for fishing etc. The undefined pH trigger value has been suggested in recognition that potential metalliferous drainage risks may be more closely linked to pH than salinity.

Both criteria reflect the intent of previous closure plans (1999 and 2005) adapted to reflect the expected closure landform and improved knowledge base.

As described in Section 13 *Water*, water quality, water levels, water flows and the landform design are interlinked, such that changing one factor influences the others. Consequently, several different landform designs have been reviewed and tested prior to recommending the current landform design as the most appropriate for the Yandicoogina area. Ongoing investigations are required to confirm water quality and define the post-mining land use.

Post-closure evaluation of groundwater and /or lake water quality recovery is proposed to confirm the model performs as predicted.

The fourth water related completion criteria addresses environmental aspects known to be sensitive to water conditions*: Alluvial groundwater systems support remnant phreatophytic vegetation.*

The impact on riparian vegetation was a key concern during the approval of the mining operation. Riparian vegetation was predicted to be impacted, with some loss, by dewatering and discharge activities. At closure, recovery and re-adjustment of the remaining (remnant) phreatophtic vegetation is expected as groundwater systems recover.

Following discussion with stakeholders, criteria referring to tree health / death was removed in the 2011 closure plan review, as the closure landform (continuous channel) could not accommodate this expectation. The post-closure landform recommended in this closure plan is expected to achieve this criterion, and in recognition of the importance

[170] The reference to predicted values reflects the fact that equilibrium conditions may not be reached prior to relinquishment.

of riparian systems, the criterion "*Tree deaths more than 2km from the edge of each pit do not result from water quality or drawdown impacts stemming from the post-closure landform*" has been returned[171]. to the closure plan.

In accordance with Ministerial Statement 914 Condition 7-6, the existing Vegetation and Groundwater Dependent Ecosystems Monitoring and Management Plan will continue to be implemented until advised otherwise by the CEO of the EPA. For closure criteria purposes, evaluation of the health of phreatophytic vegetation will be compared to vegetation health post-mining.

However, as discussed in Section 13 *Water* and with the previous water related completion criterion, groundwater levels and water quality at Yandicoogina are sensitive to small changes in landform design and will be influenced by external factors including the cumulative impact of mining and climate effects. External factors will need to be continuously reviewed as part of the closure plan updates to determine if the completion criteria remain appropriate.

24.3 Biodiversity

The objective for biodiversity is*: Final landforms are rehabilitated to be compatible with post-mining land use.* Rehabilitated land is expected to support ecosystem function(s) compatible with the post-mining land use, using local provenance species where practicable and considering habitat needs of native fauna.

Three indicative completion criteria are proposed that reflect generic rehabilitation expectations:

- *Vegetation on rehabilitated land is native and self-sustaining,*
- *Habitat for native fauna is provided in appropriate rehabilitated areas, and*
- *The prevalence of invasive species (weeds, feral animals) is similar to that in nearby reference sites.*

Rehabilitation practices have been developed and are being implemented to ensure that these positive biodiversity outcomes will be achieved through the closure process, as described in Section 14 *Biodiversity.*

24.4 Public safety hazards

The objective to address public safety hazards is simply*: Public safety hazards have been addressed.* Stakeholder interests and post-mining land use will be considered in the identification of public safety hazards and the development of measures to eliminate or mitigate those hazards.

The indicative completion criterion "*Measures to eliminate or mitigate public safety hazards have been agreed with stakeholders and have been implemented*" reflects the commitment to public safety.

This completion criterion will be addressed during the decommissioning study and will include identification of potential hazards to the public in the decommissioned area and audit(s) to confirm that hazard mitigation measures have been implemented, eg removal of access roads to hill pits, abandonment bunds, and contaminated site management.

[171] This criterion was originally proposed in the 2003 Hamersley's Yandicoogina Project Closure Plan.

Table 15: Indicative completion criteria.

Objective	Indicative completion criteria	Indicative process for measurement	Indicative evidence and metrics
Landform stability			
Rehabilitated landforms are stable and designed to manage floodwater appropriately	Erosion does not threaten the long term stability of the landform	Visual and measured assessment of erosion from rehabilitated areas for comparison of trends Post-closure evaluation of long-term erosion due to flooding	Rill and gully frequency Gully depth and width Water monitoring: • volumes, flows, levels • quality / chemistry Weather data and climate trends
Water features			
The environmental and cultural heritage values associated with creek flows and function are maintained post-closure	Surface water remains at a level and quality that ensures retention of ecological function and cultural value	Post-closure evaluation of surface water conditions against baseline (pre-mining) conditions and / or reference site trends over time. Post-closure evaluation of ecological values (vegetation and fauna) against baseline (pre-mining) conditions and / or reference site trends over time.	Photographic evidence that: • a disturbance buffer has been maintained • water is present post-closure Ecological survey(s) to determine: • fauna diversity / richness • vegetation, habitat • tree health monitoring Water monitoring: • volumes, flows, levels • quality / chemistry Weather data and climate trends
Environmental values of Fortescue Marsh are not compromised	The frequency of large flood events is maintained at the downstream tenement boundary	Post-closure evaluation of flood conditions against baseline (pre-mining) conditions.	Water monitoring: • volumes, flows, levels • quality / chemistry Weather data and climate trends
Water quality within pit lakes support natural ecosystems and are compatible with post-mining land use	Groundwater salinity is not predicted[172] to exceed 2,500mg/L at the downstream tenement boundary. OR Lake salinity is not predicted to exceed 4,500mg/L or pH >X.	Post-closure evaluation of groundwater recovery conditions against model predictions. AND / OR Post-closure evaluation of lake water quality recovery conditions against model predictions.	Water monitoring: • volumes, flows, levels • quality / chemistry Weather data and climate trends

[172] The reference to predicted values reflects the fact that equilibrium conditions may not be reached prior to relinquishment.

Objective	Indicative completion criteria	Indicative process for measurement	Indicative evidence and metrics
Alluvial groundwater systems support remnant phreatophytic vegetation	Tree deaths more than 2km from the edge of each pit do not result from water quality or drawdown impacts stemming from the post-closure landform.	Post-closure evaluation of phreatophytic vegetation against post-mining conditions and / or reference site trends over time.	Ecological survey(s) to determine: • tree health monitoring Water monitoring: • volumes, flows, levels • quality / chemistry Weather data and climate trends
Biodiversity			
Final landforms are rehabilitated to be compatible with final land use	Vegetation on rehabilitated land is native and self-sustaining Habitat for native fauna is provided in appropriate rehabilitated areas The prevalence of invasive species (weeds, feral animals) is similar to that in nearby reference sites.	Field vegetation monitoring for comparison of trends Field monitoring of fauna habitat indicators for comparison of trends	Vegetation monitoring including: • Species richness • Species diversity • Percentage cover Records of seed provenance Fauna habitat monitoring (may include): • spinifex cover • shrub cover • evidence of scats/tracks • litter cover • indicator species (e.g. ants)
Public safety hazards			
Public safety hazards have been addressed	Measures to eliminate or mitigate public safety hazards have been agreed with stakeholders and have been implemented.	Identification of potential hazards to the public in the decommissioned area. Audit(s) to confirm that hazard mitigation measures have been implemented.	Reports: • Geotechnical evaluation • Fibrous materials audit • Contaminated sites audit • Electrical safety inspection • Public access evaluation • Traditional Owner cultural access requirements

Financial provision for closure

Rio Tinto considers specifics of the closure cost estimate to be commercially sensitive information. This section outlines the general process used to develop the closure cost estimate.

25. Principles of Rio Tinto closure cost estimation

Closure cost estimates are determined based on methods outlined in the Rio Tinto Closure Standard and the Rio Tinto Accounting Policy. Two closure costs are developed for each site:

- a Present Closure Obligation (PCO) which is indicative of costs associated with closure of the mine given its current footprint; and
- 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 (ie removal of infrastructure)[173];
- final landform construction;
- rehabilitation and biodiversity management;
- heritage management;
- workforce management (ie training costs and redundancy payments)[174];
- monitoring costs;
- costs associated with the development of a Decommissioning 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 Rio Tinto Accounting Policy; and
- a 20% contingency factor[175].

26. Closure cost estimation methods

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 closure cost estimation methodology is based on methods outlined in the Rio Tinto Closure Standard and Rio Tinto Accounting Policy, with the level of accuracy increasing as the site approaches closure[176]. A 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 (usually 3-yearly).

Note that for commercial reasons the actual estimate is not documented in this closure plan.

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[173] The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. The site is sufficiently remote that deconstruction for the purposes of materials salvage and recycling is likely to be cost prohibitive. However; opportunities for salvage and recycling will be sought as the site approaches closure.

[174] Workforce management costs have only been included in the Total Provision Cost.

[175] Costs associated with decontamination are assessed curing closure plan development but are costed separately as they are classifies as operating costs, not closure costs. Separate funds are also allocated to the Rehabilitation and Closure Working Group to undertake research and trials required to improve closure outcomes.

[176] The level of accuracy applied to Rio Tinto Iron Ore estimates is as follows: greater than 10 years from closure: ±30%; between 10 years and 5 years from closure: ±20%; and less than 5 years from closure: ±15%.

Closure implementation

Closure planning occurs throughout the life of the mine. Studies to close gaps in the knowledge base, the implementation strategy for rehabilitation and decommissioning and other closure related activities undertaken by Rio Tinto that inform how closure is implemented are documented in this section.

27. Strategy to achieve closure

Rio Tinto Iron Ore's closure implementation strategy is guided by the Rio Tinto Group Sustainable Development Policy. The Policy aims to contribute to sustainable development by helping to satisfy global and community needs and aspirations, whether environmental, economic or social. This involves making sustainable development considerations an integral part of the Group's planning and decision-making processes, at all stages of a project: concept development, operation and closure.

The closure implementation strategy follows a risk based approach to management and is summarised in the following elements.

1. Technical and practical knowledge base
   - Improve, validate and maintain knowledge to achieve closure objectives
   - Undertake studies and trials to remove knowledge gaps (task list)
   - Stakeholder engagement

2. Closing planning process
   - Integrated life of mine planning and design review
   - Expansion studies
   - Research and improvement activities
   - Regular closure plan updates
   - Preparation of a decommissioning plan five years from closure

3. Progressive closure activities
   - Baseline monitoring
   - Progressive rehabilitation
   - Rehabilitation monitoring

4. Review
   - Closure plan
   - Financial liability
   - Process improvements

27.1 Task list

The issues evaluation process (refer to Section 22) identifies issues that may not be addressed by our standard management processes or where there is insufficient knowledge available to determine if the standard management processes is appropriate. The closure task list (Table 16) summarises the actions, such as studies or trials, identified through the issues evaluation process and any other aspects of the closure planning process requiring attention, ie process improvements, to achieve the closure objectives.

Rio Tinto Iron Ore manages a consolidated register of closure tasks from all of its Pilbara operations in order to enable improved prioritisation and management; ensure adequate, timely resourcing for tasks; and provide a mechanism for reporting progress against the tasks. Actions / tasks and accountabilities are reviewed each year and re-evaluated during closure plan updates.

Actions that are not included in the current closure task list, yet relate to closure, include:

- minor knowledge gaps where current knowledge is sufficiently developed to understand and achieve closure outcomes such that the action will only add marginal or academic value;
- gaps associated with the stage of mine development that will be addressed through current standard management processes and procedures;
- contingency solutions identified as alternative management options if it the current management practice shows evidence that it will not achieve the closure objectives (eg as a results of mine plan changes, evolution of stakeholder expectations etc); and
- activities that will be undertaken as part of the decommissioning study (eg detailed design).

Closure tasks that have been completed and the results integrated into the closure plan are recorded in Appendix E.

Table 16: Closure task list for Yandicoogina.

Issue	Task	Status
Objectives and criteria	Undertake stakeholder consultation to confirm that objectives, completion criteria and measurement tools are appropriate, and revise if required	Ongoing
Ongoing reviews and updates	Review data collected and information developed through the operation life. Use data / information to improve models, interpretations and verify predictions.	Ongoing
Closure landform	Undertake detailed hydrological and engineering assessment to design erosion control structures	To commence prior to decommissioning
	Identify sources of backfill material and capping material to achieve closure landform	Ongoing
	Consider the landscape design requirements for the repatriation of cultural use into the closure landform	To commence prior to decommissioning
	Develop (and maintain) a progressive rehabilitation schedule.	Ongoing
	Confirm that the mine plan and schedule can deliver a closure landform that aligns with closure objectives	Ongoing
AMD	Undertake alkaline leach tests on Yandicoogina mineral wastes	Study underway
Pit lake and groundwater	Undertake geochemical modelling with groundwater chemistry to understand additional salt loads and other pit lake water chemistry	To commence ~2015 Acceptance of post-mining concept from stakeholders required
	Confirm groundwater and pit lake quality, and how the water quality will change over time.	Ongoing
	Identify opportunities to enhance aquifer recovery	Ongoing
	Undertake drilling to develop an improved hydrogeological conceptual model that covers areas relevant to the closure plan	Drill programme underway
	Undertake programme (ie drilling) to develop a better understanding of surface water and groundwater interactions	New programme to commence after 2017
	Review the available water balance model technology to enable improved prediction of pit lake water levels	Ongoing
Surface water	Review the behaviour of Phil's Creek during mining to understand the amount of leakage.	During mining of JSW-C deposit
	Assess the impacts of seasonal flushing of channel / lake water downstream on vegetation and fauna	Due to commence

Issue	Task	Status
	(towards Fortescue Marsh) during periods of heavy rainfall (including floods)	after 2017
Biodiversity	Undertake research to improve knowledge of rehabilitation of (riparian environments) new landforms / habitats, including the best methods for restoration of Pilbara creek line habitats.	Due to commence in 2014 / 2015
	Investigate how to balance the requirement to apply topsoil on channel banks to enable vegetation establishment with short-term erosion management goals	Due to commence after 2017
	Undertake rehabilitation trials for different landform and substrate types	Due to commence after 2017
	Establish faunal reference sites, and commence monitoring faunal assemblages	Project underway
	Assess impacts of closure implementation on stygofauna populations.	Study underway
	Research Northern Quoll habitat requirements to enhance habitat potential in final landforms.	Due to commence in 2014 / 2015
	Research Pilbara Olive Python habitat requirements to enhance habitat potential in final landforms.	Due to commence in 2014 / 2015
	Assess the ability of pit lake water to sustain aquatic flora and fauna, and support other species	Due to commence after 2017
	Assess the impacts of closure implementation on groundwater dependent vegetation	Due to commence after 2017
	Extend the invasive species management plan to address closure conditions	To commence prior to decommissioning
Cultural heritage	Update the Yandicoogina Cultural Heritage Management Plan to include closure strategies and implement it as a working document.	Ongoing
	Undertake a gap analysis to identify areas requiring heritage survey and areas of significance which should be avoided and managed.	To commence ~2015 Acceptance of post-mining concept from stakeholders required
	Undertake as required heritage surveys (ethnographic and archaeological) with the traditional owners.	Ongoing
	Continued consultation and information share with the traditional owner groups regarding the proposed mine closure plan, including repatriation of cultural material.	Ongoing
	Consult with the traditional owner group regarding specific water values.	Due to commence after 2017
Other stakeholders	Consult with BHPBIO to ascertain compatibility of closure strategies with the BHPBIO Yandi mine and Marillana Stations (owned by BHPB)	Ongoing

27.2 Closure domains

Rio Tinto Iron Ore uses closure domains to group areas with common features, rehabilitation and decommissioning requirements at closure. Detailed closure strategies for the rehabilitation and decommissioning of individual closure domains, beyond the current management practices, will be developed during decommissioning studies as part of the Decommissioning Plan. However, aspects that require long term planning, such as top soil allocations / prioritisation and habitat requirements, are identified at strategic level as part of the closure domain implementation strategy.

The closure domains identified for Yandicoogina are described in Table 17. Due to the nature of iron ore mining and the ongoing expansion of mining activities, the closure domains are highly dynamic during the early stages of the mine development and subsequent expansion phases.

Table 17: Yandicoogina closure domains

Domain	Area	Implementation strategy
Pits		
Future lakes	JC lake Phils Creek lake JSW-C lake JSW-A lake Oxbow lake Billiard lake	• Opportunistic backfill only. • Re-establish surface drainage and erosion controls (as required) and manage surface water flow into pit. • Considering surface water requirements, construct abandonment bund (or similar) around the perimetre of exposed high wall, unless bound by steep topography, outside zone of geotechnical instability. • Shrub and/or tree planting at the outside edge of bund to lessen visual impact (where possible). • Identify and implement means to declare public safety risk and restrict public access. • No revegetation undertaken in areas that will be under water.
Backfill to above water table (Includes in pit waste dumps and waste fines)	Junction Central Junction South East Phils Creek landbridge JSW-C west JSW-A east JSW-A west BS-south BS-north	• Backfill ~10m above groundwater recovery level. Shape open faces according to Landform Design guidelines. • If waste fines cells are present, cap with 2m layer of inert waste. • Landscape surface to include surface drainage and erosion controls, as appropriate. • Considering surface water requirements, construct abandonment bund (or similar) around the perimetre of exposed high wall and open faces, unless bound by steep topography, outside zone of geotechnical instability. • Topsoil and mulch spread over the dump surface to a maximum depth of 200mm. Deep rip and seed.
Backfill to floodplain TOP SOIL PRIORITY	BS- central	• Backfill to ~original surface level. • Topsoil and mulch spread over the dump surface to a maximum depth of 200mm. Deep rip and seed to establish flood plain vegetation. • Remove levee and landscape surface to include surface drainage and erosion controls, as appropriate (re-use competent materials from levee). • Complete rehabilitation of disturbed areas.
Waste dumps		
Temporary waste dumps	All external waste dumps and temporary in pit waste dumps ROM pad	• Ensure material requirements for all in pit backfill and non-mineral waste disposal has been achieved. (See Pit domains) • Shape any remaining external mineral waste according to Landform Design guidelines. • Topsoil and mulch spread over the dump surface to a maximum depth of 200mm. Deep rip and seed.
Other mining landforms		
Borrow areas	Borrow pits	• No backfill required • Respread topsoil windrows and stockpiled vegetation onto disturbed area. Deep rip and seed.

Landfill	Landfill sites	• Cap with at least 2m of competent inert material. • Spread topsoil windrows and stockpiled vegetation onto disturbed area. Deep rip and seed.
Infrastructure and utilities		
Infrastructure	Above ground pipes and services Workshops/ admin offices Crushers and conveyors Ammonium nitrate plant Accommodation camp Culverted crossings	• Demolish or dismantle built structures to footing level. Dispose to an appropriate waste site. • Rehabilitate in accordance with the appropriate category of resulting "Disturbance area" (see domains classes below)
Below ground services	Electrical Pipes Bore casings Stormwater Fire services	• Disconnected and remain in situ. • Bore holes excavated 40cm below ground, capped and buried. • Any services brought to the surface during ripping will be collected and disposed of at a waste disposal facility.
Disturbed area – High	Footings Sealed roads and parking areas	• Break up (in situ) footing >5m2 and other similar concentrate areas, cover with 1m of clean waste • Remove footings <5m2, bitumen and bury in suitable location. • Contaminated soil will be land-farmed • Fill holes with inert competent material. Reshape and contour to blend with adjacent relief and drainage. Preliminary ripping if the area is very compacted. • Spread topsoil windrows and stockpiled vegetation onto disturbed area. Deep rip and seed.
Disturbed area – Moderate	Heavy vehicle roads Borefield Drains and creek crossings	• Extensive earthworks and reshaping of non-waste dump areas to either return the area to natural relief or create a compatible landform consistent with the surrounding natural relief and landforms. • Natural drainage lines to be re-established where practicable or redirected to enter drainage system downstream of obstacle. • If the area is very compacted then it may require a preliminary ripping, prior to topsoil, deep rip and seed treatment.
Disturbed area – Low	Laydown areas Unsealed access roads Stockpile areas	• 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 or redirected to enter drainage system downstream of obstacle. • Where top soil has not been removed and compaction is limited to two wheel tracks may be best left to rehabilitate naturally. Other tracks will be ripped or scarified, depending on the amount of compaction present. On slopes, rip parallel to contours.

27.3 Indicative closure timing

Indicative dates for closure activities, excluding on going monitoring, by closure domain is presented in Table 18.

Table 18: Indicative timing of site domains

Domain	Areas	Indicative completion date
Future lakes		Progressively as areas available and at cessation of mining
	JC lake	• Commence after 2017
	Phils Creek lake	• Lake groundwater recovery method yet to be determined
	JSW-C lake	
	JSW-A lake	
	Oxbow lake	
	Billiard lake	• Cessation of mining
Backfill to above water table		Progressively as areas available and at cessation of mining
	Junction Central	• Underway
	Junction Central (west)	• Commence after 2022 (linked to JSW-C)
	Junction South East	• Cessation of mining
	Phils Creek landbridge	• Commence after 2015
	JSW-C east	• Commence after 2023 (linked to JSW-A)
	JSW-C west	• Commence after 2024 (linked to JSW-A)
	JSW-A east	• Commence after 2025 (linked to Oxbow)
	JSW-A west	• Commence after 2025 (linked to Oxbow deposit)
	BS-south (pocket)	• Commence after 2031
	BS-north	• Cessation of mining
Backfill to floodplain	BS- central	Progressive rehabilitation during operations, with completion after 2037
Temporary waste dumps	All	At cessation of mining
Borrow areas	All	Progressively as areas available
Landfill	All	Progressive through mine life once capacity reached
Infrastructure	All	At cessation of mining
Below ground services	All	At cessation of mining
Disturbed Area – High	All	At cessation of mining
Disturbed area – Moderate	All	At cessation of mining
Disturbed Area – Low	All	At cessation of mining

28. Progressive closure activities

28.1 Rehabilitation

Rehabilitation is the physical process of restoring disturbed land to a functioning, natural ecosystem. Rehabilitation is conducted in accordance with the Rio Tinto Iron Ore's Rehabilitation handbook[177]. The Rehabilitation handbook addresses:

- soil resource management;
- rehabilitation techniques;
- local provenance species seeding practices;
- records and data management; and
- on-going monitoring.

The Rehabilitation handbook is updated periodically to incorporate information learnt from other rehabilitation projects undertaken in the Pilbara and to reflect changes in industry standards.

The availability of land for rehabilitation is linked to the mine plan, which is dynamic throughout the life the mine. The process at Rio Tinto Iron Ore operations is as follows:

- A rehabilitation schedule and plan project resources are developed from the 5 year mine plan (updated quarterly) which identifies areas available for rehabilitation in the medium term.
- Rehabilitation designs are completed and budgets are allocated for the work.
- On budget approval, rehabilitation designs are finalised and earthworks undertaken.
- Rehabilitation monitoring is scheduled, typically commencing within 1 year of seeding.

No deviations to standard rehabilitation procedures are proposed for Yandicoogina, and implementation will include the following tasks:

- identify areas that have been disturbed during exploration and construction activities that are available for rehabilitation;
- reshape and contour land where possible to blend with natural relief and drainage;
- where available, topsoil will be spread to a maximum depth of 200mm (with fresh topsoil if possible);
- where disturbed areas have become compacted, deep rip to an appropriate depth prior to seeding;
- undertake revegetation activities to ensure a suitable vegetation cover and composition. This may include the application of seed from local species, and signposting to restrict access to rehabilitated areas; and
- record rehabilitated areas on internal GIS databases, and include within the rehabilitation monitoring programme where appropriate.

Where seeding is undertaken, suitable Pilbara provenance seed will be used where available. Site specific seed mixes will be developed and the composition and volumes of seed used will vary between rehabilitation areas. However, seed mixes will comprise seed from species native to the area, with representation from a range of functional groups. Seeding will be carried out by either a dozer-mounted mechanical seeder or by hand.

28.2 Rehabilitation and closure progress

To date, rehabilitation activities have been limited to areas outside of the mine area that were disturbed during the development of the mine, ie rail borrow areas. As presented in Table 18, areas are expected to become available for rehabilitation, at the earliest, after 2017.

The performance of revegetated areas is discussed in Section 14.5 *Progressive rehabilitation activities*.

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[177] Rio Tinto Iron Ore, *Rehabilitation Handbook,* RTIO-HSE-0011608

28.3 Rehabilitation performance and validation

Rehabilitation and closure projects undertaken by Rio Tinto Iron Ore in the Pilbara that have been completed recently, or are currently scheduled, are presented in Table 19. Lessons learnt during these activities and from subsequent monitoring campaigns are used to inform and update our standard management practices and will improve closure outcomes for this site.

Table 19: Rehabilitation and closure implementation projects

Project	Completion date	Description
Marandoo WD1	Completed 2010	Standard waste dump rehabilitation.
Channar 84E5	Completed 2011	Major rehabilitation project over two years involving significant earthworks to achieve final landform specifications.
Dampier open areas	Completed 2011	Landscaping and rehabilitation of open areas for dust control. The project included trialing of several methods to ameliorate poor quality soils, which will be assessed in 2012.
Tom Price MME1	Commenced 2011 Completed 2012	Rehabilitation of a backfilled pit area.
Tom Price TPR1	Commenced 2011 Completed 2012	Standard waste dump rehabilitation.
Eastern Ranges 23E	Completed 2013	Standard waste dump rehabilitation.
West Angelas North and South WD	Completed 2012	Progressive rehabilitation of waste dump sections .
Legacy rail borrow pits	Completed 2013	Standard borrow pit rehabilitation.
Mesa K Gravel Pit South	Completed 2013	Standard waste dump rehabilitation

Recent research projects undertaken to improve closure outcomes across the business are presented in Table 20. Outcomes from these studies have been integrated into the update of management strategies and plans, to validate knowledge base assumptions, and to identify additional areas for further research.

Table 20: Rehabilitation and closure research projects

Research project	Description
Seed Science Programme	2009-2012. Seed research including aspects such as phenology, collection, viability and germination.
Provenance Zones	Ongoing project commenced 2010. Genetic studies are being conducted on a number of key species to identify appropriate provenance zones for subsequent rehabilitation.
Historic Rehabilitation Review	2010-2012. Collation and review of historic rehabilitation data spanning from the 1970's, with data evaluation to continue in 2012.
Review of Internal Final Landform Design Guidelines	2009-2012. Comprehensive erodibility testing has been conducted on mineral wastes present at Rio Tinto Iron Ore group sites, and landform evolution modelling conducted to identify appropriate waste dump designs. The outcomes of previous rehabilitation, including a concave slope rehabilitation project conducted at Nammuldi in 2007, have been used in model validation. The internal *Final Landform Design Guidelines* were revised with outcomes implemented from 2012 onwards. Additional waste sampling and refinement of the guidelines is ongoing.

Research project	Description
Seed Orchard Trial	2011-2013 (ongoing). A trial seed orchard has been established at the Hamersley Agriculture Project (Marandoo), with a view to addressing seed deficits. If successful, the project may be implemented at the Nammuldi agriculture project.
Terrestrial Fauna Colonisation	2011-2012. Campaign fauna monitoring was undertaken in 2011, in conjunction with habitat characterisation. Results were used to develop a habitat assessment tool in 2012.
Geochemical Testing	Ongoing. Static testing to identify AMD risks associated with all mineral wastes present at Rio Tinto Iron Ore group sites has been conducted over many years, with kinetic testing undertaken for high risk wastes. Programmes have been extended to address kinetic testing of additional wastes.
Waste Dump Geochemistry	2011. Physical testing and modelling has been conducted on the NTD2 black shale waste dump at Tom Price to understand geochemical behaviours within the dump. Results will inform management of black shale dumps across the business to reduce the potential for AMD risks
Pit Lake Bioremediation	Ongoing project commenced 2010 in collaboration with Edith Cowan University. Research to identify the potential for bioremediation of acidic pit lakes through the encouragement of sulphur reducing bacteria.
Pit Lake Water Quality Modelling	Ongoing. Rio Tinto Iron Ore has been working in collaboration with several consultancies to develop and improve pit lake water quality modelling tools, both with respect to salinity and acid/metal contaminants.
Pit Void Internal Guidance	2011-2012. Internal guidance documentation is being developed to assist in the determination of whether it is appropriate for pit voids to remain post-closure, or whether backfilling is required. The guidance document is due to be drafted by 2012, and will be subject to stakeholder consultation.
Rehabilitation Quality Metric	2012 Onwards. In 2012 the Rehabilitation Quality Metric (RQM) project was initiated by RTIO’s Rehabilitation Team. The purpose of this project is to develop a repeatable method to compare condition of rehabilitation areas to pre-determined reference sites.
Alternative growth medium	2010. RTIO commissioned a study into the evaluation of mine mineral wastes as an alternative rehabilitation growth medium. This study presented a number of mineral wastes which would be suitable as a surface growth medium in the absence of topsoil

29. Decommissioning

When the site moves to within five years of scheduled closure, a decommissioning plan is prepared. Decommissioning plans are used to direct the physical closure, dismantling and subsequent rehabilitation of the site (excluding progressive rehabilitation undertaken during operations), and include location specific management plans for each closure aspect in each closure domain identified. The Decommissioning Plan builds upon strategies developed in earlier closure plans and details how closure will be implemented.

A decommissioning study is undertaken at this time, to support development of the Decommissioning Plan. Stakeholder engagement and endorsement of the final completion criteria is facilitated at this time. This study also determines how infrastructure, decontamination, rehabilitation, the workforce and communications will be managed throughout the mine closure period, specific to the Yandicoogina site.

Decommissioning is anticipated to commence at the cessation of mining activities, as most areas of the mine, mine equipment and infrastructure will be fully utilised until the end of the mine life. However, as with progressive rehabilitation, opportunities to decommission areas in advance and facilitate progressive rehabilitation will be reviewed through the mine life.

Generic decommissioning strategies have been developed by Rio Tinto Iron Ore for Pilbara iron ore mines to assist in the development of cost estimates and to guide the decommissioning study and process. Some specific details associated with these strategies are described below.

29.1 Infrastructure

The Rio Tinto Iron Ore guidance for the removal of infrastructure in the Pilbara includes:

- a procedure for determining unit rates for infrastructure decommissioning, and how to apply them to Rio Tinto Iron Ore group operations;
- negotiating with the Western Australian State Government before removing infrastructure at closure, in accordance with State Agreement requirements;
- actively investigating opportunities to salvage materials for recycling or reuse as the site approaches closure;
- removing materials that have the potential to be hazardous to the environment or human health from site and disposing in accordance with Western Australian Government Controlled Waste Guidelines;
- completing contaminated sites assessment before removing infrastructure, with remedial action taken, if required to ensure that it is safe to do so;
- demolishing or burying any infrastructure not retained by the State Government on site, or deconstructing to enable recycling or reuse; and
- retaining infrastructure in situ when it is at least one metre below the final ground level, after it has been drained to remove any potentially hazardous materials.

29.2 Decontamination

A contaminated sites register maintained during operations records the location and details of any suspected or known contaminated areas. Used at closure, this inventory identifies sites that require specific decontamination and the measures employed to achieve the required standard.

29.3 Workforce management

A Rio Tinto Iron Ore closure workforce management strategy is currently being drafted, and will apply to all Rio Tinto Iron Ore sites in the Pilbara. The main objectives of the strategy are to:

- provide a framework for supporting employees through closure ;
- ensure that the workforce is engaged and well informed of the sequence of events leading up to closure, including how their roles will be affected;
- ensure that roles are reduced in a smooth and well-timed manner, that enables Rio Tinto Iron Ore to retain the required skill sets until closure;
- ensure a clear, practical and fair set of policies for employees' entitlements is in place at the timing of closure;
- ensure appropriate support systems and processes are developed and in place;
- ensure that line leaders are equipped with the necessary skills and tools to manage the transition process;
- provide input into the workforce closure cost estimation calculation; and
- ensure alignment with Rio Tinto Iron Ore's commitments to the Traditional Owner Agreements and the communities closure commitments.

Site specific implementation plans will be developed as the site approaches closure.

29.4 Communication and consultation

To achieve closure, stakeholder concerns must be acknowledged and managed appropriately. A generic communication and consultation strategy, in relation to closure, is currently under development. This strategy will provide the guidance and direction for stakeholder communication and consultation to support the closure process at Yandicoogina.

A Communication and Consultation Work Practice[178] is currently used to provide the mandatory requirements for effectively managing and facilitating open communication and consultation between employees, contractors, suppliers, customers and external stakeholders, in the area of health, safety, environment and quality. The registers developed to support this Work Practice will be employed to develop the Yandicoogina communication and consultation strategy.

30. Unexpected closure and temporary closure

Whilst Rio Tinto Iron Ore 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 Rio Tinto Iron Ore would continue to operate in the Pilbara and that it could continue to manage closure of its sites. It should be noted that the iron ore group is one group within the global Rio Tinto group of companies, which further mitigates this risk.

It is recognised that this closure plan includes the Billiard expansion deposits that have yet to receive environmental approval to mine from Western Australian regulators. Contingency plans have been considered should mining approval not be received. For example, two options considered for the closure landform are presented in Figure 21 and Figure 22. Mineral waste generated as a consequence of mining the Billiards expansion deposits (Pocket, Billiards South and Billiards North) enable landform stability and potential water quality issues at JSE and Billiards South to be resolved. For this reason, the environmental outcomes that can be achieved, as presented in this closure plan, as a consequence of the development of the Billiards expansion deposits are superior to the environmental outcomes that would result if no further approvals were granted or if only the Billiards South and Pocket deposits were approved for mining.

Figure 21 shows where mineral waste would be placed and the pit lakes that are likely to form if no further mining approvals were granted for the Yandicoogina mine. In this closure landform contingency option, from Oxbow to JC the closure landform remains similar to that as presented in Section 20 *Post-closure landform* with the exception that pit lakes would be introduced at JSE, due to the low volume of mineral waste. These lakes are expected to act as groundwater sinks, resulting in the build up of salts, leading to highly saline lake water and possibly high pH conditions, which could potentially release trace metals into the groundwater and / or fringing vegetation.

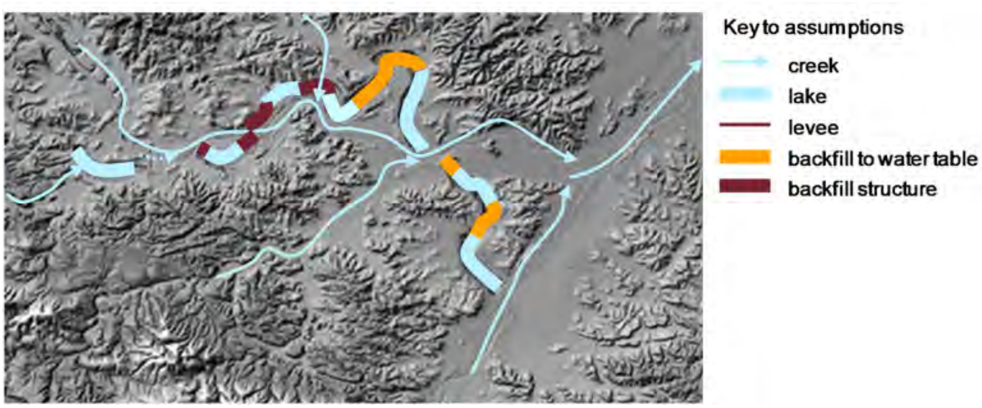

Figure 21: Contingency plan illustrating a closure landform if no further approvals are granted.

Figure 22 illustrates the strategy that would be used if mining approvals is granted only for the Billiards South and Pocket deposits. In this contingency option, additional mineral waste generated through the act of mining the Billiards South deposit is prioritised for backfill into the JSE mine void. From Oxbow to JC the closure landform remains similar to that as presented in Section 20 *Post-closure landform*.

[178] Rio Tinto (2011) Iron Ore (WA) Communication and Consultation Work Practice, September RTIO-HSE-0123681

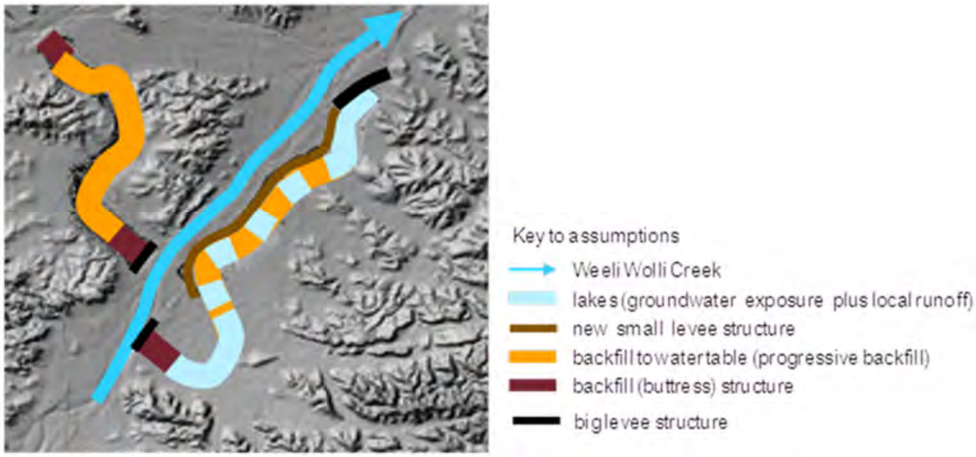

Figure 22: Contingency plan illustrating a closure landform for the JSE and Billiards South areas, if only the southern portion of the Billiard deposit is granted approval to mine.

As a consequence of the low mineral waste volume available, it would not be possible to reinstate the flood plain, as presented in Section 20. Instead, waste would be placed at locations within the mine void, to add strength the pit wall adjacent to the creek.

Figure 23 illustrates how this closure concept could be implemented. In this example, erosion protection is afforded to the landform by creating a small, visually sympathetic levee from the dismantling of the “big levee” that is proposed to be built to divert flood waters during mining operations. Although it is anticipated that some sections of the “big levee” would remain in situ at key locations to minimise early creek capture. The small levee would be designed to maintain the flow of small flood event while protecting the pit wall from erosion as larger event over top the levee and flow into the mine void.

Behind the small levee, the groundwater system is expected to recover to create a series of permanent pit lakes. These lakes will be disconnected from the Weeli Wolli Creek surface water flows for most of the year, but will receive fresh water via rainfall, local runoff from the eastern catchments, infiltration (through the pit walls, due to the exposure of the Weeli Wolli Creek alluvial aquifer in the pit wall), and as a consequence of large flood events overtopping the small levee.

The landform design presented in Figure 23, for example, has been designed to minimise the potential for long term changes to the Weeli Wolli Creek low flow channel and floodway. Events of less than ten year average recurrence interval would be expected to flow without loss of flood volume.

The storage capacity of the void is limited, due to the natural topographic low elevation on the northern end of the Billiards South pit. Thus during very large rainfall and flood events, some of the water stored within the void would be returned to Weeli Wolli Creek. In the example provided, it is estimated that the storage volume (the total potential for loss of water to Fortescue Marsh) would be around five percent of the total flow volume that contributes to a 100 year flood event. Consequently, the flood regime of Fortescue Marsh is not expect to be impacted.

Overtopping of the pit void could result in the flushing of some salts from the Billiards South mine void into the flood waters. The exact quality, quality and impact of the salinity of water will require further study, in conjunction with the landform design, should the need for unexpected closure of the Yandicoogina mine be triggered following development of the Billiards South mine area.

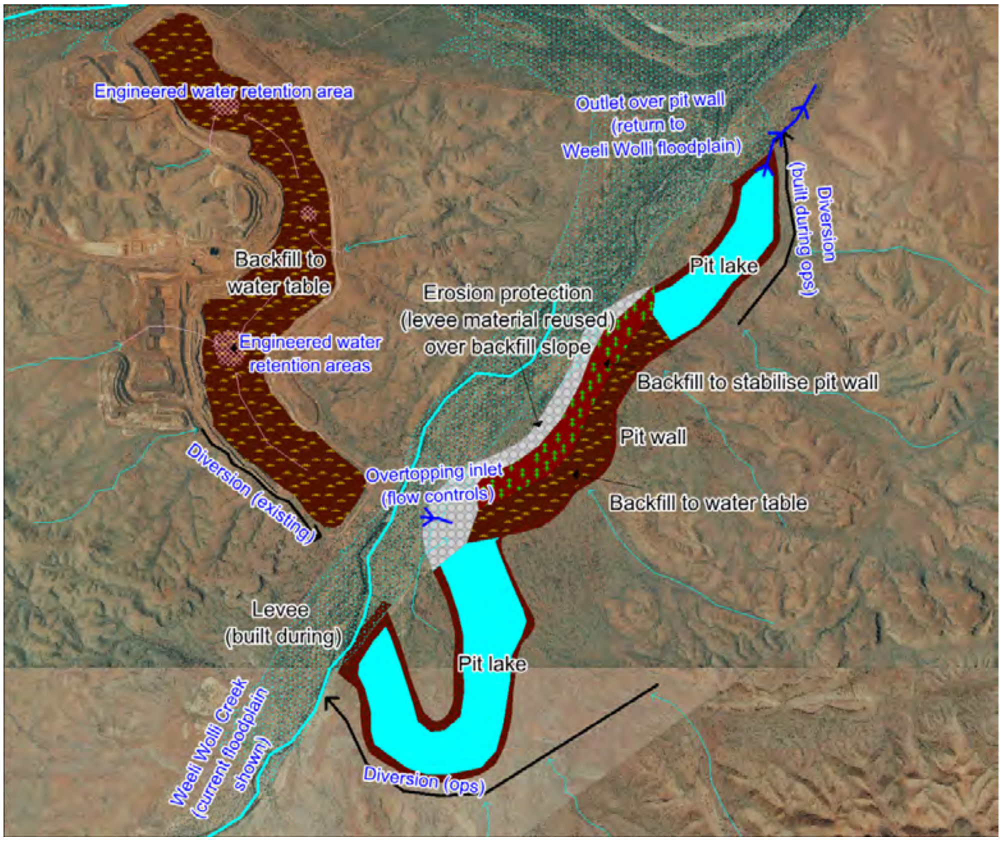

Figure 23: A landform design option for the JSE and Billiards South areas, if only the southern portion of the Billiard deposit is granted approval to mine.

Both closure contingency options, closure after mining JSE and closure after mining Billiards South, are able to comply with the closure objectives established for Yandicoogina, as defined in Section 19.

In the event of unplanned or sudden closure, Rio Tinto Iron Ore will notify all relevant authorities including the DMP. The existing closure plan for the site would then be revised and a Decommissioning Plan, as discussed in Section 29, would be prepared and submitted to the DMP and other relevant authorities within three months of notification of closure. The Decommissioning Plan will include undertaking detailed consultation with stakeholders. As discussed in Section 29, work will commence on closure implementation activities once the Decommissioning Plan is approved by the relevant authorities.

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, which will demonstrate how ongoing 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.

Closure monitoring and maintenance

Monitoring information collected during operations is used to inform the closure plan, while monitoring during closure is used to validate predictions and track rehabilitation success.

31. Operation monitoring programmes

An extensive environmental monitoring programme is underway at Yandicoogina 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. Results that are relevant to closure are summarised in the environment knowledge base; and
- Operational monitoring, which occurs throughout the life of the mine, in line with regulatory requirements and the Rio Tinto operational standards. Results that are relevant to closure are incorporated in the environment knowledge base when it is reviewed;

A summary of the information currently collected by the operation and used to inform the closure plan is listed in Table 21. Note the frequency of data collection is indicative only, with monitoring frequency (and some parameters) adapted to reflect the changing certainty (increasing and decreasing) of various aspects as the mine develops.

Table 21: Existing monitoring programmes

Aspect	Location	Frequency	Parameters measured
Soil quality	Land farm	Quarterly	TRH, pH, Total N, Total P, Soil Moisture, C:N:P Ratio, BTEX, PAH , heavy metals
Riparian vegetation	Yandicoogina	Annually	Aerial photography, DMSV
Riparian vegetation	Weeli Wolli and Marillana Creeks	Quarterly 6 monthly	Digital Cover Photography (DCP) Community structure, species diversity and abundance
Riparian vegetation	Whole site	Annually	Sum of approved clearing areas within riparian vegetation communities
Riparian and terrestrial vegetation	Marillana Creek	6 monthly	Vegetation monitoring transects
Revegetation			Refer to closure plan Section 14.4 *Revegetation* for monitoring procedures
Weeds	Whole site	Ongoing	Visual with annual eradication programme
Meteorological	Yandi Weather Station	Monthly	Monthly rainfall total
Groundwater quantity	Abstracted water	Continuous	Volume abstracted
Groundwater quality / quantity	Mine aquifers	Monthly	pH, EC, Temperature, Run Hours, Cumulative Flow, Instantaneous Rate Flow, Water Level Elevation

Aspect	Location	Frequency	Parameters measured
Groundwater quality / quantity	Mine aquifers	Annually	pH, EC, TDS calculated, Na, K, Ca, Mg, CL, CO3, HCO3, SO4, NO3
Groundwater level	Whole site	Monthly	Water level elevation
Surface water quantity	Discharge outlets	Monthly	Cumulative volume discharged (m3)
Surface water quantity	Weeli Wolli Creek	Ongoing	Extent of the saturated creek bed
Discharge quality	Discharge outlets and creek alluvium water	Quarterly 6 monthly	TDS, TSS, EC, pH, Total P, Total N, NO3, NH3, Se, Hg, pH, EC, TDS, TSS, Al, Ca, Mg, Na, K, SO4, Pb, Cu, Fe, Mn, Mo, Zn, As, Cd, Cr
Background surface water quality	Nominated points	Fortnightly	as per discharge quality
Aquatic invertebrates	Weeli Wolli Creek	6 monthly	Aquatic invertebrate abundance and diversity
Subterranean fauna/habitat	Yandicoogina	Opportunistic	Stygofauna assemblages
Geomorphology / bathymetry	Discharge outlets	6 monthly & after flood events	Inspection and photographic records to monitor for erosion
Geomorphology / bathymetry	Marillana Creek	6 monthly	Channel cross sectional area

Stakeholder consultation processes, as discussed in Section 17, are used to monitor the opinions and expectations for closure of Traditional Owner, regulator, non-government organisations and other stakeholders throughout the mine life.

32. Closure monitoring programmes

Monitoring undertaken after decommissioning and rehabilitation works are complete is used to evaluate and / or demonstrate that the closure objectives have been met for the Yandicoogina.

A specific closure monitoring programme will be finalised as the site approaches closure as part of the Decommissioning Plan, based on the agreed completion criteria (Section 24). This current plan outlines the principles that will be employed in the design of that monitoring programme rather than specific monitoring aspects and frequency.

32.1 Expected monitoring program

For the purposes of this plan, closure monitoring is assumed to be conducted in three phases:

- pre-closure monitoring, which occurs as the site approaches closure to underpin assessment of post-closure performance;
- closure monitoring, which is conducted during the period of active site closure (approximately two years following the cessation of mining); and
- post-closure monitoring, which is conducted on a regular basis until the completion criteria have been met and that the site is able to be relinquished or the parameters reach a steady state.

Table 22 highlights aspects that will be considered in the different closure monitoring phases. At present only pre-closure monitoring of rehabilitation is being undertaken specifically to address closure needs.

The remaining monitoring programmes will be developed as part of the detailed rehabilitation design when sufficient information will be available. The monitoring programmes will be sufficiently flexible to enable adjustments to be made if results indicate that more or less monitoring is warranted at any particular phase.

For example, monitoring during the period of active site closure will be the most intensive. The closure strategy has been designed to achieve a walk-away closure solution; monitoring during the closure monitoring period will be design to ensure the landform design performs as desired or is corrected as required. Minimal management is anticipated to be required during the post-closure monitoring period, at which time data will be collected to verify the modelling prediction of, for example, groundwater recovery, water quality and surface water flow regimes.

Table 22: Expected components of the closure monitoring program

Aspect	Phase		
	Pre-closure	**During decommissioning**	**Post-decommissioning**
Erosion monitoring	✓	✓	✓
Vegetation monitoring (ie revegetation success)	✓	✓	✓
Fauna survey	✓	✓	✓
Stygofauna survey	✓	✓	✓
Water quality monitoring	✓	✓	✓
Contaminated sites assessment	✓	✓	
Ecology function study	✓		✓
Hydrology/hydrogeology study	✓		✓
Heritage survey	✓	✓	

32.1.1 Baseline surveys and monitoring

In addition to the baseline surveys and control site monitoring collected before and during operations, additional baseline surveys may be required to establish the post-mining environmental conditions. Aspects that will need to be collected to establish the post-mining conditions include water levels outside the active mine area, riparian vegetation condition, stygofauna populations and potentially terrestrial fauna. An ecological risk assessment, conducted as part of the decommissioning study, will be used to inform the development of further closure baseline survey / control site monitoring programme (ie additional to current baseline monitoring programmes).

33. Post-closure maintenance

Post closure, maintenance will continue as required until it is determined that the closure objectives have been met or it is otherwise agreed with Government to allow relinquishment of the site.

Management of information and data

The retention and accessibility of multi-disciplinary mine records, is vital to successful mine closure and rehabilitation. This section provides an overview of the information management systems used by Rio Tinto Iron Ore, in order to manage closure related data.

34. Management of information and data

34.1 Iron Ore Document Management System (IODMS)

Rio Tinto Iron Ore operates a comprehensive 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.

34.2 Closure knowledge base

The closure knowledge database is a new knowledge management process designed to bring closure related research and monitoring outcomes together into one searchable location.

The closure knowledge database 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.

34.3 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[179].

The user groups currently utilising this software include:

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[179] Rio Tinto Iron Ore (2012) IS & T Business process documentation – SRA EnviroSys Application. RTIO-PDE-0055230

- environment;
- hydrogeology;
- water management;
- infrastructure / utilities; and
- mine operations.

Data collected includes:
- groundwater – biological, chemical, field, levels, production;
- marine water – biological, chemical, field;
- soil chemistry;
- surface water – biological, chemical, field, levels, production;
- tonnes moisture;
- water metres; and
- weather – rainfall, temperatures.

EnviroSys is used across all WA Rio Tinto Iron Ore sites in the Pilbara, and in Perth. Its application is necessary to support the building of closure knowledge bases, as well as ensure compliance with internal Rio Tinto standards, ISO 14001 certification and operating licenses pertaining to data management.

34.4 Legal and other requirements system

The Legal and Other Requirements System (LAORS) is used by Rio Tinto Iron Ore 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
  - lists accountabilities for specific conditions within approvals and clauses within legislation;
  - lists required actions to comply with approvals and or legislation; and
  - lists 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

35. Rio Tinto Iron Ore (WA) rehabilitation guidance

Attachments:

- Landform design guidelines
- Rehabilitation handbook

52 pages

Rio Tinto Iron Ore (WA) Landform Design Guidelines

October 2012

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Contents page

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1. Introduction

Rio Tinto Iron Ore (WA)'s rehabilitation & closure objective is to create landforms that;

a) are safe and stable

b) considered aesthetically compatible with the surrounding landscape

c) support native vegetation

d) are free draining and non polluting

e) meet an agreed post mining land use

Rio Tinto Iron Ore (WA) also aims to complete rehabilitation progressively in order to meet government requirements and to reduce rehabilitation costs at the end of mining.

This document and the related internal documents listed below aim to help achieve the above objectives by providing guidance to Rio Tinto Iron Ore (WA) personnel involved in waste dump design and rehabilitation. These guideline will also assist RTIO in minimising rework and provide a greater degree of closure certainty (relinquishment). The information provided in this document is a consolidation of research, industry trends, government guidelines and field observations.

Related internal documents include;

- The design or construction of waste dumps containing black shale. For completeness, all information relating to management of potential acid forming (PAF) material and resultant Acid Rock Drainage (ARD) is contained in the Iron Ore (WA) Spontaneous Combustion and ARD (SCARD) Management Plan for Operations. This is available via the following link: http://iodms/iodms/drl/objectId/090188a38040b172 or in FDMS as document number RTIO-HSE-0010872.

- Landloch erodibility work and batter selector/design tool must be used when designing waste landforms. The batter selector/design tool is contained within this document. The report supporting the tool titled "Final Landform Design Criteria for Use During Mine Planning" is located at - Final Landform Design Criteria for Use During Mine Planning: http://iodms/iodms/drl/objectId/090188a3804e09b6 or in FDMS as document number RTIO-HSE-0159989. The batter selector/design tool will define acceptable lift heights, berm widths and slope angles for final landforms (rehab designs) based on waste type and location.

- The management of Topsoil and subsoil. Refer to the "Soil Resource Management Procedure" which is available on the HSEQ website via "10. Operational Control" then via the Environment tab and "E9 Land Use Stewardship" or via the following link- http://iodms/iodms/Wsapi?message=getfile&objectid=090188a3802f36e3&docbas

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e=iodms_v2&web=true&name=RTIO-HSE-0011596 or in FDMS as document number RTIO-HSE-0011596.

- Rehabilitation Management Plan which is available on the HSEQ website via “10. Operational Control” then via the Environment tab and “E9 Land Use Stewardship” or via the following link-http://rtio.riotinto.org/HSEQ/CategoryElement.aspx?siteid=1&elementnum=10&categoryid=83&type=environment,or in FDMS as document number RTIO-HSE-0058421.

- Rehabilitation Handbook which details the process from planning and implementation through to data and records, revegetation and monitoring. It is available from FDMS, document number RTIO-HSE-0011608 and via the link: http://iodms/iodms/drl/objectId/090188a38037a319

- Progressive Rehabilitation – Process & Responsibilities, this details accountabilities from rehabilitation design & approval, tender, implementation, review and close out through to monitoring. It is available in FDMS, document number RTIO-HSE-0083199 and via the link: http://iodms/iodms/drl/objectId/090188a3802b1ab7

- Rehabilitation – Design and Approval Process, which assists with completing rehabilitation designs. It is available in FDMS, document number RTIO-HSE_0072956 and via the link: http://iodms/iodms/drl/objectId/090188a38029eca7

- Mineral Waste Management Work Practice which is available on the HSEQ website via “10. Operational Control” then via the Environment tab and “E8 Mineral Waste Management” or via the following link - http://iodms/iodms/Wsapi?message=getfile&objectid=090188a380302a14&docbase=iodms_v2&web=true&name=RTIO-HSE-0040347

- Other internal documents may also need to be considered when designing final landforms including site specific mineral waste management plans and fibrous management plans.

This document and the related internal documents apply to historic, active and future waste landforms.

When using the guidelines - the following needs to be kept in mind;

- A single set of design criteria cannot be applied to all waste dumps across the business. Given the large variability in location, mineral waste types, age, dump dimensions, and situations – discretion needs to be applied and each dump must be considered individually.

- All waste dumps should be inspected in the field before a rehabilitation design is completed. Ensure that the final as-built survey data is used. A new survey pick up of the as-built landform should be requested if unsure.

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- All rehabilitation designs must have sign-off from key stakeholders. This includes personnel from mine planning, mine operations, hydrogeology, geotechnical and environment. The dump design checklist may be used for this process.

- Rehabilitation is a dynamic practice and flexibility in design is required. Trials should be encouraged and documented and new techniques incorporated. The guidelines should be reviewed on a regular basis.

Rehabilitation should be completed progressively; therefore dumps should be designed to allow for progressive rehabilitation where possible (e.g. bottom lift can be rehabilitated while the above lifts are active).

To aid in completing rehabilitation designs a check sheet has been provided in Appendix A titled “Waste Dump Design Cheat Sheet”.

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2. Background

Closure is an inevitable part of the mining process. The Government Department responsible for closure is the Department of Mines and Petroleum (DMP).

In the past, mining companies broadly applied a standard single set of design criteria to all waste dumps based on Department of Minerals and Energy Guidelines for Mining in Arid Environments produced in 1996. These criteria made little reference to the climate in which a landform was situated, the materials from which it was created, or the completed shape of the landform once sited in the environment.

A single approach and standard slope gradient is no longer acceptable and there are a number of cases where this approach has proven to be ineffective at meeting desired rehabilitation and closure objectives. As a result waste dump designs must now be completed on a case by case basis ensuring all factors are considered (e.g. material type, rainfall, surrounding landscape). The development of rehabilitated waste dumps and final sign off from government is now process/outcomes driven, with the final objective remaining the same – to build a safe and stable non-polluting landform compatible with an agreed post mining land use – but the process by which that is achieved must be site specific and justifiable. The likelihood of gaining sign off from Government is greatly improved if sites can demonstrate they have gone through a process that considers all factors when designing waste dumps.

In general, the DMP Waste Rock Dumps guidelines (September 2009) recommend:

- Selecting an appropriate location (e.g. not interrupting significant natural drainage lines, blending the waste dump into the surrounding landscape where possible)

- Conducting waste rock characterisation prior to construction;

- Designing the profile of the dump to ensure that the final structure is safe, stable and not prone to significant erosion;

- Incorporating drainage control structures that will manage expected rainfall and runoff events;

- Apply topsoil and deep rip along the contour and seed using local provenance seed.

In addition the Mine Rehabilitation Handbook released by the Department of Industry Tourism and Resources in 2006 recommends designing landform to reduce both costs of construction and long term maintenance costs.

In summary, although the DMP do have guidelines, they are only guidelines. They do not guarantee relinquishment or the avoidance of additional rework and do not mandate specific design criteria. Mining companies are strongly encouraged to conduct research and develop site or region specific landform design criteria.

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In addition to the Waste Rock Dumps guidelines (September 2009), the DMP and the Environmental Protection Authority (EPA) have released Guidelines for Preparing Mine Closure Plans (June 2011). These guidelines outline the requirements for mine closure plans including detail on considerations required when designing final landforms. These guidelines and requirements will be discussed in more detail in section 2.2.

In response to the challenges of designing rehabilitated landforms, RTIO (WA) has completed a significant project that will allow the systematic consideration of waste type and climate when designing final landforms. This project builds upon landform erosion studies and design projects completed by RTIO (WA) since 1998. The key outcome of this project is the batter selector/design tool. It is a standalone excel workbook, and it is described in these design guidelines and provided as an embedded object in Section 3.4. This tool will not only assist RTIO (WA) in planning (and ultimately building) safe, stable and non-polluting landforms, but will also assist in meeting the new requirements of the Guidelines for Preparing Mine Closure Plans.

2.1 Current Situation

Tom Price and Paraburdoo operations have been building waste dumps since the 1970s. Many of these waste dumps were constructed when closure considerations were not part of the mining process and hence may not have utilised some of the more conventional rehabilitation methods. These waste dumps were designed with the intention of keeping haul distances to a minimum, maximising dump life (storage) and minimising footprint - hence very large dumps were often created in single lifts on the edge of hill slopes at angle of repose. These dumps are typically actively eroding, yielding sediment that may potentially move to the surrounding landscape, and support low levels of vegetation (**Figure 1**).

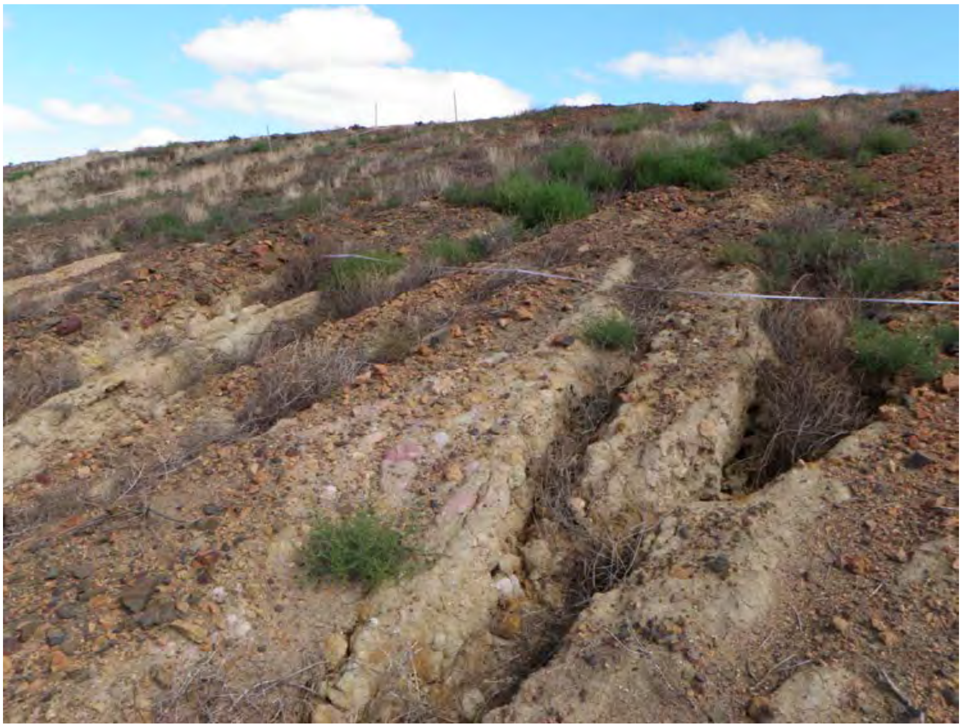

Figure 1 An example of an actively eroding steep dump batter.

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Rio Tinto Iron Ore (WA) has a liability in the form of un-rehabilitated waste dumps. The liability is increasing as Rio Tinto Iron Ore (WA) generates more waste dump surfaces annually than it rehabilitates. Rehabilitating historic dumps using current best practices is a major investment in time and cost, and understanding the waste material characteristics is critical if suitable final landforms are to be constructed.

Where rehabilitation has taken place there is considerable variability in final landform shapes and techniques used between and within mine sites. Slopes may vary in gradient from 15-25 degrees, berms are often present but generally construction quality is inadequate, severe gullying is sometimes evident, complex surface treatments (e.g. moonscaping, (**Figure 2**) have been trialled, rock lined drains have been constructed, and there appears to be examples of dumps that have been cross-ripped and others that have not been cross-ripped. Useful information has been obtained from these previously built final landforms to understand what designs have and haven't worked well in the Pilbara.

Figure 2 Moonscaping rehabilitation trialled at Tom Price

2.2 Closure Guidelines

In 2011 the DMP and EPA introduced closure guidelines that aim to provide guidance on the preparation of Mine Closure Plans to meet Western Australian regulatory requirements. The guidelines require companies to identify and provide proposed controls to enable management of environmental issues including (but not limited to) potentially problematic materials (such as dispersive and sodic materials). The guidelines require the adequate characterisation of materials intended for use in mine rehabilitation activities (including physical, chemical and nutrient) to ensure that the closure objectives such as the construction of safe, stable and non-polluting landforms can be achieved.

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A project to allow the systematic consideration of waste type in combination with climate was commenced in 2010 by RTIO (WA) and finalised early in 2012. The outputs of this project will enable RTIO (WA) to meet the DMP and EPA closure guidelines. This work involved erosion studies to determine the runoff potential and erodibility of representative waste types across its Pilbara Operations. Combining the wastes' runoff potential and erodibility characteristics with site specific climate data enables RTIO (WA) to utilise site specific batter design parameters (batter slope gradient, shape, slope length, height, and berm width if used) that provide greater certainty in achieving required closure objectives.

These rehab design criteria (batter design parameters) are housed within the batter selector/design tool. This tool allows the user to extract batter design criteria that ensure minimal erosion potential based on inputted waste types combined with mine site location (defines the appropriate climate). This tool should be used by mine planners when considering final landform/rehab designs. It will not only provide information of stable dump/landform design, but also provide other information that may have to be planned for such as not having enough competent material at the end of mining (and therefore the need to segregate competent waste for capping throughout the mine life). The tool considers only batter erosional stability, and as such does not consider all aspects of dump design. For example, it does not consider black shale management or fibrous material requirements – if these are relevant specific management plans and requirements will also need to be considered.

The batter selector/design tool should be viewed as one tool within a range of tools or processes utilised to define the final landform shape. Rehabilitation designs for historic dumps will have to be handled in consultation with an RTIO (WA) rehabilitation specialist, as these historic dumps may not conform to the new erodibility research. Adhering to the parameters in this tool will ensure that RTIO (WA) meet the requirements of the new closure guidelines.

It should be noted that the batter selector/design tool provides guidance on suitable **final landform** parameters (i.e. the rehabilitation design). To enable the final landform to be achieved a back-calculation must be done to determine the as built/as dumped/dump to design that will be utilised throughout operations. For example if the final landform/ rehab design stipulates a 20m lift at 20 degrees and a 10m berm width, the "dump to" design may be a 20m lift with 40 m berms (at angle of repose of 38 degrees). This would allow the 10m berm to be achieved once the 38 degree slopes are pushed down to the rehab slope design of 20 degrees. It is critical the "dump to" design considers the final/rehab design. For example the berm widths determined by the batter selector/design tool represent acceptable widths **after rehabilitation** (i.e. rehab design), when the slopes have been battered down and not for the final "dump to" design when waste is sitting at angle of repose.

2.3 The Surrounding Environment

The Pilbara region is semi-arid with highly variable rainfall, both spatially and temporally. Average annual rainfall in the Pilbara region is ~350 mm, with annual totals ranging from less than 100 mm to almost 1000 mm. Rainfall is typically associated with tropical low pressure systems and thunderstorm activity from the monsoonal trough that develops over northern Australia during summer. Winters are typically dry and mild though winter rain

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events can occur in June and July as a result of rainfall caused by tropical cloud bands that intermittently affect the region. The majority of the precipitation occurs during summer however the southern coastal areas experience a greater proportion of the annual rain during winter months. It is not uncommon for the summer rain to be dominated by a single large event. For example, Tropical Cyclone Joan passed over the Pilbara region in December 1975 and produced 380 mm of rainfall at Marandoo in two days.

The region contains rugged mountain ranges surrounded by undulating, rocky plains and low hills (**Figure 3** and **Figure 4**). Much of the topography is steep and sloped, generally erosion resistant and sometimes with sparse vegetation cover. In most areas, drainage of the higher relief land discharges to major river systems that are ephemeral with occasional permanent surface water pools.

Figure 3 (above) typical Pilbara landscape showing rugged hills interspersed amongst undulating plains and low hills

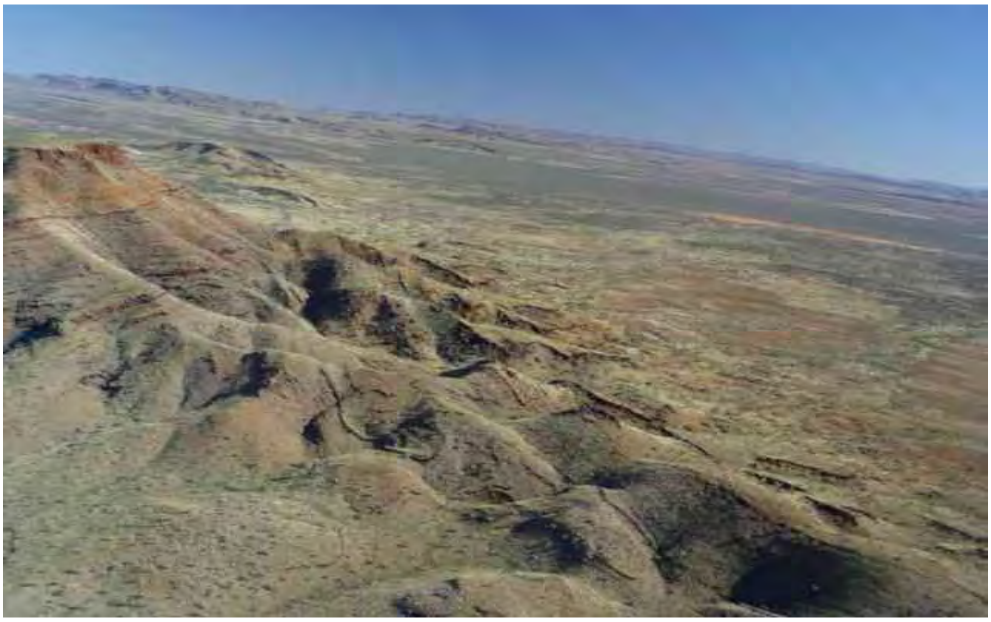

Figure 4 Pilbara landscape showing complex range systems protruding from the surrounding flat plains

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Soil types are principally hard alkaline red soils on the plains with shallow skeletal soils on the hills. A surface layer of gravel and shingle derived from the harder surrounding rocks occurs on the plains.

Vegetation in the region varies from open grasslands dominated by *Spinifex* species to open shrublands dominated by *Acacia* species. Eucalyptus trees are common along major drainage lines.

3. Waste Dump Design

3.1 Objectives

As outlined in the introduction, when considering waste dumps, the objective is to create landforms that;

a) are safe and stable

b) are considered aesthetically compatible with the surrounding landscape

c) support native vegetation

d) are free draining and non polluting

e) compatible with agreed post mining land use

f) can be rehabilitated progressively.

These objectives are discussed in further detail in this chapter. In addition to the above objectives it is important to identify if any existing commitments exist, these can be found in a sites ministerial statements , management plans or site specific closure plan, via LAORS or by contacting the RTIO Approvals team.

or in a sites closure plan. Examples of specific commitments may include rock armouring final rehabilitated slopes or installing a store and release cover on a waste dump.

A critical consideration when designing a waste dump is the management of surface water. There are two components to this, namely, the impact of water on the landform and the impact of the landform on water.

If these risks are understood and controlled then the following benefits are realised:

- ponding and hence large scale erosion failures or slumps are avoided
- gully erosion on slopes is minimised
- plant growth encouraged

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- surface run-off has minimal sediment load
- minimal sedimentation of natural drainage lines
- minimal erosion of waste dump toes

3.1.1 Safe

A safe landform typically refers to waste dumps that are geotechnically assessed as safe. Rehabilitated slopes with batter gradients much less than angle of repose are typically geotechnically stable. Further, when water management is controlled such that the concentration and pooling of water against dump edges is prevented, significant large-scale failures can be avoided. Other considerations of designing a safe landform include specific management of hazardous materials including fibrous and potentially acid forming materials, if possible a dump should be designed to minimise the exposure of and rehandling of this material.

3.1.2 Stable

Stability in the rehabilitation context refers to erosional stability. From DMP's perspective this means no significant gully erosion, no large sediment fans, no sedimentation of local drainage lines, and the presence of an established vegetation community (or monitoring data to suggest one is developing). It is acknowledged that sediment loss will occur from rehabilitated batter slopes but that erosion should not adversely impact vegetation establishment and growth on the dump or vegetation growth within the surrounding environment. If gullies do exist, erosion monitoring data must be able to demonstrate that they are armouring and stabilising, otherwise remedial actions may be required. Although vegetation is often assumed as a part of stability considerations, the low levels of cover typically present in the Pilbara render it largely ineffective at controlling erosion, particularly during the early stages of rehabilitation when most of the rills and gullies form. Therefore, stability needs to be achieved without the reliance of vegetative cover. Any additional protection afforded by plant cover should be considered complementary. A stable surface will assist vegetation establishment and growth in the long term. Vegetation also has benefits in terms of faunal habitat and aesthetics.

The batters within the batter selector/design tool are all predicted to have long-term average annual erosion rates (averages over the entire batter) of <5t/ha/y, and long-term peak erosion rates (at any point on the slope) of <10 t/ha/yr. These values are set such that the potential for rill initiation is limited, therefore significantly reducing the chance of more significant erosion features such as gullies developing.

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3.1.3 Natural Landscape (aesthetically compatible)

The surrounding landscape in the Pilbara is very irregular, often steep and rocky but also with low rolling hills.

This provides opportunities for:

- designing landforms that may not follow the conventional linear models
- constructing landforms that abut natural topography
- making landforms less visible to public view

To meet the objective of being aesthetically compatible with the surrounding landscape final landforms should be designed to be no higher than the surrounding landscape. Some operations also have specific height restrictions and these can be found in legal documents such as ministerial statements and associated management plans.

3.1.4 Vegetation

Only local provenance seed mixes are used in rehabilitation. Observations in the natural environment suggest that many Pilbara plant species can grow on a range of slopes and rock types.

As discussed in section 3.1.2, vegetation provides several benefits for closure, however its importance in stabilising surfaces should not be overstated.

3.1.5 Free Draining and Non-Polluting

The primary pollutant source likely to be generated by the creation of a waste landform is sediment laden runoff. Sediment concentrations in runoff changes in response to the amount of erosion that occurs, and the type of sediment (finer sediment particles will be transported further than coarser-grained sediment). Therefore to achieve a non-polluting landform the controls and considerations as discussed above in sections 3.1.1 and 3.1.2 should be implemented.

3.1.6 Meet an Agreed Post-Mining Land Use

Final landform design and subsequent rehabilitation should take into consideration the agreed post-mining land use (and enable this to be achieved). It is assumed across RTIO (WA) operations that the agreed post-mining land use at closure is an ecosystem

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consisting of native vegetation (comparable to adjacent native vegetation). Final landform/rehab designs completed utilising these guidelines combined with progressive rehabilitation can help operations work towards meeting this post mining land use.

3.1.7 Progressive Rehabilitation

Designing dumps to allow for progressive rehabilitation is critical for a number of reasons, including enabling rehabilitation to be completed throughout the mine's life (and not leaving it all until the end of mining).

Progressive rehabilitation;

- is an expectation of the DMP
- significantly reduces the costs of rehabilitation
- allows for learning's to be incorporated into future programmes of work
- improves the techniques utilised
- reduces exposed land and dust generation
- reduces the risks of sediment runoff affecting surrounding vegetation
- is viewed favourably by RTIO (WA)'s stakeholders (including both the community and regulatory bodies).

Examples of designing to allow for progressive rehabilitation include building final landforms lift by lift rather than having several active lifts, so rehabilitation of a lower lift may be completed whilst still dumping on the upper lifts.

3.2 Selecting the right criteria

The general process for designing the most suitable final landform is as follows:

- Determine if any existing commitments exist such as commitments made during project approvals or in closure plans
- Locate the dump (in-pit, out-of-pit, stand along, abutting an existing hill), and consider surface water flows both on and into the dump, and around the dump
- Consult with hydrologists/surface water specialists if there is going to be surface water running onto the waste dump from surrounding landforms (the batter selector/design tool does not take this into consideration)
- Determine maximum dump height (based on surrounding landscape and any site specific commitments)

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- Determine any footprint constraints (e.g. streams and drainage lines, heritage sites, infrastructure)
- Determine waste types present in the dump using the geological/mining block model or with the assistance of geologists
- Determine the relative proportions of the major and minor wastes to be considered and populate the table in the batter selector/design tool
- Use the batter selector/design tool to define suitable batter configurations (maximum lift height, maximum slope gradient, minimum berm width and back slope) for each waste type
- Determine the most appropriate configuration that accommodates the majority of the waste. At this stage, it should be noted whether further controls (other than the application of the selected configuration) are required, such as capping with competent material or encapsulation of highly erodible wastes, and who is accountable for managing and implementing these controls.

3.3 Location

The location of a waste dump is, for all intents and purposes, to be considered as final, and haul distance should not be the sole consideration for placement. Considerations for waste dump locations are discussed further below.

3.3.1 In-pit disposal (backfilling)

In-pit disposal should always be considered a priority in preference to constructing out-of-pit (above ground) waste dumps. Backfilling opportunities reduce the disturbance footprint, the resultant waste dumps in most cases require less reshaping (and monitoring), and can prevent the development of water filled final pit voids. In-pit disposal is also generally better for visual amenity, can result in a reduction in dust (due to less surface areas exposed) and require significantly less controls for erosion and sediment movement. If longer hauls are required to achieve in-pit disposal, these should be offset against the realised benefits and decreased liability, including the potential for reduction of black shale exposure on pit floors and walls, and reduced dump rehabilitation and remediation costs.

Any out-of-pit waste dump can only be approved if in-pit opportunities do not exist or backfilling is demonstrated not to be feasible. Backfilling pits with waste (as opposed to the creation of out-of-pit waste dumps) is the preferred position of the DMP and EPA.

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3.3.2 Out-of-pit waste dumps

Out-of-pit dump locations need to consider the following:

- Mining Approvals – a site's Ministerial Conditions and Commitments and the mining proposal may have restrictions on the size (especially height) and location of waste dumps. This information can be located on the HSEQ website, LAORS or by contacting the RTIO Approvals team, or by consulting the site specific mine closure plan.

- The approved clearance footprint – dumps must be located within the approved project area. Within this area an approvals permit request may need to be submitted. Any additional area required to rehabilitate the dump must be considered when planning footprint requirements.

- Has the area been sterilized for ore

- Are there infrastructure limitations (roads, power lines), is there sufficient access for heavy equipment

- Are there ethnographic, heritage or environmental restrictions/limitations

- Hydrology – because the Pilbara is characterised by rainfall extremes, it is essential to conduct an assessment of the hydrology of the surrounding landscape and associated drainage lines. Waste dumps can have an impact in catchments both upstream and downstream of their location. Both situations need to be considered when conducting a hydrological study. Some aspects to consider include:

    - Large and intense rainfall events can produce surface water flows that have the potential to cause severe erosion along the toes of waste dumps. The rainfall itself can result in significant ponding on the top surfaces of waste dumps that could potentially overflow down the dump face. Both of these scenarios can result in severe gullying and compromise dump stability. Modelling of intense rainfall events and the runoff they produce can assist in determining if a proposed location is suitable.

    - Waste dumps can act as barriers to flow paths and cause ponding. Ideally waste dumps should not be placed in established drainages with large upstream catchment areas.

    - Waste dumps can create downstream runoff shadows by changing natural drainage lines. It is a DMP requirement that significant drainage lines are maintained to provide environmental flows to downstream areas, preferably via the use of culverts

    - Downstream catchments or drainage lines must not receive excessive sediment from dump slopes. It is a DMP requirement that abandonment bunds are created at the perimeter of waste dumps to ensure this is avoided.

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- In the case where a dump abuts an existing hill, seepage of water onto the dump top will flow through the dump and interact with the now buried surface of the existing hill. Saturation of the dump can occur at this interface, causing increased seepage at the dump toe, and possibly geotechnical instability. The impact of infiltrating water should be considered and managed accordingly.

- Ensure there are no natural springs or seeps near the proposed dump location.

- If it is unavoidable that a waste dump is to be placed in a valley then sometimes the best outcome is to fill the entire valley - as opposed to disrupting natural water flows in a number of valleys – thus reducing final overall environmental impact.

- Small dumps on steep hill slopes and waste dumps as the highest point of elevation on the landscape should be avoided.

- Visual amenity – where possible, waste dumps should not be located in a highly visible location.

3.4 Waste Dump Shape

Waste dumps should be safe, stable and non-polluting. They should be designed to minimise erosion potential, and therefore the amount of sediment delivered from the dump to the surrounding environment. In order to promote waste dumps that fit the natural landscape (and increase visual amenity) curved waste dump footprint shapes are encouraged over square/rectangular dumps. To avoid machinery issues during rehabilitation works, the radius of curvature should be kept broad (>50m). Heavy machinery tends to slip on sharp corners, and these slips can cause points at which erosion potential is increased.

When setting a landform's footprint shape, the primary aims are to ensure compliance with all conditions and restrictions of the site and to ensure a waste dump that will be safe and stable in the long term. The batter selector/design tool will provide critical information on suitable batter slope configurations. It is no longer acceptable to design dumps with the sole aim being to minimise footprint. If footprint constraints render the designs indicated by the batter selector/design tool as unachievable, further controls will be needed to ensure safe and stable slopes. These controls may include the strategic placement of materials (e.g. rock armouring), use of in-pit disposal (the lack of available footprint may make this option suitable), or the acquisition of more land on which the waste can be stored.

Batter Selector
Design Tool.xlsx

The batter selector/ design tool includes both concave and batter/berm style batter configuration. Concave profiles are preferred over the batter/berm style configurations. In most cases, application of a concave batter profile will require more footprint than the batter/berm configurations. It must be noted that the conventional batter/berm configurations are less resistant to erosion than slopes that do not contain berms (such as

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a concave-shaped slope). Berms have a finite storage capacity that once exceeded will often result in irreversible failure of the entire batter slope. Where berms are used, they **must be** constructed to design and to a high quality standard (to ensure they do not over top or fail). Their construction is more complex than simply pushing up a windrow at the crest of a berm. They must be created on the contour, sufficiently compacted and contain sufficient storage to accommodate the runoff from the upslope batter and the sediment that will deposit in it over time.

The batter selector tool embedded in this section includes a tab of instructions so once opened users can work their way through the user input to determine design criteria for specific waste types.

3.5 Waste Dump Tops

It is critical to ensure that any water accumulating on the tops of waste dumps does not overtop and cascade down a waste dump slope. This may result in severe erosion. It is also critical to reduce ponding of water on top of dumps as this may result in tunnelling and also poor vegetation establishment.

Factors to consider:

- Waste dumps should be designed where possible to not receive surface water from surrounding upland landscapes. If the dump is placed such that the top does receive run on from upland areas, a hydrologist must be consulted and review the design to ensure adequate water control measures are incorporated into the design to contain and control this water.

- The surface of the waste dump top must be sloped towards natural topography and/or towards the centre of the dump. This minimises the risk of overtopping.

- All waste dump tops should be designed to manage water. Hydrological expertise should be sought to assist with this.

A bund wall needs to be constructed around the perimeter of the waste dump top to prevent surface water cascading over the edge. The bund and top surface of the waste dump should be backsloped to ensure water drains away from the bund and doesn’t pool against it. Ponding behind the batter crest bund can result in failure of the structure.

Bunds are to have the following characteristics:

- At least 1.5m high

- Thoroughly compacted and constructed of non hazardous competent material;

- Have their outer face continuous with the outer lift profile and have the same surface material applied to it;

- Have a width across the top of the bund of at least 2 m; and

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- Have their inner face sloping gradually inwards at a gradient of no less than 1V:10H.

In addition to constructing a bund wall, water also needs to be managed on the top surface of the dump.

A number of options may be utilised to manage water on the top of a dump, these are described below.

- If the waste dump is in close proximity to active mining areas and suitable waste types (subsoil) are available then the top surface may be *loosely* paddock dumped (**Figure 5**). Some of the paddock dumped loads should be topsoil/subsoil to serve as initial vegetation 'islands'. Paddock dumping should only occur if suitable waste is available, highly erodible or hazardous material should never be used. Paddock dumping has the following advantages:

    - acts as an effective water store
    - reduces catchment size
    - promotes infiltration & prevents excessive water ponding
    - creates micro niches and provides seed catchment
    - creates an irregular surface making it look more natural.

Plan View of Top of Waste Dump that has been paddock dumped

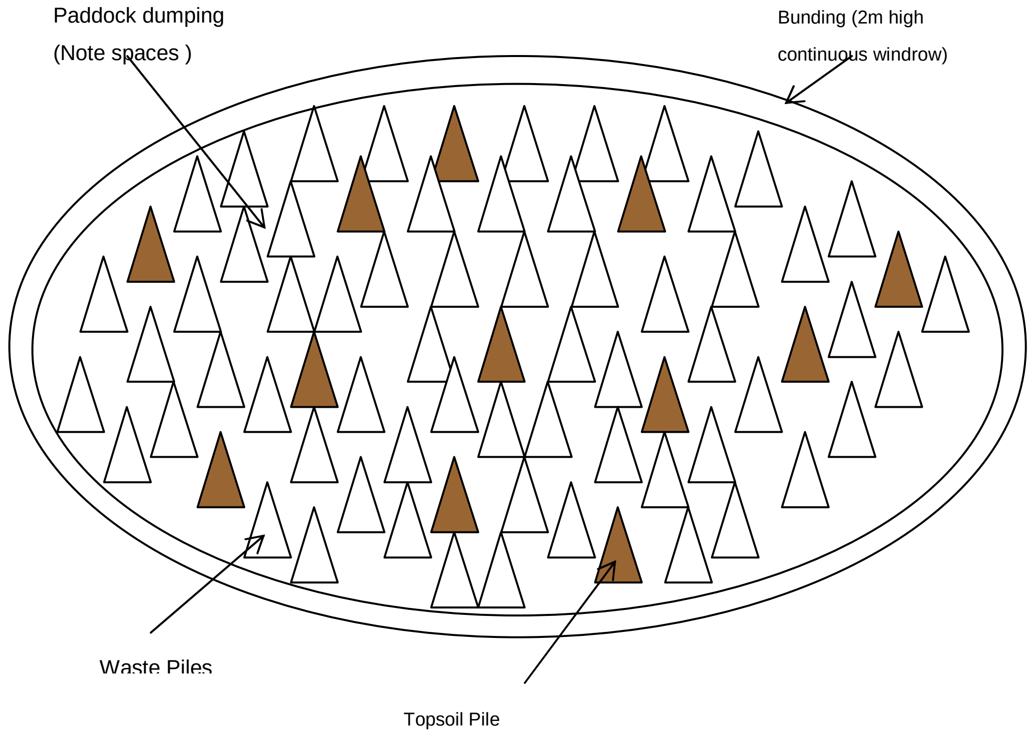

Figure 5 Diagram showing plan view of loosely paddock dumping

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If paddock dumping is not considered appropriate (limited access to suitable waste, the area might be too small, it may be considered not appropriate due to nearby visual receptors), then an alternate water control design is to create cells on top of the dump.

The cells should be shaped to have bund walls (**Figure 6, 7, 8, 9 and 10**). Cells should not exceed 1 hectare with excess water being directed to scalloped low points within these areas.

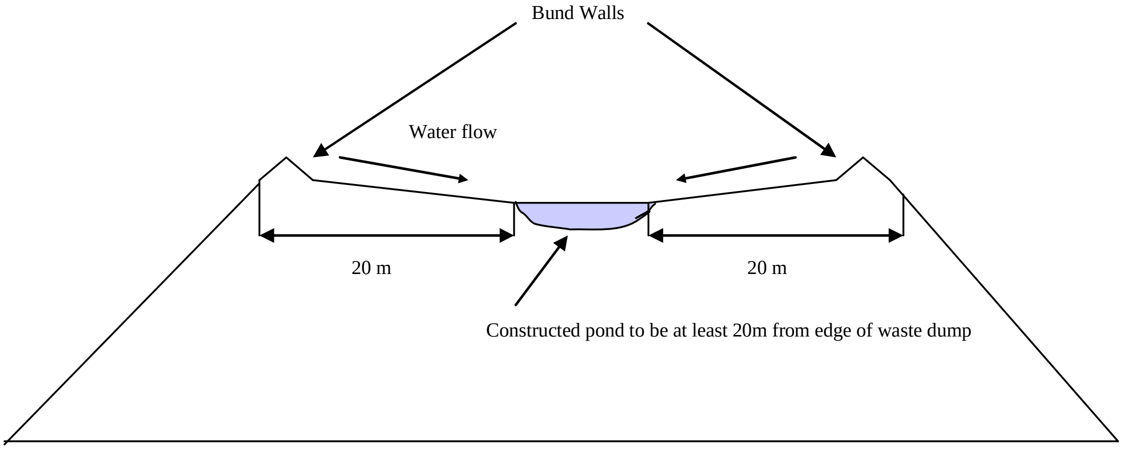

Figure 6 Side view of surface of waste dump

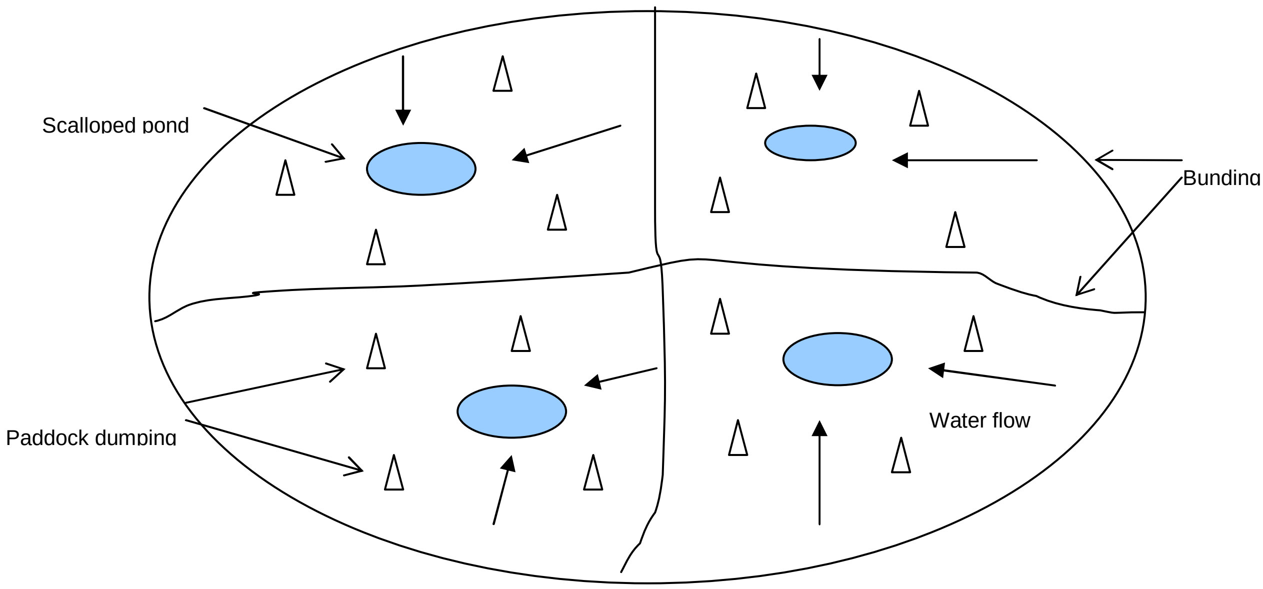

Figure 7 Division of top surface of waste dump into cells

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Figure 8 Dividing bunds on top of waste dumps, Meekatharra site

Figure 9 Dividing bunds on top of waste dumps, Meekatharra site

Figure 10 Example of waste dump crest bund

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3.6 Waste Dump Batter Slopes

As discussed earlier effective water management is critical to minimising uncontrolled erosion.

Erosion is determined by;

- material type on the outer slope
- slope length
- slope gradient
- shape of slope (e.g. linear, concave)
- erosional forces (rainfall intensity & volume)

Slope design criteria must aim to minimise erosion.

The following guidance on design criteria for waste dump slopes assumes no surface water runoff from the top of the waste dump onto the slopes below.

3.6.1 Material Classification

Broadly, speaking, the materials on the outer surface of a landform will determine its erosion characteristics.

The material type is a significant factor in predicting permeability (rate at which water infiltrates) which in turn helps determine the amount of surface water runoff that is likely to be generated during a rainfall event. When coupled with a material erodibility, the amount and nature of the rainfall and runoff event will determine the amount of erosion that occurs. Batter design criteria must aim to reduce runoff where possible, and have sufficiently erosion-resistant surfaces such that erosion is minimised.

Landforms constructed from low erosion potential materials would have a wider range of slope configurations that are predicted to have acceptably low erosion potential, whereas options for materials of high erosion potential will be significantly limited, and in most cases should not be placed on the outer surface of constructed landforms without sufficient augmentation with more erosion resistant materials i.e. rock. Erodibility classifications for a range of RTIO (WA) mine site materials are shown in **Table 1**. These are indicative only and useful during planning.

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Table 1 Erodibility classifications for RTIO(WA) representative waste materials

Dominant Waste Type	Proportion of Waste Types of Differing Hardness (%)		Average Estimated Rock Cover (%)	Range of Estimated Rock Covers (%)	Typical Erosion Class
	Hard	Med+Soft			
BIF (Dales Gorge, Joffre, Footwall Zone)	78	32	70	60-90	Low
Hydrated Zone	30	70	90	70-90	Low
Whaleback Shale	45	55	50	30-70	Medium
West Angelas Shale	14	86	30	20-40	High
Topsoil	0	100	40	30-50	High
Alluvials	-	-	40	40-50	High
Detritals	13	87	20	20-30	High
Clay waste	0	100		10	High
Weathered pisolite	0	100		10	High
Dolerite	0	100		30	High
Low Grade Ore	-	-	25	Oct-50	High
Powdery BIF	0	100		30	High
Coarse Tails	-	-		10	High

It is important to note this table summarises the erodibility characteristics of RTIO waste types (by showing a typical erosion class) and some wastes show a range of erodibilities. For example Detritals collected and analysed from Western Turner Syncline had ~20% rock and a high erodibility classification whilst Detritals collected and analysed from Hope Downs 1 had 30% rock and on analysis were determined to be medium erodibility. Table 1 above determines the “typical” erodibility of waste types and in the case of Detritals it is considered High.

It is important to note that how a material is placed will affect the stability of a material. For example, a material with a low erodibility classification can be used to create an unstable slope if the gradient is too high and/or the slope length too great. Therefore these classifications should be used as a guide only, and are useful when comparing the relative erodibility of different wastes.

The permeability of RTIO (WA) waste materials vary significantly and in many cases the final outer slopes may be a mixture of materials (BIF dominated wastes, shale dominated wastes, detritals etc). It is important for the batter selector/design tool to be utilised in the planning stage (where possible) prior to the overall final landform shape and size being integrated into the whole mine plan. It is easier to adjust a design at the planning phase than once mining has started and the landform exists.

The following pages show photographic examples of some high, medium and low erodibility wastes. In many cases the erodibility is linked to the rock content of the waste with rockier wastes being more resistant to erosion and therefore considered less erodible or of low erodibility.

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Photographic References for Erodibility Classifications

<u>High Erodibility</u>

Shale

Detritals (Western Turner Syncline)

Powdery BIF

Powdery BIF

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Moderate Erodibility

Whaleback Shale

Detritals (Hope Downs 1)

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Photographic References for Erodibility Classifications

Low Erodibility

Banded Iron Formation (BIF)

BIF

Hydrated

BIF

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3.6.2 Slope Dimensions

The batter selector/design tool should be used to determine the suitable design criteria for a site's waste landform. This is achieved by considering both the relative proportions of the wastes, and the mine schedule. The design criteria must account for the majority of the wastes present, in a dump however it is the schedule that will predict what material will eventually end up on the outside of the dump. It is important to use the two together, as a design criteria may account for 80% of the waste, but if the other 20% ends up on the outside of the dump, the design chosen may not correctly account for that waste.

As stated previously, if the mine schedule is known, and it can be seen that highly erodible wastes will end up on the outside of the dump if standard dumping strategies are employed, then material with lower erosion potential may need to be segregated and reserved for use on the outer surface of the dump to increase surface stability.

The batter selector/design tool should be used to guide batter configurations. The erosion studies completed to inform these guidelines uses observed climate data for the Pilbara region and proven erosion assessment methods. The batter selector/design tool defines optimal combinations of waste types and slope dimensions using the climatic conditions for each site, reinforcing the need to use the tool correctly, on a case by case basis for each dump being considered.

3.6.3 Concave slopes

Commonly (though not by necessity), rehabilitated landforms tend to have linear batter slopes and roughly rectangular or square footprints. Although this may be the most economic means of dumping wastes, this shape does not necessarily complement the surrounding landscape. Many natural hill slopes are typically concave in profile rather than linear. Utilisation of concave profiles (provided they are stable) is encouraged.

On most slopes, as runoff moves down slope, it accumulates and increases in energy, increasing erosion potential. On a concave slope, as the water moves further down the profile the gradient also decreases, reducing the energy of the water and the potential for erosion (**Figure 11**).

There is no generic natural concave slope that can be applied, as criteria will vary according to waste rock type and dump height (**Figure** 12 **12**). Constructed landforms differ from natural landforms in that they are constructed from unconsolidated, fractured materials. They therefore will have different hydrological characteristics (e.g. different runoff characteristics), and hence the stable profile will also be different to that found on undisturbed concaved slopes.

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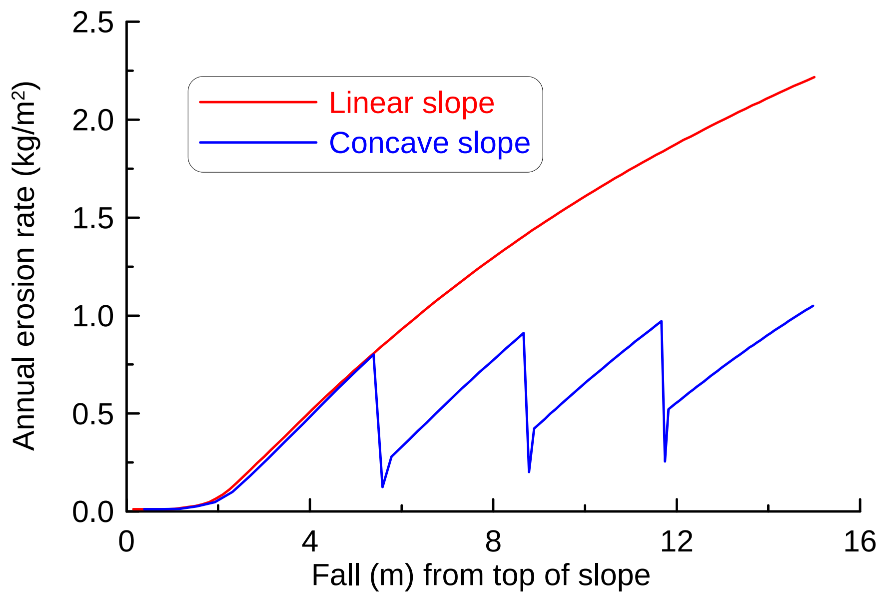

Figure 11 Comparison of predicted rates of erosion for linear and concave slopes on an average gradient of 15%, note that erosion of 1 kg/m^2 is equivalent to erosion of 10 t/ha

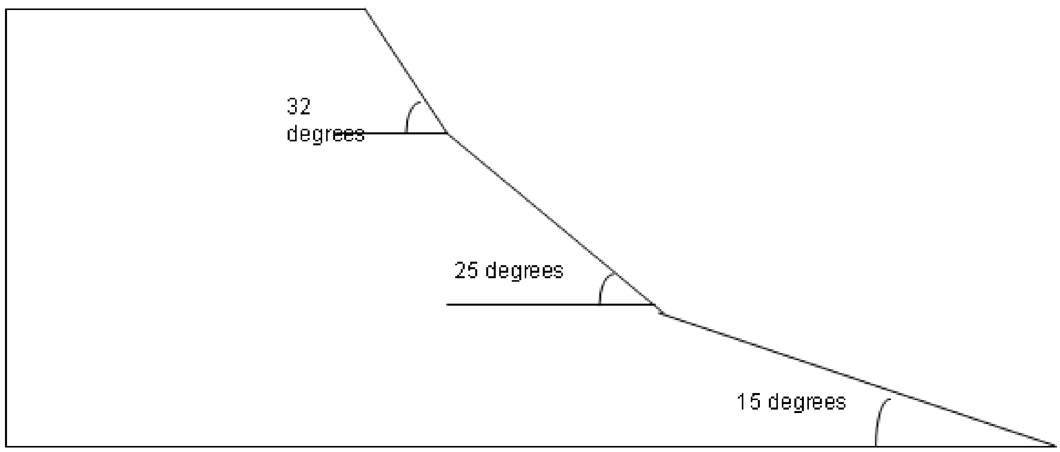

Figure 12 Example of a concave slope built as a series of 3 straight segments. This cannot be applying generically with no regard to materials or climate.

3.6.4 Surface treatments

Surface treatments (e.g. berms, rock armouring, contour ripping, and drainage) are often very useful in minimising erosion by controlling surface water runoff and facilitating plant growth, particularly in the short to medium term. Over a long time frame however, many surface treatments may not significantly decrease erosion rates and may in fact be the cause of significant erosion. This occurs when;

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- structures like berms are not properly constructed and surface water flows are concentrated and discharged in an uncontrolled fashion
- differential settling occurring within a dump
- gradual siltation of berms, contour ripping etc.
- a very large, intense rainfall event occurs that exceeds capacity of drainage structures

Irrespective of the surface treatments chosen, it is critical to ensure that they are designed with sufficient capacity **and** constructed to a high quality standard. Failure to do so will definitely cause severe erosion.

3.6.4.1 Berms

Berms are often used and recommended as a means of reducing slope length and acting as key water management structures. It is assumed that they prevent the build-up of speed and volume of surface water flows and will provide this function for the long term. However, field-based observations indicate that berms only serve as a short to midterm measure and even then must be built correctly. Berms essentially trap any water from the upslope batter segment. This water is then either channelled off the dump via constructed rock lined drains or via natural drainage lines on abutting natural topography, or the berm will simply act as a short term water storage facility and allow the water to infiltrate into the dump. Large berms are often called terraces.

Berms are effective if they are constructed correctly and not expected to last forever. They will eventually fail as the berms do gradually retain sediment behind them there by reducing their capacity to store water and increasing the likelihood of overtopping. This risk can be minimised by employing very wide berms that have a back-sloping gradient that increases their storage capacity.

The size and back slope gradient of a berm should be based on the waste material present on the outer surface of the landform and the size of the upper slope batter (longer upslope batters will require larger berms to control the water). The required berm characteristics are detailed for each slope in the batter selector/design tool. Common to all berms are the following (refer to **figures 13 & 14**):

- The berm must have a width greater than or equal to the minimum berm width listed in the batter selector/design tool.
- The berm must have a back slope gradient greater than or equal to minimum back sloping gradient listed in the batter selector/design tool.

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- Berms can be divided into cells using cross bunds every 100m. This limits lateral movement of water along the berm. The floors of the cells should be ripped to increase infiltration rates.

- If the berm can intersect natural topography, the berms should be sloped towards it at a gradient of 2% to direct drainage off the waste dump. Hydrology advice must be sought to determine if further controls are required in this situation (such as rock armouring at the interface with the landscape).

The construction of the berm must be (refer to **figure 15**);

- thoroughly compacted and constructed of non hazardous low erodbility material;

- have their outer face continuous with the outer lift profile and have the same surface material applied to it

- Have their inner face sloping gradually inwards (back sloped)

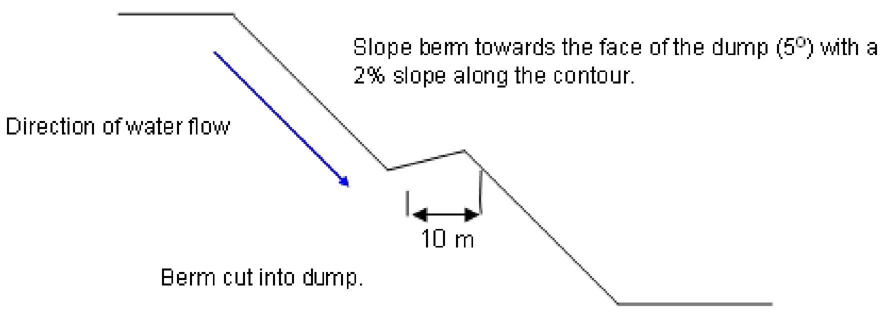

Figure 13 Example of correct berm construction (note the width and back slope will be determined by the batter selector tool)

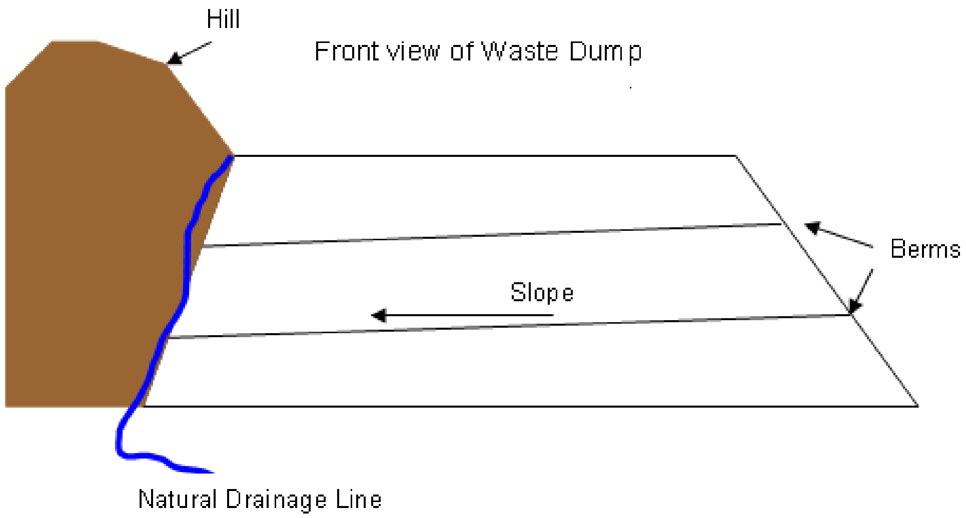

Figure 14 Front of a waste dump showing drainage directed to the natural drainage line

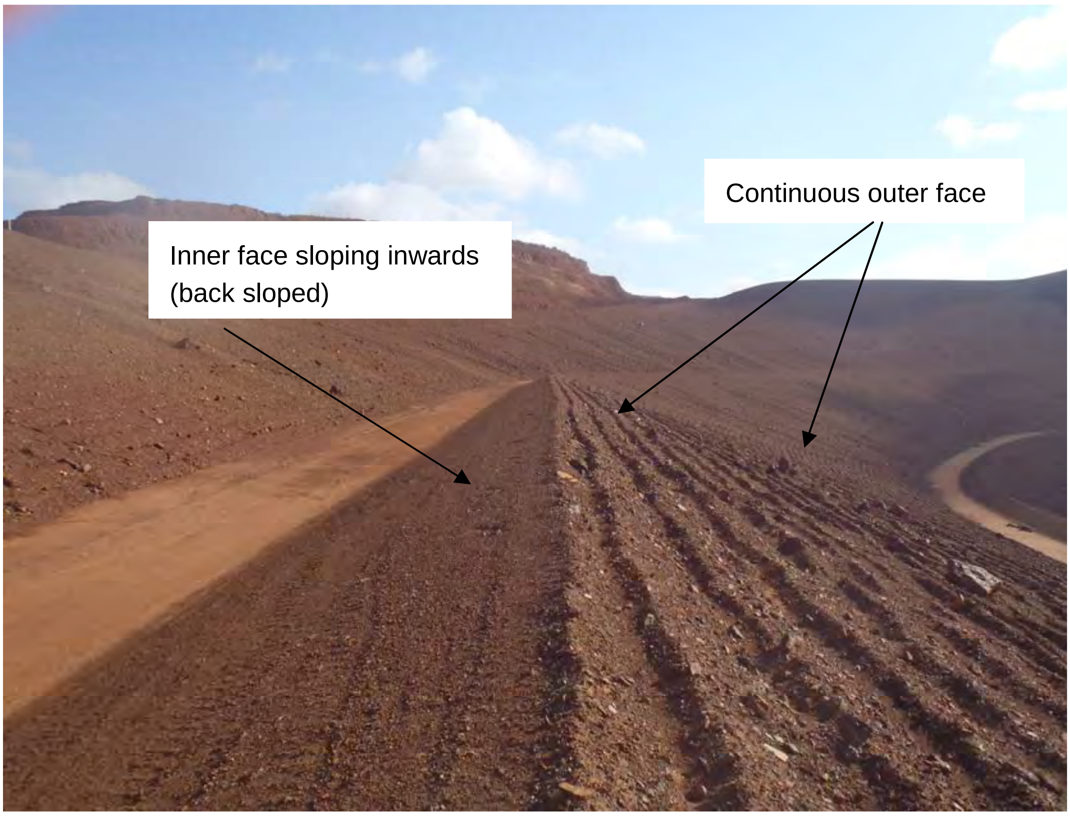

Figure 15 Example of berm construction showing back sloping of the berm and continuous outer slope

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3.6.4.2 Topsoil application

Topsoil is vital for rehabilitation success as it provides seeds and vegetation with the nutrients required for germination and growth. It also contains microbes and can be a seed store. Topsoil should be applied to waste dumps once reshaping work has been completed. Where possible topsoil should be sourced from nearby areas being disturbed as direct replacement of topsoil increases the quality of the soil. This also greatly reduces costs as the topsoil is only handled once.

The depth topsoil applied varies between 10cm and 20cm. This should be decided with guidance from the Rehabilitation Specialist and will be dependent on topsoil type and availability, slope length and gradient, and slope material type. Generally a depth of greater than 20cm results in increased erosion and loss of topsoil from the waste dump slopes and wastes a valuable resource.

Where topsoil cannot be directly replaced on to other rehabilitation areas, it should be collected and stored in stockpiles as outlined in the "Soil Resource Management Procedure" that can be located on the HSEQ website or in FDMS as RTIO-HSE-0011596.

3.6.4.3 Moonscaping

This technique was largely discarded in the mid 1990's after some failures in the region following heavy rain events. It is no longer considered an appropriate method to utilise due to continued failures of this technique in the Pilbara.

3.6.4.4 Contour Ripping

Application of contour ripping increases infiltration of water and traps both seed and nutrient on batter slopes. It is critical that ripping occur along the contour, and it is advised that rip lines be surveyed in prior to machinery commencing work. If ripping is completed off contour, water will tend to flow down slope along the rip lines and can cause serious erosion. Ripping should be completed as the very last stage of rehabilitation and will sometimes incorporate seeding. It is important to ensure seeding is completed as soon as possible on completion of ripping and must be done prior to any rainfall (as the soil can become crusted following rainfall and inhibit seed germination).

There are a number of options for ripping, including the depth of ripping and spacing between rip lines. The type of ripping performed should be decided in conjunction with the Rehabilitation Specialist and will vary depending on material characteristics, depth of topsoil available, slope length and gradient, and machinery available.

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3.6.4.5 Vegetation, Seeding, and Fertilisation

Vegetation cover is typically ineffective as a means of creating surface stability. However, in the long term vegetation can have some benefits in terms of stabilising the soil profile via the extension of their roots. The presence of roots can also increase infiltration rates, reduce runoff, and result in reduced erosion potential.

The best source of seed is from fresh topsoil collected from the mine site. If topsoil is not available, then only local provenance seed should be used in seeding mixes. The collection, storage and use of seeds are coordinated by the Rehabilitation Team. Further information is contained in the Rehabilitation Handbook (the reference and link to this is provided in section 1 of this document).

Seeding waste dumps is the final stage of rehabilitation and can occur via hand seeding or by machines. If seeding is completed with machines it is usually done in conjunction with ripping (the seeder is rear mounted on the dozer). Hand seeding is completed after the landform has been ripped.

Fertiliser may be applied at the time of seeding, but must not be mixed with the seed. Fertiliser is a one-off application. Rates of application should aim to replace the nutrient lost via stripping of vegetation and the disturbance and dilution of the topsoil with less fertile subsoil materials.

3.6.4.6 Base Windrows

A continuous windrow (at least 1.5m high) should be constructed around the base of all out-of-pit waste dumps, both active and inactive. The windrow ensures any sediment laden water that may discharge from the waste dump does not enter surrounding environment.

3.6.4.7 Other Surface Treatments

Vertical rock drains are not included as drainage control in these guidelines as the batter configurations are designed to deal with runoff on the batter slopes themselves. They are no longer recommended for use in the Pilbara. Rock lined drainage structures may however have a role where there is an obvious point to direct water, for example, at the interface between converging slopes or where water is directed toward an abutting natural feature. The discharge areas can be protected with competent rocky material.

Rock mulching or armouring (placing and lightly mixing coarse material into the surface of finer materials) increases surface roughness and can prevent concentration of overland flows. Planning of the waste dump should include the sourcing, storage, and transport of rocky material to the waste dump for this purpose, where required.

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Armouring with coarse tree debris can also be completed to reduce surface erosion and aid in seed establishment (by providing more favourable conditions for seed germination). Where used, it is recommended vegetation not be mulched chipped, have a diameter of 2-10cm, and be track-rolled with a dozer into 1-2m long lengths prior to spreading (longer pieces of debris tend to get caught in the dozer rippers). Tree debris should be applied to the slope and then ripped with a dozer to align the debris along the contour.

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4. References

Chandler, Willgoose, Hancock – Dump Design Guidelines (Environmental) May 2003.

Environment Australia - Landform Design for Rehabilitation - Best Practice Environmental Management in Mining, May 1998.

Environment Australia - Rehabilitation and Revegetation - Best Practice Environmental Management in Mining, June 1995.

Landloch – Erodibility Measurements on Samples from Hamersley Iron mines in the Pilbara Region. Revised Report. August 2001.

Landloch - WEPP simulations of stable (non rilling) slope lengths and heights, based on field rainfall simulator runoff and erosion data from Section 6, Tom Price Mine. April 2002.

Landloch – Review of Material Erodibility Measurements and Erosion Modelling, Hamersley Iron, Pilbara Operations. March 2003.

Landloch – Design Guidelines for Waste Dump Outer Batter Slopes, Hamersley Iron. June 2004.

Landloch – Final Landform Design Criteria for Use During Mine Planning. Rio Tinto Iron Ore, Western Australia. February 2012.

Vasey, Loch, Willgoose – Rough and Rocky Landforms. 2000 MCA Environmental Workshop

Government of Western Australia Department of Mines and Petroleum, "Waste Rock Dumps – Environmental Notes on Mining" September 2009. (Accessed 1st August 2012) http://www.dmp.wa.gov.au/documents/waste_rock_dumps.docx.pdf

Government of Western Australia Department of Mines and Petroleum, "Guidelines for Preparing Mine Closure Plans" June 2011, http://www.dmp.wa.gov.au/documents/Mine_Closure(2).pdf Accessed 1st August 2012. Environmental Protection Authority.

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5. Appendix A

Waste Dump Design Cheat Sheet

This cheat sheet is a summary of considerations discussed in “Rio Tinto Iron Ore (WA) Landform Design Guidelines” and aimed to be a quick reference guide.

Location:

- **Overall Design** - Will the design allow for progressive rehabilitation?
- **In-pit vs. Out-of-pit -** can the waste dump be in-pit, has the out of pit location been sterilised?
- **Approvals -** are there specific commitments for the site and waste dumps, what is the maximum dump height, do we have the correct approvals for out of pit dumps, have footprint constraints been considered (heritage, infrastructure, drainage lines), is there enough area to fit the rehab (pushed down slopes) and not just the dump to design?
- **Surface Water/Hydrology** - have surface water flows been maintained, will there be ponding against the waste dump, does the location avoid drainage lines/flood zones, will there be large water flows onto the waste dump from upslope areas, is the dump stand alone of abutting landscape, will it cause water ponding upstream?

Waste Dump Shape and Design:

- **Waste Type** - Has the waste type been considered, is it high, medium, low erodibility, has the batter selector/design tool been utilised, are there additional controls required such as encapsulating highly erodible material?
- **Slopes** – Is the slope length and gradient less than the recommended maximum for the material type and climate (from the batter selector tool) ? Have concave slopes been considered?
- **Surface Water Management** – does water flow onto the dump from the surrounding landscape – if so has hydrology advice been sought, has water flow from the top of the dump onto lower slopes eliminated?
- **Berms** - are berms required and have they been included in the design? Is the berm width and back slope angle greater than the recommended minimum for the material type, batter configuration, and climate? Will the berm width following dump construction be large enough to achieve the minimum berm width for the rehab design?
- **Top of the Dump-** Has the dump top surface design been considered, is there competent material and access available to achieve it (e.g. continuous windrow around perimeter) ?

Surface Treatment:

- **Topsoil-** has topsoil been sourced and volumes required calculated? Is there any nearby disturbance that could supply topsoil?
- **Rock Armouring** – is armouring or other treatments required to ensure stability of slopes, is there enough competent rock available for armouring, where will it be sourced from, is there space available near the dump for it to be stored?
- **Base Windrow** - has a windrow around the base of the out-of pit waste dump been included in the design; is there adequate material to achieve this?
- **Rehab Design and Conversion to Dump To Design -** does the “dump to” design enable achievement of the rehab design (including clearance at toe of dump, minimum berms widths) ?

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Iron Ore (WA)

Rehabilitation Handbook

March 2011

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Contents page

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1 Introduction

1.1 Purpose of the Handbook

The aim of this document is to be a practical guideline for rehabilitation activities. The emphasis is on providing all personnel involved with rehabilitation an overview of the process and basic understanding of factors involved in planning and implementing rehabilitation activities. The handbook contains links to other relevant documents within the business.

The main areas covered by this handbook include:

- Soil Resource Management;
- Approvals Co-ordination system (Approvals Requests);
- Rehabilitation (Waste dumps, Tailings Storage Facilities', Borrow Pits, Exploration);
- Records and Data Management;
- Revegetation; and
- Monitoring.

This handbook is closely linked to the RTIO (WA) Rehabilitation Management Plan (RTIO-HSE-0058421). This plan contains the process steps and key accountabilities involved in rehabilitation across Iron Ore (WA) Pilbara operations. The Rehabilitation Management Plan contains further details regarding:

- Legal & regulatory requirements;
- Corporate requirements;
- Objectives and targets ;
- Roles and responsibilities; and
- Planning processes.

The content of this document is based on government and industry guidelines, legislation and current best practice within the mining industry. It is a working document subject to periodic review and update.

2 Soil Resource Management

In the Pilbara, soils are often of poor quality with very little organic matter. However, many Pilbara plants produce large numbers of seeds which accumulate in the soil and become a vital resource for rehabilitation activities. Soil Resource Management is therefore essential to achieve successful rehabilitation post mining and disturbance.

The Soil Resource Management Procedure (RTIO-HSE-0011596) outlines the overall requirements and responsibilities relating to the five main stages of soil management;

- Planning;
- Recovery;
- Stockpiling & Storage;
- Dispersal; and
- Monitoring & Reporting.

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The Procedure documents the standard for topsoil and subsoil stripping and handling on all Iron Ore (WA) Pilbara operations. This standard is aimed at maximising topsoil recovery while retaining soil viability and productivity to maximise future success in rehabilitation programs. As Iron Ore (WA) conducts ground disturbing activities as part of its operations, it is vital that soil resources are understood and managed in a responsible manner with the intention of future use.

Records and data management is vital to track location, volume and to maintain quality of data. For soil resources, it is important to ensure that mapping follows the Data Standard - Soil Stockpiles (RTIO-HSE-0056798). This data standard provides the required formatting for all soil stockpile data.

3 Rehabilitation Planning and Implementation

3.1 Introduction

Rehabilitation across RTIO sites requires strategic planning and implementation. The RTIO (WA) Rehabilitation Management Plan (RTIO-HSE-0058421) outlines the process steps and key responsibilities involved with rehabilitation across Pilbara operations. The document provides an overview of:

- Corporate and regulatory requirements;
- Baseline data collection requirements;
- Rehabilitation planning, implementation and monitoring processes;
- Roles, responsibilities and accountabilities;
- Rehabilitation goals and business targets;
- Links to procedures, guidelines and standards; and
- Data and records management.

The Rehabilitation Management Plan provides details on operational planning in which mining operations complete the 5 year mine plan, the Quarterly Production Plan (2 year mine plan) and the short term plan (13 week mine plan). Rehabilitation management requires integration into operational planning to allow for activities to be appropriately incorporated. The areas which are available for rehabilitation are identified and scheduled through the 5 year mine plans. The Sustainable Development Template - 5 Year Mine Plans (RTIO-HSE-0062073) document is used as a template for required information in the 5 year mine plans.

The Progressive Rehabilitation Process and Responsibilities (RTIO-HSE-0083199) document contains the process steps and requirements for rehabilitation across the Pilbara mining operations.

3.2 Approvals Coordination

The Approvals Coordination process must be followed for any ground disturbance, including rehabilitation activities. This ensures that environmental, heritage, tenure and other factors have been considered and required approvals obtained.

An application for an Approvals request permit should be made as early as possible as it can take some time (several months or more depending on the complexity of the proposal) to obtain approval.

Approvals permits are purpose specific; any area to be rehabilitated requires an approvals request to be submitted over the entire area for the purpose of rehabilitation.

For further information please refer to Iron Ore Intranet - Approvals Coordination.

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3.3 Waste Dumps

3.3.1 Waste Dump Design

When the need for a new waste dump has been identified the environmental, economic and safety constraints need to be considered. The final rehabilitation requirements also need to be assessed and a waste dump should not be created unless the final rehabilitation design is achievable; as this will ensure that the total cost of the liability created is known and accounted for. Designing the waste dump with rehabilitation in mind can also reduce the final cost of rehabilitation as it minimises the rehandling of waste that is required, and the configuration and stability of the waste dump can be optimised during construction to minimise erosion and facilitate progressive rehabilitation.

To assist in designing waste dumps a guide is available in the "Pilbara Iron Landform Design Guidelines (IEMS-PI-PRO-069)" and as follows.

Factors to consider in developing a waste dump rehabilitation design for waste dumps include the following:

Existing commitments –

- Project approval commitments in ministerial statements and management plans
- Rio Tinto Group commitments in the Closure Standard and Environment Standards
- Closure plan commitments and requirements

Construction method / Schedule –

- Will the design allow for progressive rehabilitation?
- Is there sufficient access to the area for heavy equipment?

Location

- Are there any topographic / landscape limitations such as height limits?
- Are there any infrastructure limitations such as the placement of power lines?
- In-pit vs out of pit - can the waste dump be situated in-pit?
- Has the area been sterilised for ore?
- Do we have the correct approvals for out of pit dumps?
- Is there sufficient tenure area for waste dump rehabilitation?
- Is the dump against a steep hill? Is the dump the highest point of elevation? Are there other options?

Water Management

- What is the proximity to the underlying aquifer?
- Has the impact of surface water run off been assessed related to potentially acid forming (PAF) material?
- Have surface water flows been mapped / maintained? Are culverts required? Will there be ponding against the waste dump? Will there be large water flows onto the waste dump?
- Is there sufficient drainage?

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- Will water pool away from the edge of the dump and away from berms? Is the waste dump sloped so water will drain towards natural topography? Has water flow off the top of the dump been eliminated?

Waste Materials

- Has waste material been classified as high, medium or low erodibility?
- Have the slope lengths been minimised? Is the slope length less than the recommended maximum for the material type? Are berms required to reduce slope lengths?
- Is the gradient less than the recommended maximum for the material type?
- Have concave slopes been considered (See Plate 1)?
- Does the waste dump contain sulfidic or fibrous materials?
- Have the requirements of the RTIO (WA) Spontaneous Combustion & ARD (SCARD) Management Plan for Operations (RTIO-HSE-0010872) and Fibrous Materials Management Plan (RTIO-PDE-0062061) been met?
- Is there the opportunity to stockpile inert/neutralising material for rehabilitation during construction of a waste dump with hazardous or PAF materials?

Surface Treatments and Soil

- Are berms required and have they been included in the design?
- Has topsoil been sourced and volumes required calculated? Is there any nearby disturbance that could supply topsoil?
- Has ripping been considered and contours identified to ensure correct angles for ripping?
- Where seeding is required; are local provenance seeds available and when will they be applied (eg with ripping or after ripping via hand)?
- Have all other options been considered; for example rock or vegetation armouring; have rocks/vegetation sources been identified?
- Has a windrow around the base of the out-of pit waste dump been included in the design?

Consultation and communication –

- Have relevant stakeholders including operations personnel been consulted on the rehabilitation design?
- Have internal specialists been consulted in order to determine the characteristics of the design?

3.3.2 Waste dump design - Cost Estimation

In order to budget for rehabilitation of waste dumps, there are requirements to complete a cost estimation of the works required. The characteristics of the projects are also used in the preparation of tender documents for rehabilitation projects.

Internal cost estimations are useful in assessment of contractor tenders for RTIO projects.

The Rehabilitation Design and Approval Process (RTIO-HSE-0072956) details the information requirements needed and should be included in the design memo for sign off.

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3.3.3 Waste dump design – Sign off

Once the design has been developed, review and sign off is required by the following roles:

- Manager Long Term Mine Planning
- Specialist Mining Engineer
- Specialist Geotechnical Engineer
- Specialist Hydrologist
- Specialist Rehabilitation
- Specialist Environment (Geology)
- Technical Services Superintendent

It is recommended that a memorandum is developed, which contains the design information as detailed in Rehabilitation Design and Approval Process (RTIO-HSE-0072956). The memorandum should also detail the location of all design files and layers.

Plate 1: Illustration of a concave slope design (left photo with topsoil applied, right photo without topsoil)

3.4 Flat and Undulating Areas

Flat and undulating areas include laydown areas, haul roads, building sites and bitumen roads. Rehabilitation of these areas should include:

- Removing or burying all rubbish and infrastructure before rehabilitation is carried out.
- Removing any contaminated soil, or designated hazardous materials to be remediated separately.
- Reforming the area so that it blends in with the surrounding landscape, including knocking down spoil piles and if possible reinstating any drainage lines that was present prior to clearing.
- The final profile of the constructed drainage line should consist of a flat base and sloped banks to allow for free drainage. Depth should not exceed 0.5m.
- The channel width should depend on the volume of water that is anticipated to flow down the channel. When constructing the channel all effort should be made to blend the constructed channel in with any natural drainage lines. For areas where friable, easily erodible material exists, or where there is the potential for high volume flows, it may be necessary to cover the base of the constructed channel with BIF rock material or available equivalent.

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- Any steep slopes that have been artificially made need to be dozed to less than 20 degrees or rock armoured to prevent erosion.
- If the area is large with a slight slope, then windrows should be constructed on the contour approximately every 50m to prevent large sheet water flows.
- Roads are usually ripped along their length if they are not wide enough for contour ripping. If a treatment such as a salt or acid based dust suppressant has been used on the road then clean fill maybe required over the road so that plant germination is not suppressed.
- Re-spread topsoil windrows and stockpiled vegetation onto haul roads, and deep rip to 800 mm to break up as required for seedling establishment. If seeding is required, contact the Rehabilitation Specialist.

3.4.1 Tracks

- Determine whether tracks will require rehabilitation. Those where top soil has not been removed and compaction is limited to only wheel tracks may be best left to rehabilitate naturally.
- Tracks which will serve no ongoing useful purpose for either RTIO Pilbara operations or other land users should have access blocked, be closed and rehabilitated. Consultation with relevant stakeholders should take place prior to track closure and rehabilitation.
- Tracks where top soil has been removed should be rehabilitated by pushing in the wind rows and re-spreading topsoil and vegetative material.
- Re-establish the natural landform and drainage patterns.
- Tracks should be ripped or scarified, depending on the amount of compaction present. On slopes, rip parallel to contours. This will prevent erosion, retain water and promote plant establishment.

Figure 2: Exploration track and drill pad rehabilitation

3.5 Tailing Storage Facilities

Several sites produce tailings as a result of the mining process. Tailings are usually deposited into a designed storage facility or completed pit area.

The same design criteria used for waste dumps need to be applied to coarse tailings dumps. However, due to the erodible nature of the coarse tails, geotechnical investigation work has been undertaken on the historical dumps in order to assess their engineering properties, and this needs to be taken into account when creating a design. Capping material may be required to ensure vegetation growth.

There is currently no defined procedure for the rehabilitation of the tailings facilities in the Pilbara Operations. The site closure plans generally assume a capping layer would be required. Tailings rehabilitation requires trials to be implemented in order to develop our requirements. Where drainage from the dams is sufficient, tailings dams generally dry out within one to two years and may be top soiled, ripped and seeded. In regard to use of coarse

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tailings in rehabilitation please refer to the Landform Design Guidelines and erodibility references in the Appendix.

3.6 Borrow Pits

Borrow pits are area's from which construction materials have been removed to provide sand, gravel or rock for building or fill purposes. Borrow pits should be rehabilitated as per the Borrow Pit Specification and Management Procedure (RTIO-HSE-0010872) .

The purpose of the procedure is to outline the principles and objectives for development, operation and rehabilitation of new and existing borrow pits. This procedure makes reference to particular issues in borrow pit specification and design. The document also includes a checklist for the selection, design; operation and rehabilitation of borrow pits.

3.7 Other infrastructure e.g. (Haul Roads, ROM etc)

Rehabilitation of haul roads and Run of Mine (ROM) pads are designed and undertaken with site specific details such as tenement, utilities and infrastructure determining the requirements. Follow rehabilitation procedures as outlined for Waste Dumps when rehabilitating these areas.

Compacted areas such as Laydown's and roads require deep ripping (dozer Tyne at full depth of 1-1.5m). Deep ripping is required in these areas to increase infiltration and allow vegetation re-establishment.

3.8 Other areas

Areas that are not covered by this guideline may need to be rehabilitated on a case by case basis, dependant on a number of factors. Examples of this might include pits, in-pit waste dumps and land bridges. Advice should be sourced from Technical services and Environment.

Emergency access areas such as fire breaks should be rehabbed as per section 3.9 or utilising a grader to scarify the surface. Due to the low levels of disturbance some of these areas may rehabilitate naturally. Where areas are naturally rehabilitating, consult with the Rehabilitation Specialist to see if they will meet rehabilitation requirements.

3.9 Exploration and Evaluation Areas

Rehabilitation of exploration areas must take place within 6 months of excavation unless approval has been granted by the Department of Mines and Petroleum. The following procedure is used for planning rehabilitation of exploration areas. The Operational Control Procedure 7 - Closure, Rehabilitation and Monitoring (RTIO-HSE-0010718) contains further details related to exploration related rehabilitation.

3.10 Specialist Skills

Completion of rehabilitation earthworks is quite different in nature to civil and mine development earthworks. Completion of rehabilitation activities needs to be completed by experienced operators and supervisors that have an understanding of what the required outcomes are.

In completion of any rehabilitation project, supervision during the works is vital and needs to be completed by a knowledgeable/experienced person.

4 Mineral Waste, Sulfidic and Hazardous Materials Management

The RTIO (WA) Mineral Waste Management Plan (RTIO-HSE-0040347) provides the requirements for assessing and managing risks associated with mineral wastes. The Fibrous Minerals Management Plan should also be followed for fibrous material.

Sulfidic materials should be managed as per the RTIO (WA) Spontaneous Combustion & ARD (SCARD) Management Plan for Operations (RTIO-HSE-0010872). This document outlines the accountabilities and requirements in order to manage environmental, social and economic impacts of sulfidic materials.

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Design and rehabilitation criteria for waste dumps containing sulfidic materials are contained in the SCARD management plan.

5 Records & Data Management

It is critical that rehabilitation methodologies are documented and recorded. This information often proves vital in explaining results and when interpreting monitoring results.

5.1 Prior to Rehabilitation Project

- Develop rehabilitation design and scope in conjunction with Rehabilitation Specialist. Obtain sign off on scope;
- Ensure all designs, cost estimation, scoping documents and tender information are appropriately stored and accessible (see section 3.3.2 for waste dumps); and
- Ensure Contractor Management and mobilisation procedures are followed.

5.2 During Rehabilitation Project

- Ensure that the Rehabilitation Daily Recorder (RTIO-HSE-0070196) is being filled out daily and stored for the duration of the project. This information is used in future cost forecasting.

5.3 Upon Completion of Rehabilitation

- Erect appropriate signage using IEMS Site Signage Templates (RTIO-HSE-0068873) and the Branding Guidelines http://rtio.riotinto.org/KeyInformation/Brandguidelines/ to advise that rehabilitation is in progress and personnel are not permitted to enter the area;
- Document the rehabilitation procedures implemented. Use the Rehabilitation Record Template (RTIO-HSE-0069300) to document rehabilitation works;
- Provide data requirements to the Rehabilitation Specialist. The data should follow the Data Standard - Rehabilitation & Disturbance (RTIO-HSE-0059592) a template is available on O:\Environment\Rehab_Disturbance 'Rehabilitation Areas Template';
- Submit completed Rehabilitation Daily Recorder (RTIO-HSE-0070196) sheets and summary of works to Rehabilitation Specialist; and
- Complete Waste dump data sheet (if project involved rehabilitation of a waste dump) Waste Dump Environmental Data Sheet.

6. Revegetation

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. The size of the rehabilitation area will normally determine if the area should be seeded by hand, or by machinery and a specially design seeder. Any area greater than about 3 ha is usually mechanically seeded, as it is quicker and more cost effective. The Rehabilitation Specialist is responsible for seed planning and purchasing.

Revegetation works requires integrative planning with seed sourced from the Seed Shed in Dampier operated and managed by RTIO CCWE team. The facility is kept at cool temperatures to enable seed to be stored for a number of years. Revegetation works requires seed sourcing notification as soon as practicable, usually up to a year in advance to ensure

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suitable species are collected during the picking season. Please refer to the Seed Shed Management Plan (RTIO-HSE-0011489) for further information about the seed shed.

Figure 3: 2 year old rehabilitation at the Lens C Concave slope

6.1 Seed Mixes, Mechanical Seeding and Fertiliser Application

The seed mixes should be based on the vegetation mix in the surrounding the area (i.e. the species present, and their percentage of the total). For botanical details refer to the Revegetation reference site reports available from the Rehabilitation Specialist. The Rehabilitation Specialist is responsible for seed mixes.

Seed mix lists need to be sent in conjunction with the seed, so that they can be passed onto the seeding contractor, and also to assist with future interpretation of monitoring results, and should provide information on:

- Species used
- Total weight of seed sent
- Weight of each species within the mix (to calculate % of species within the seed mix)
- Assumed weight of seed/ha

Seed used for rehabilitation is required to be provenance seed, that is, it is collected from the local bio-geographical area. Picking seeds requires a licence from the Department of Environment and Conservation.

If mechanical seeding is being carried out, then the seed mixes need to be divided (eg heavy seed, light seed) to suit the compartments within the seeder – the contract seeder should be contacted for this information.

Mechanical seeding and fertiliser application is organised by the Rehabilitation Specialist as part of a rehabilitation scope. Mechanical seeding uses a specially designed seeder attached to the ripper bar of the dozer to carry out the ripping. The rehabilitation area is then ripped, seeded and fertilised at the same time. This method delivers seed directly into the fresh rip lines where it should gain the most moisture and have the best chance of survival.

6.2 General ripping requirements

Deep ripping increases the infiltration of water into the soil, traps run off, and reduces erosion, and produces a favourable germination niche for seeds to settle. Ripping can be done either along the contour, or sloped to a natural surface to facilitate the run-off of excess water. It is very important that at least one line should be surveyed in for each waste dump to provide an accurate guide for the dozer operator.

Ripping of waste dumps should be carried out using a dozer with a three tine ripper attached. The three tines speed up the ripping process as well as making it easier to track rip the area,

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so no compacted track marks are left in the rehabilitation area. It is imperative that ripping is completed accurately along contours to avoid low spots susceptible to erosion.

If ripping and seeding are not being done simultaneously, then ripping should be done immediately following the re-contouring and top soiling of an area. Rip as deep (1.0-2.0 m) as possible. If this results in a large amount of rock being pulled up to the surface, reduce the depth of ripping until this no longer occurs. The spacing between rip lines should be no greater than 1.5 metres apart.

6.3 Revegetation Scheduling

The following information is useful for revegetation scheduling:

- Seed collection seasons are generally on an annual basis subject to environmental conditions
- Rehabilitation needs to be planned well in advance in order to give sufficient time for seed collection of required species and quantities
- Contract seeding and dozers with triple tyne attachments generally need to be organised up to 3 months before rehabilitation work
- Fertiliser is typically obtained via stores, and brought in 40kg bags fur to ease in application; and
- At least 2-3 weeks notice is usually required for direct seeder operators.

7 Monitoring

7.1 Purpose/Objectives

The objective of the monitoring program is to monitor progress and evaluate the successional development of the rehabilitation and thereby provide useful feedback for the improvement of rehabilitation techniques. This can help assess progress towards long term rehabilitation objectives.

Monitoring also provides vital information which can be used to set realistic and achievable completion criteria. The objective can be achieved by examining changes in key parameters over time, and by comparing results from the rehabilitation with those from corresponding reference sites.

Relinquishment can only be achieved after an assessment by stakeholders demonstrates the rehabilitation objectives and criteria have been met. For vegetation this generally means re-establishing a vegetation community similar to that present in an adjacent control area in terms of composition, structure and function.

7.2 Location and Schedule

The Environment group conducts rehabilitation monitoring on an annual basis at a number of sites. The Rehabilitation Monitoring Schedule contains information in regards to the monitoring transects, their location and schedule information in regards to past and future monitoring. Monitoring is generally conducted during the cooler months from May to August and is coordinated by the Rehabilitation Specialist.

Locations of the monitoring and control sites can also be accessed on GIS (O:\Environment\Rehab_and_Disturbance\Rehab_Monitoring_Locations).

It is important that Site Environmental Advisors understand the location of monitoring sites, as this can assist during approval request assessments. The proposed disturbance of a monitoring site should be discussed with the Rehabilitation Specialist.

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7.3 Monitoring Methods

7.3.1 Revegetation monitoring

The Vegetation Monitoring Procedure - Rehabilitation (RTIO-HSE-0010757) details the monitoring methodology for assessing vegetation development. The procedure requires transects to be established in rehabilitation and an associated control site. The transects are comprised of a number of 2x2 meter quadrats in which vegetation parameters such as species number and % cover are recorded.

The rehabilitation development is compared to the control site values. Data analysis is completed by an external consultant to assess the progress towards an acceptable outcome.

7.3.2 Erosion monitoring

Iron Ore (WA) has an Erosion Monitoring Procedure (RTIO-HSE-0011605) that is implemented on rehabilitated waste dump slopes. The erosion monitoring is carried out on the same schedule and transect as the vegetation monitoring transect.

The monitoring involves the examination of transects for the number of rills and gullies and their width and depth. Sedimentation loss can also be estimated by constructing dams at the base of the waste dump or control, from which loss per unit area can be measured. These measurements can then be compared for change over a time frame.

Erosion is one area of performance criteria that can be used to assess the progress of the rehabilitation and the degree to which objectives are being met. This may indicate whether further management intervention is required in order to achieve acceptable landform outcomes.

Sediment loss and long term stability are both dependent on erosion rates. By measuring both stability and sediment loss over time along the same transects, for both rehabilitated areas and controls, the overall success of the rehabilitation from an erosion perspective can be established.

Natural or control slopes will have been eroding over thousands of years, and therefore should be stable with only low rates of sediment loss and stabilised gully formations. Baseline erosion data can be obtained from these slopes in order to develop acceptable erosion criteria for slopes.

7.3.3 Ecosystem Function Analysis

Ecosystem Function Analysis (EFA) is a monitoring methodology that uses indicators observed in the field to assess function of landscapes from a biophysical perspective. The data is compared to local analogue or control sites, which capture any changes resulting from climatic fluctuations. In successful rehabilitation, steady improvements are expected, in soil structure and soil protection, vegetative cover and development, and stability of erosion features, these are indicators of rehabilitation success. EFA data should gradually trend upward and plateau as the ecosystem becomes stable and self-sustaining.

EFA is made up of three modules:

- Landscape function analysis (LFA);
- Vegetation composition and dynamics; and
- Habitat complexity.

The EFA monitoring methodology is being implemented at the Robe Valley sites (Mesa J, K, L,M). Further information on EFA can be found on the CSIRO website.

7.4 Reporting

Reporting progress of rehabilitation is a regulatory requirement. A summary of results of rehabilitation monitoring is included in the Annual Environmental Report. Rehabilitation data may also be reported as part of Native vegetation clearing permits and Rio Tinto S&E surveys.

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Refer to the Environmental reporting plan, timelines and guidelines (RTIO-HSE-0033128) for further information about reporting requirements.

7.5 Completion Criteria & Closure

Iron Ore (WA) does not currently have detailed and agreed completion criteria. Conceptual closure objectives have been included in site closure plans. Work has commenced on the development of rehabilitation completion criteria, and is expected to continue through 2010.

For further information in regards to closure plans, access the Sustainable Development website or the Closure Planning Specialist.

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Appendix 1

Landform Design Related Documents

Chandler, L. (2002), Dump design guidelines (environmental) (RTIO-PDE-0054883)

Chandler, L. (2006), Geomorphic design of stable engineered landforms in a semi-arid environment, PhD thesis, University of Newcastle (RTIO-PDE-0023842)

Erosion Related Documents:

Landloch pty ltd (1997), Field rainfall simulator studies, Mt Tom Price, 1. Field and laboratory data in a spreadsheet format.

Landloch (1998), Field rainfall simulator studies. project Np. 9107. Runoff and erosion properties and management of waste rockslopes, Mt Tom Price mine. 2 Data interpretation and computer simulations of hillslope erosion (RTIO-PDE-0054886)

Landloch (1998), Field rainfall simulator studies. Project No. 9107. Runoff and erosion properties and management of waste rock slopes, Mt Tom Price, Supplement 1998 (RTIO-PDE-0054887)

Landloch pty ltd (1998), Waste dump rehabilitation for Hamersley Iron at Tom Price, Phase 2 – Investigation, Laboratory investigation of erodability of a range of spoils.

Landloch pty ltd (1998), Waste dump rehabilitation for Hamersley Iron at Tom Price, Results of flume investigations of the stability of rock mulches.

Landloch (2001), Erodibility measurements on samples from Hamersley Iron mines in the Pilbara region. 1. Results of laboratory studies, WEPP and SIBERIA parameter derivation, runoff and erosion modelling using WEPP (RTIO-PDE-0054888)

Landloch (2002), Particle size, cohesion, and erodibility Pilbara Mines (RTIO-PDE-0054889)

Landloch (2002), WEPP simulations of stable (non-rilling) slope lengths and heights, based on field rainfall simulator runoff and erosion data from Section 6, Tom Price Mine (RTIO-PDE-0054881)

Landloch (2003), Review of Material Erodibility Measurements and Erosion Modelling, Hamersley Iron Pilbara Operations (RTIO-PDE-0054885)

Landloch (2003), Soil particle size distribution report, Progress report.

Landloch (2006), Field rainfall simulator and overland flow study of waste and topsoil erodability - Nammuldi and West Angelas Mines - Pilbara Iron (RTIO-HSE-0036709)

Lu, Hua et. al, (2001), Prediction of sheet and rill erosion over the australian continent, incorporating monthly soil loss distribution, CSIRO Land and Water, Technical Report 13/01 (RTIO-PDE-0056719).

Soil and Rock Engineering (1996), Proposed coarse tailings rehabilitation, Slope stability and design issues, Tom Price.

Willgoose, G. and Hancock, G. (1998), Erosion simulation of 3 sisters formation and original topography at the Hamersley Iron, Tom Price mine, Western Australia, Progress report.

Vegetation related documents

RTIO-HSE-0086578 - Viability tests - Triodia - Mulga research centre 1996:
http://iodms/iodms/drl/objectId/090188a3802c4ee4

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RTIO-HSE-0086577 - Spinifex re-establishment AMIRA Report June 1999:
http://iodms/iodms/drl/objectId/090188a3802c4ee1

RTIO-HSE-0086576 - Spinifex re-establishment AMIRA Report May 1999:
http://iodms/iodms/drl/objectId/090188a3802c4ee0

RTIO-HSE-0086576 - Spinifex re-establishment AMIRA Report May 1999:
http://iodms/iodms/drl/objectId/090188a3802c4ee0

RTIO-HSE-0086574 - A review of the Acacia - Acacia victoriae - Maslin 1992:
http://iodms/iodms/drl/objectId/090188a3802c4ede

RTIO-HSE-0086573 - A review of the Acacia - Acacia bivenosa - Chapman 1992:
http://iodms/iodms/drl/objectId/090188a3802c4edd

Soil related documents

RTIO-HSE-0086575 - Soil Microbiology for revegetation AMIRA Final Report May 1995:
http://iodms/iodms/drl/objectId/090188a3802c4edf

Ecohydrology related documents

RTIO-HSE-0188053 - Ecohydrological Characterisation of the Natural and Rehabilitation ecosystems at Newcrests Telfer Mine (Meriwa report no. 297 Dec 2012):
http://iodms/iodms/drl/objectId/090188a380689c9a

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Appendix B

36. Yandicoogina legal review and register of obligations

Attachments:

- LAORS table of obligations
- Freehills general closure obligations

47 pages

LAORS Approval / Agreement and Legislative Requirements Report

Type: Approval / Agreement, Site Name: Yandicoogina, Project Name: All, Discipline: Environment, Approval Type: All, Regulatory Body: All, Status: All, Closure Obligation: Yes, Enviroment Reporting Requirement: No, Included Historic: No, Phase Regulatory: All, Phase RTIO: All, Document Details: No

Site Name	Project Name	Discipline	Type	Expiry Date	Title	Reference No	Requirement	Approval Type	Regulatory Body	Resp Person	Deleg / App Person	Phase Regul.	Phase RTIO	Status	Cl Obl	Env Rep Req	Enviro Report Type	First Report Due Date	Rep Freq	Comments
Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.1 Decommissioning and Rehabilitation	Within 12 months following commissioning of the Junction South West or Oxbow pits, whichever is first, the proponent shall prepare and implement a Yandicoogina Decommissioning and Rehabilitation Plan in accordance with the Guidelines for Preparing Mine Closure Plans, June 2011 and any updates to the requirements of the CEO on advice of the Department of Mines and Petroleum.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y	MSR C	30/04/2012	Annual	
Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.2 Decommissioning and Rehabilitation	The Yandicoogina Decommissioning and Rehabilitation Plan required pursuant to condition 9-1 shall ensure that closure planning and rehabilitation are carried out in a coordinated, progressive manner and are integrated with development planning, consistent with current best practice, and the agreed land uses.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y	MSR C	30/04/2012	Annual	

Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.3 Decommissioning and Rehabilitation	The Yandicoogina Decommissioning and Rehabilitation Plan required pursuant to condition 9-1 shall set out procedures to: (1) manage long-term hydrogeological impacts of mining the channel iron deposit; (2) model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of waste material landforms; (3) manage over the long-term the surface water systems affected by the open pit; (4) progressively rehabilitate all disturbed areas to a standard suitable for the agreed end land use(s), with consideration and incorporation of: (a) the characteristics of the pre-mining ecosystems within the project area (through research and baseline surveys); (b) the performance of previously rehabilitated areas within the mining lease; (c) the performance of rehabilitation areas at the proponent's other operations in the Pilbara; and (d) best practice rehabilitation techniques used elsewhere in the mining industry. (5) develop and identify completion criteria; (6) monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria; (7) report on the rehabilitation and monitoring results; (8) remove all infrastructure; (9) develop management strategies and/or contingency measures in the event that operational experience and/or monitoring identify any significant environmental impact as a result of the proposal; (10) manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates; and (11) develop a 'walk away' solution for the decommissioned mine site.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y				

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Advice

General closure obligations

10 September 2013

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Contents

Table of contents

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Contents

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Contents

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General closure obligations

Scope

This document outlines the general obligations relating to mine closure that arise under legislation and common law (**General Obligations**).

It is intended that this document be read in conjunction with any review of the specific closure requirements that apply to each particular Rio Tinto Iron Ore (**RTIO**) operation (ie under State agreements, approvals, licences and other commitments).

Key issues

The main sources of General Obligations relating to the closure of RTIO's sites arise from:

- *Guidelines for Preparing Mine Closure Plans*, published jointly by the Department of Mines and Petroleum (**DMP**) and the Environmental Protection Authority (**EPA**) (the **Guidelines**);
- environmental licensing and pollution control provisions under Part V of the *Environmental Protection Act 1986* (WA);
- obligations and approvals under the State Agreements to which RTIO is a party;
- obligations and approvals under the *Environmental Protection (Controlled Waste) Regulations 2004* (WA);
- obligations and offences under the *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA);
- obligations and offences under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth);
- obligations arising under the *Contaminated Sites Act 2003* (WA);
- requirements imposed by the *Mining Act 1978* (WA) (**Mining Act**) and the *Mining Regulations 1981* (WA);
- obligations imposed by the *Mines Safety and Inspection Act 1994* (WA) and *Mines Safety and Inspection Regulations 1995* (WA);
- offences created under the *Criminal Code Compilation Act 1913* (WA);
- standards set by ISO 14001:2004; and

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- common law liability arising from:
  - nuisance;
  - negligence;
  - breach of statutory duty; and
  - standards of reasonableness and the relevance of guidelines and codes of practice.
- agreements arising from negotiations with Traditional Owners; and
- obligations arising from joint venture arrangements.

This review also comments on:

- the Rio Tinto Closure Standard (V4.0 2012); and
- future legal developments that may affect closure standards.

Recommendations

We note that this document relates only to the General Obligations as at 10 September 2013. Environmental law is a rapidly developing area of law. This advice should be reviewed and updated every 5 years initially, with more frequent reviews occurring closer to the time of closure for a particular RTIO site.

We also note that this document relates only to a long term plan for site closure.

We recommend that RTIO consider planning for a forced, rapid closure scenario to ensure legal risks in that instance are appropriately managed.

Further, we recommend that RTIO review the specific obligations and closure plans in respect of each particular RTIO operation.

This document does not cover RTIO's contractual relations with contractors and other third parties. If it does not already do so, RTIO should have a process for dealing with those relations in a closure scenario.

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Detailed advice

1 General commentary – managing different types of legal risk

In considering the General Obligations for closure outlined in this document, it is important to be aware of the nature of the obligation imposed on RTIO.

The process of identifying the nature of the obligation imposed on RTIO will enable RTIO to:

- eliminate the legal risks that can be eliminated; and
- properly manage the legal risks that cannot be eliminated,

when planning for closure (eg take practical steps to relinquish or minimise particular legal risks to the extent they can be).

1.1 Risk categorisation under the Environmental Protection Act

RTIO's most serious potential environmental liabilities arise under the *Environmental Protection Act 1986* (WA) (**EP Act**) and associated regulations. These liabilities also include a range of potential offences (see discussion in parts 3 and 5 of this document).

Offences under the EP Act can relevantly be categorised on the basis of whether they apply to:

(a) the occupier of the relevant premises;

(b) 'any person'; or

(c) the holder of a licence, works approval or other authorisation.

1.2 'Occupiers' and 'holders of a licence, works approval or other authorisation'

In relation to category (a) and (c) risks, there are some basic steps that RTIO can take to eliminate (or at least reduce) its risk exposure.

For offences which apply to the occupier of the relevant premises, only the occupier may be prosecuted. Section 3 of the EP Act provides that 'occupier', in relation to:

(a) any premises: means a person who is in occupation or control of those premises, whether or not that person is the owner of those premises; or

(b) premises different parts of which are occupied by different persons: means, in relation to any such part, a person who is in occupation or control of that part, whether or not that person is the owner of that part.

Examples of occupier offences include the duty on occupiers to take certain measures under section 51 of the EP Act (see discussion in part 4.10 of this document). In relation to this category of liability, it is possible for RTIO to take steps to eliminate (or at least reduce) its potential liability by ceasing to occupy the premises.

Similarly, in relation to the holder of a works approval, licence or other authorisation, it is possible for RTIO to take steps to eliminate (or at least reduce) its potential liability by relinquishing the relevant authorisation.

Acts as occupier or the holder of an authority are crystallised on expiry of occupation or the authority and there is no risk following that expiry that these offences can be committed. However, a risk remains that a prosecution will be instituted for an offence caused by acts prior to the expiry, subject to the relevant limitation periods (considered in part 4.2 below).

1.3 'Any person' offences

By comparison, in relation to 'any person' liabilities RTIO cannot simply relinquish its risk exposure.

These liabilities attach to the person (which includes a company), and do not extinguish upon ceasing to occupy a premises or the relinquishment of the authorisation.

1.4 Application of risk categorisation to this report

To assist RTIO in the identification and management of different legal risks, we have categorised each of the different liabilities under the identified legislation as:

- extinguishable liability (eg upon ceasing to occupy the premises or upon relinquishment of the licence etc); or
- ongoing liability (ie in the case of 'personal' offences).

2 Extent of RTIO liability

The extent of RTIO's legal liability under legislation or common law will often rest on what constitutes an acceptable standard of performance. Legally, the determination of what is acceptable is influenced by current industry and community standards. Such standards vary with the advent of new methods and technology ('best practice') and with changing views of justice or loss shifting. This is particularly so for environmental issues where the community shows increasing levels of concern about pollution and contaminated land.

In the case of legal liability for mine closure, a key issue will be whether in closing its operations RTIO has taken reasonable steps to safeguard against causing environmental impact. In determining what is reasonable in the circumstances of a particular case, where required to do so courts will take into account the state of knowledge for a range of matters such as technology and standards of performance in management at the time the operation was closed.

A closure plan must be able to adapt to shifting industry and community standards. The extent to which RTIO complies with relevant guidelines and codes of practice, prepared by regulators or the mining industry, will be relevant in determining legal liability where it is necessary to judge an acceptable standard of performance. While compliance with such standards is likely to be a key factor in establishing whether RTIO's closure practices are acceptable, the courts have made it clear that such standards should not be considered an authoritative guide for determining liability. Nevertheless, adherence to guidelines and codes of practice is important in establishing the defence of due diligence or refuting an allegation of negligence.

Completion criteria developed by RTIO in consultation with key stakeholders will form the basis on which mine closure performance is measured and reported to government, and will determine when a site is assessed as suitable for relinquishment.

We are instructed that RTIO prepares indicative criteria at the project approval stage, with the intent that these will evolve over the life of mine and be finalised as the site approaches closure. RTIO endeavours to finalise and agree completion criteria with stakeholders when preparing decommissioning plans (that is, 5 years before scheduled closure).

The Guidelines state that:

- Development of completion criteria should commence either during the project approval stage for new projects, or as early as possible for existing projects, and will be reviewed and refined throughout the development and operation of the project.
- Indicative completion criteria may be acceptable at the project approval stage, provided that they are capable of objective verification and based on the best available data at the time. As the project progresses and more information becomes available, more comprehensive and detailed completion criteria should be developed.

The closer a project is to completion the more certain the regulator will expect the completion criteria to be. There is no clear obligation imposed under the legislation of the Guidelines. However, it will be increasingly difficult for RTIO to explain unknowns or gaps in completion criteria as a project approaches the point of decommissioning. The section below provides further details on the obligations under the Guidelines.

3 Guidelines for Preparing Mine Closure Plans

3.1 Background

From 1 July 2011, all new RTIO mining proposals, in respect of new or existing mine sites, submitted to the DMP under the Mining Act, are required to include a Mine Closure Plan (**MCP**) which is to:

- be in the form required by the guidelines approved by the Director General of Mines for the purposes of the Mining Act; and
- contain information of the kind required by these guidelines about the decommissioning of each proposed mine, and the rehabilitation of the land, in respect of which a mining lease is sought or granted, as the case requires.

Further to this, the DMP has stated that it will require all existing RTIO mining proposals to prepare a MCP in this form by 30 June 2014.

Following the publication of the June 2011 Guidelines, a frequently asked questions document entitled 'Administration of Mine Closure Plans' (**FAQ Document**) was released by the DMP. The purpose of the Guidelines is to ensure that a planning process is in place so mines can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and without unacceptable liability resting with the State.

Although described as Guidelines, section 70O of the Mining Act defines 'mine closure plan' to mean a document that-

(a) is in the form required by the guidelines; and

(b) contains information of the kind required by the guidelines.

In this regard, the Guidelines establish minimum industry standards for closure and are more akin to a standard.

3.2 Applicability and time-frame

MCPs are required for all new RTIO mining proposals submitted to the DMP under the Mining Act.

For all RTIO mining proposals that are not subject to the Mining Act (ie pre-1899 title or minerals-to-owner tenure, Hampton locations or State Agreement Act projects), RTIO may be required to submit an MCP to the EPA as part of the Part IV Environmental Impact Assessment process.

The vast majority of mining proposals submitted by RTIO are submitted under State Agreements with very few mining proposals being submitted to the DMP under the Mining Act. Therefore, RTIO is usually only required to submit mining proposals to the DMP for ancillary support infrastructure where that infrastructure sits on Mining Act tenure and there is a condition on that tenure requiring the submission of a mining proposal to DMP. The DMP has verbally indicated that it will not require full closure plans for such infrastructure, and to date has considered the brief closure strategies submitted by RTIO with these proposals to be sufficient. However this position has no legislative basis and more comprehensive closure plans may be required in the future once priority sites have approved closure plans in place.

RTIO should note that the DMP has stated that the Guidelines will apply to projects under specific extractive licenses (including RTIO's State Agreements). However, in our view there is no legislative authority for this.

DMP has stated that existing mining operations that have a proposal or Notice of Intent approved by the DMP prior to 1 July 2011 will be required to submit a MCP to the DMP by 30 June 2014. Also, existing mining operations will be required to submit a new MCP if they significantly alter the nature of the operations.

The DMP is in the process of sending letters to all existing mining project operators specifying individual deadlines for the completion of MCPs and imposing tenement conditions to this effect. The DMP has stated that it will require MCPs to be submitted to DMP for all existing sites by 30 June 2014. Projects will be prioritised depending on prior closure planning, the lifespan of the mine, rehabilitation liability and the level of public interest.

MCPs submitted with mining proposals should be approved within 30 business days (the current timeframe for approval of mining proposals). However, DMP has stated that it plans to trial 60 business day approval timeframes for new MCPs.

If DMP considers that a MCP does not meet the standards specified in the Guidelines the FAQ Document states that the tenement holder will be given two formal opportunities to address any deficiencies and if, in the opinion of the Assessing Officer, the MCP remains deficient, then they will make a recommendation to the Regional Minerals Manager to reject the MCP.

3.3 Preparation of MCPs

Planning for mine closure should be fully integrated in the life of mine planning, and should start as early as possible and continue through to final closure and relinquishment. For new projects, closure planning should start in the project feasibility stage (before project approvals).

RTIO's MCPs must be site-specific. Generic 'off-the-shelf' closure plans will not be accepted by the DMP or the EPA.

3.4 Structure of MCPs

RTIO's MCPs must identify post-mining land use options and set out site-specific closure objectives that are consistent with those land use options. A MCP must also include completion criteria, to provide the basis on which successful rehabilitation and mine closure is determined. According to the Guidelines, the structure of RTIO's MCPs should be as follows, unless an alternative format has been agreed to in writing by the DMP or EPA:

- Cover Page;
- Checklist;
- Table of Contents;
- Scope and Purpose;
- Project Summary;
- Identification of Closure Obligations and Commitments;
- Collection and Analysis of Closure Data;
- Stakeholder Consultation;
- Post-mining Land Use(s) and Closure Objectives;
- Identification and Management of Closure Issues;
- Development of Completion Criteria;
- Financial Provisioning for Closure;
- Closure Implementation;
- Closure Monitoring and Maintenance; and
- Management of Information and Data.

3.5 Risk-based principle

RTIO's MCPs must be prepared in accordance with a risk-based approach to mine closure. This means that the level of detail required by the DMP and EPA will increase as environmental risk increases.

A risk-based approach to RTIO's MCP preparation will require a consideration of material characterisation, data on the local environmental and climatic conditions, and consideration of potential impacts through contaminant pathways and environmental receptors.

Characterisation of materials needs to be carried out prior to project approval to a sufficient level of detail to develop a workable MCP. For existing operations, this work should start as soon as possible. Characterisation of materials should include the identification of materials with potential to adversely affect the environment.

3.6 Adaptive management principle

RTIO's MCPs must also be prepared in accordance with principles of adaptive management. This is important in case of temporary or sudden mine closure. MCPs must demonstrate that appropriate systems for monitoring, maintenance and record keeping are in place.

3.7 Consultation in preparation of MCPs

Consultation must take place between RTIO and stakeholders. This must include acknowledging and responding to stakeholder's concerns.

Post-mining land uses should be identified and agreed upon through consultation before approval of new projects. This should take into account the operational life span of the project, opportunities to improve management outcomes of the wider environmental setting and landscape, as well as possibilities for multiple land uses.

For existing mining projects, post-mining land uses should be agreed as soon as practicable.

3.8 Change and review of MCPs

Any substantial change to RTIO's MCPs regulated under the Mining Act will require a new Mining Proposal to be submitted to DMP for approval. The Mining Proposal will be subject to the same approval requirements as those for a new mining operation or project. If the new Mining Proposal constitutes changes to a proposal approved under Part IV of the EP Act, the changes must also be approved in accordance with processes and procedures under that Act.

RTIO's MCPs regulated under the Mining Act will be required to be reviewed every three years, or any other time period stipulated by the DMP. In respect of MCPs prepared for the purposes of Part IV of the EPA, requirements for review and the associating time period may be stipulated in the conditions attached to the approval. Where the conditions do not stipulate a requirement for review RTIO is under no obligation to review the MCP.

RTIO's MCPs will be available for public scrutiny once approval has been given by the DMP.

3.9 Mining bonds

At this stage, cost estimates conducted for the purpose of demonstrating financial provisioning for MCPs are not intended to be applied in the calculation of mining securities. However, we note that mining securities are not required for State Agreement sites, and bonded sites are proposed to transition to the Mining Rehabilitation Fund scheme by July 2014.

The financial provisioning requirements in MCPs are for tenement holders to demonstrate that they will have funds available in the future to address their financial obligations for mine rehabilitation.

3.10 Legal Obligations Register

One of the implications of MCPs is the preparation of Legal Obligations Registers. Relevant legal obligations need to be identified and a Register created in a suitable form.

4 Environmental Protection Act

4.1 Background

Outlined below are the obligations for closure which arise under the EP Act.

Part IV of the EP Act relates to the environmental assessment of proposals and subsequent approval by the Minister for the Environment (**Minister**). The Minister may place certain conditions on an approval that may affect closure operations. The main offences under Part IV relate to failing to comply with a Part IV approval (sections 47 and 48).

Part V of the EP Act provides requirements for environmental licensing and pollution control. The failure to properly implement a closure plan may result in offences being committed against these provisions. The main potential offences relate to the pollution control offences created by sections 49, 50, 50A, 50B, 51, 51C, 58, 65 and 73 of the EP Act.

4.2 Limitation periods

A prosecution for a Tier 1 offence (e.g. pollution and environmental harm offences, and breach of Ministerial Statement conditions) may be brought at any time.

Prosecutions for other offences under the EP Act can only be brought within 24 months of either that date on which:

- the alleged offence was committed; or
- the day on which evidence of the alleged offence first came to the attention of a person authorised to institute the prosecution.

The effect of the second limb is that the risk of prosecution continues until 24 months of when the relevant authority becomes aware.

4.3 Section 47 – Ministerial approval

Ministerial Statements, which approve the implementation of proposals and which set out the commitments to be fulfilled by the proponent in implementing a proposal, invariably contain conditions which impart obligations on proponents. In the case of current mining proposals, many conditions will impart obligations on proponents which continue to run until closure of the mine. Section 47 of the EP Act provides that it is an offence not to comply with ministerial conditions and a maximum penalty of $250,000 applies to a corporation, with a daily penalty of $50,000.

As discussed above, proponents may be required to submit and comply with a MCP under a condition of a Ministerial Statement. If this is the case, a mining company that breaches an obligation contained in such a MCP would commit an offence under s 47 of the EP Act.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon expiry of the Ministerial Approval.

4.4 Section 48 – Control of Implementation of proposal

If RTIO fails to comply with a Ministerial Condition or procedure or does not fully comply with its monitoring obligations, and the Minister issues an order requiring RTIO to:

1. stop the implementation of its proposal for a period not exceeding 24 hours; and
2. take certain steps for the purpose of complying with a Condition or procedure of an implementation proposal, or for preventing, controlling or abating any Pollution or Environmental Harm caused by the non-compliance with the Condition or procedure,

then it is an offence for RTIO to fail to comply with such order.

The offence carries a maximum penalty of $325,000 for a corporation, with a daily penalty of $65,000.

Risk categorisation = ongoing liability.

4.5 Section 49 – Causing pollution

Section 49 provides for offences by any 'person who causes pollution or allows pollution to be caused,' with or without intention or criminal negligence.

'Pollution' means direct or indirect alteration to the environment:

(a) to its detriment or degradation;

(b) to the detriment of an environmental value; or

(c) of a prescribed kind,

that involves an emission.

'Emission' means:

(a) discharge of waste;

(b) emission of noise, odour or electromagnetic radiation; or

(c) transmission of electromagnetic radiation.

The offence of pollution is a Tier 1 offence which may attract penalties of up to $1,000,000 for companies with a daily penalty of up to $200,000 or $500,000 or five years imprisonment or both for individuals (including directors, officers and employees of a company) with a daily penalty of up to $100,000.

The penalty for this offence is greater if it occurs with intent or criminal negligence.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.6 Section 49 – Unreasonable emissions

Section 49 provides for offences by any person who with or without intention or criminal negligence:

(a) emits an unreasonable emission from any premises; or

(b) causes an unreasonable emission to be emitted from any premises.

'Unreasonable emission' means an emission or transmission of noise, odour or electromagnetic radiation which unreasonably interferes with the health, welfare, convenience, comfort or amenity of any person.

A reference in the EP Act to the discharge, emission or transmission of anything (whether accompanied by the expression 'into the environment' or not):

(a) is a reference to discharge, emission or transmission onto or into land, water, the atmosphere or living things; and

(b) in relation to discharge, emission or transmission from premises, includes a reference to discharge, emission or transmission onto or into land, water, the atmosphere or living things on, in, under, above or part of the premises.

This offence is either a Tier 1 or Tier 2 offence which may attract penalties of up to $250,000 for companies with a daily penalty of up to $50,000; or $125,000 for individuals (including directors, officers and employees of a company) with a daily penalty of up to $25,000.

The penalty for this offence is greater if it occurs with intent or criminal negligence.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.7 Section 49A

It is an offence to discharge or abandon any solid or liquid waste either:

(a) in water to which the public has access; or

(b) any other place.

The offence is a Tier 2 offence which attracts penalties of up to $125,000 for companies or $62,500 for individuals.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.8 Sections 50A and 50 B - Environmental harm

It is an offence to either cause or allow to be caused material environmental harm or serious environmental harm.

Environmental harm includes an alteration of the environment to the detriment or potential detriment of an environmental value. An environmental value may relate to either ecosystem health, or to a beneficial use.

'Material environmental harm' means environmental harm that -

(a) is neither trivial nor negligible; or

(b) results in actual or potential loss, property damage or damage cost of an amount, or amounts in aggregate, exceeding the threshold amount.

'Serious environmental harm' means environmental harm that -

(a) is irreversible, of a high impact or on a wide scale;

(b) is significant or in an area of high conservation value or special significance; or

(c) results in actual or potential loss, property damage or damage costs of an amount, or amounts in aggregate, exceeding five times the threshold amount.

The threshold amounts prescribed for material environmental harm and serious environmental harm are $20,000 and $100,000 respectively.

The threshold amount does not have to be exceeded in any case to constitute either material or serious environmental harm. For example, where no monetary loss arises, material environmental harm may still occur where the harm is neither trivial nor negligible.

The damage costs referred to in the definitions in relation to the threshold amounts include not only those costs for controlling or abating the discharge but also any costs involved in making good the environment. It is likely there will be many scenarios where the damage costs will either exceed, or have the potential to exceed, the threshold amount of $20,000 thereby creating an offence of material environmental harm. (Note that actual or potential loss may be measured for the threshold amount).

The penalty for environmental harm is greatest if it occurs with intent or criminal negligence. Serious environmental harm is a Tier 1 offence with a penalty of up to $1,000,000 for companies and $500,000 for individuals and up to 5 years imprisonment. The penalty for material environmental harm is up to $500,000 for companies and $250,000 and up to 3 years imprisonment for an individual.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.9 Section 50 - Discharge of waste likely to cause pollution

Section 50 provides for the offence by any person who, intentionally or with criminal negligence, causes or allows waste to be placed in any position which is likely to result in pollution.

This is a Tier 1 offence which may attract penalties of up to $1,000,000 for companies with a daily penalty of up to $200,000 or $500,000 for individuals (including directors, officers and employees of a company) with a daily penalty of up to $100,000.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.10 Section 51 – Occupiers of premises to take certain measures

Section 51 provides for the offence by an occupier of any premises who does not take all reasonable and practical measures to prevent or minimise emissions from those premises which do not comply with the prescribed standard.

This offence is a Tier 2 offence with a maximum penalty of $25,000 for an individual or a body corporate and a maximum daily penalty of $5,000.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon ceasing to occupy the relevant sites.

4.11 Section 51C – Unauthorised clearing

It is an offence to cause or allow clearing of native vegetation otherwise than in accordance with a clearing permit unless it is an exempt matter under Schedule 6 of the EP Act or the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (WA) (**Clearing Regulations**) (provided that it is not done in an environmentally sensitive area). Environmentally sensitive areas are declared in the Environmental Protection *(Environmentally Sensitive Areas) Notice 2005* (WA) by the Minister under Section 51B of the EP Act.

This offence is a Tier 1 offence with penalties up to $500,000 for a corporation with a daily penalty of up to $100,000 and $250,000 for an individual with a daily penalty of up to $50,000.

The exemptions listed in Schedule 6 of the EP Act are too numerous to mention. However, of relevance to RTIO is where the clearing is done in accordance with either a Part IV approval or in accordance with a works approval or licence. The Clearing Regulations provide further exemptions.

The CEO of the Department of Environment Regulation (**DER**) is able to apply for a clearing injunction before the Supreme Court to stop clearing that is not authorised. The Court is given a broad discretion to grant an injunction whether or not it is proved that a person intends to engage in any improper conduct (section 51S).

The EP Act provides that an occupier of a property will be deemed to have caused the clearing and the owner of the property will be deemed to have allowed the clearing in relation to the offence of unauthorised clearing unless the owner or occupier proves otherwise (section 51R).

A vegetation conservation notice may now be imposed by the CEO to require any damage caused by unauthorised clearing to be remedied or to re-establish vegetation to the state it was in prior to clearing (section 70).

Risk categorisation = ongoing liability. RTIO's potential liability for remediation of damage caused pre- or post-closure will continue.

4.12 Section 58 – Breach of environmental licence

Environmental licences are issued under Part V of the EP Act for all prescribed premises. Sites of relevance include processing/refinery operations, landfill sites and sewage facilities. Conditions of an environmental licence are generally aimed at the prevention and monitoring of waste discharges from premises and the breaching of any condition. Section 58 makes it an offence to breach a condition of an environmental licence. This is a strict liability offence, and is a Tier 2 offence with a maximum penalty of $125,000 for a body corporate and a maximum daily penalty of $25,000.

Risk categorisation = extinguishable liability. RTIO's potential liability will be relinquished upon expiry of the relevant licences and the expiry of the 2 year limitation period for breaches of licence that occurred prior to expiry.

4.13 Section 65 – Environmental protection notice (EPN)

EPNs are issued under Section 65 of the EP Act where there is or is likely to be an emission from any premises into the environment and the emission has caused or is likely to cause pollution or environmental harm. An EPN can be served on the 'owner' or the 'occupier' of the premises and only relates to current or future emissions.

An EPN may require a person to do one or more of the following:

(a) investigate the extent and nature of:
- the emissions and their consequences;
- the pollution and its consequences; or
- the environmental harm and its consequences;

(b) prepare and implement a plan for the prevention, control and abatement of the emission, pollution or environmental harm;

(c) take such measures as the CEO considers necessary to:
- prevent, control or abate the emission, pollution or environmental harm;
- comply with the standard;

(d) ensure that the amount or concentration of waste, noise, odour or electromagnetic radiation emitted from the premises, when measured at a point specified in the environmental protection notice, does not exceed the limit specified in the notice; or

(e) monitor the effectiveness or report to the CEO on any actions taken under the above.

The recipient of an EPN is liable for the carrying out of those specified measures. It is an offence not to comply with the conditions of an EPN. The offence is a Tier 2 offence with a maximum penalty of $125,000 for a body corporate and a maximum daily penalty of $25,000. It is a Tier 1 offence to intentionally or with criminal negligence not comply with an EPN for which a maximum penalty of $500,000 for a body corporate and a maximum daily penalty of $100,000 applies.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

4.14 Defence provisions

Section 74 of the EP Act provides a reasonable precautions type defence to various offences. A properly prepared and implemented closure plan will be a component of demonstrating this defence.

Section 74A provides a specific defence for causing pollution, or for causing serious environmental harm or material environmental harm. The person charged must prove that the pollution or harm occurred in the implementation of a proposal in accordance with an implementation agreement or decision (an approval under Part IV of the EP Act) or in accordance with other nominated authorisations or exemptions under the EP Act (including a works approval or licence).

Section 74B provides a specific defence for serious or material environmental harm. Again, the defence requires some form of authorisation or approval or exemption under another written law or one of a number of specified soil and land related approvals.

4.15 Section 99T – Section 99ZA – Additional Court powers

Where a person is convicted of any offence under the EP Act, the Courts are empowered to craft innovative penalty orders which include payment for damage to property, rehabilitation, repayment of any economic benefit gained as a result of an offence and a requirement to publicise the offence in addition to the imposition of a penalty.

4.16 Section 118 - Liability of directors and others

A director, or a person who is concerned in the management of the company, will be deemed liable for an offence committed by the company (and may be prosecuted for that offence) unless that person can establish one of three defences under the Act. Those defences may broadly be described as:

- no knowledge or reasonable expectation of knowledge of the commission of the offence;
- that, if in a position of influence, the person had used all due diligence and reasonable precautions to prevent the offence from occurring; or
- the body corporate had a defence to the charge (e.g. authorised discharge).

They may also be charged for an offence of the body corporate without the company being charged, although the prosecution will have to make out its case against the company before the court for the charge against the director to stand.

The removal of the limitation period for Tier 1 offences described in detail below means that directors and managers may continue to be potentially liable for an offence committed by the company in perpetuity.

Risk categorisation = ongoing liability. The potential liability for RTIO's directors and other officers will continue after closure.

4.17 Third party action

Section 73B provides for a third party cause of action in tort against the company for damages for failure to comply with an EPN, a vegetation conservation notice or a prevention notice.

The damage must be caused to property not owned or occupied by RTIO. If the damage would not have been caused if the notice had been complied with, then, by reason of

RTIO's failure to comply, the owner or occupier of the damaged property has a right of action in tort against the person in respect of that damage.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure, although is likely to be limited upon extinguishment of the relevant notice. Note that this provision does not expressly apply to closure notices. However, the common law rights for a third party to commence action remain 'post closure' (see part 21 below).

4.18 Financial assurances

Under Part VA, a proponent may be required to provide a financial assurance (akin to a bond) as a condition of a project approval issued under the EP Act. This is separate to a Mining Act performance bond (see part 7 below). The key risk here is that separate 'bonds' may apply to a project and be enforced by separate regulators under the EP Act as well as the Mining Act. As the EP Act applies to sites operated under a State Agreement Act, financial assurances can be imposed to cover such operations. These financial assurances apply as well as any royalty or other monetary obligations RTIO has under any State Agreement Act.

Financial assurances may be imposed under implementation conditions or conditions of an authorisation (such as an environmental licence, works approval or clearing permit). They may also be imposed by the CEO by written notice in relation to a closure notice, environmental protection notice, vegetation conservation notice or a prevention notice.

The CEO has the discretion to impose (with the Minister's consent) the financial assurance on a reasonable estimate of the total likely costs and expenses involved in addressing any financial matters the subject of the notice. If the financial assurance is insufficient, the CEO may recover additional costs. We note that the financial assurance only lapses on notice by the CEO. There may be situations where a closure notice or environmental protection notice is complete yet the CEO has not closed out the financial assurance. If a financial assurance requirement is imposed on the operation, RTIO's systems should acknowledge that the CEO's notice is required to obtain a return of the money that is the subject of the financial assurance.

Risk categorisation = ongoing liability. Although financial assurances may be imposed upon any authorisation, and therefore the risk of ongoing liability is minimised once the authorisation is relinquished, the potential for financial assurances to be imposed on closure notices means this is an ongoing liability risk for RTIO.

4.19 Emissions onto premises

The DER may regulate and enforce impacts (or potential impacts) of emissions within or outside the boundary of the premises. This applies to licensing emissions contained within the premises, notices, directions and prosecutions.

An emission contained on site may be the subject of regulatory action by the DER where there has been an impact (or potential impact) on an employee or other person or the wider site environment.

4.20 Other notices

Apart from EPNs (see para 4.13 above), the other notices available to the DER, include:

- closure notices (section 68A);
- ministerial stop order (section 69);
- vegetation conservation notices (section 70);

- environmental protection directions (section 71); and
- prevention notices (section 73A).

(a) Closure notices

The DER has the power to issue closure notices for operations nearing the cessation of activities. A closure notice may require a company to prepare a closure management plan, carry out investigations and require on-going monitoring. Independent audits of actions taken under a closure plan can also be required. The key risk here is increased scrutiny of closure operations from a regulator other than the DMP.

A closure notice may be the subject of a financial assurance as described in part 4.18 above.

The CEO may impose a closure notice if he considers on reasonable grounds that, as a result of anything that has been done, or has happened at a relevant premises before the expiry or revocation of an authorisation, ongoing investigation, monitoring or management is or will be required at the premises following the expiry or revocation.

The closure notice may be issued either during or after the lapsing of the relevant authorisation.

(b) Stop orders

The Minister may impose an order on a person to stop a process or activity if she considers that a person who is bound by an environmental protection notice has not complied with the notice, and the non-compliance has, is, or is about to cause conditions seriously detrimental to the environment or dangerous to human life or health.

(c) Vegetation conservation notices

Vegetation conservation notices may be imposed if the CEO suspects that unlawful clearing is likely to take place on any land, or has or is taking place on any land. Such a notice can require the person bound by the notice to repair any damage caused by the clearing and re-establish the vegetation to the state it was in prior to the clearing.

(d) Environmental protection directions

The CEO has the power to direct that the carrying on of any specific industry, trade or activity be prohibited or be subject to specific restrictions if he is satisfied that pollution, material environmental harm or serious environmental harm is occurring or is likely to occur.

(e) Prevention notices

If it is suspected that:

- any waste has been or is being discharged from any premises otherwise than in accordance with a works approval, licence or requirement contained in a closure notice or an environmental protection notice;
- a condition of pollution is likely to arise or has arisen; or
- a person has done, is doing, or is likely to do, an act in contravention of the 'environmental harm' provisions (see part 4.8 above),

then a notice may be given to that person to remove, dispense or otherwise deal with the waste being discharged or prevent the condition of pollution or environmental harm from arising or control or abate that condition.

4.21 Other Environmental Protection Act issues

Numerous Environmental Protection policies (**Policies**) have been made under Part III of the EP Act. These Policies have the force of law as though they are enacted as part of the EP Act. No Policies currently apply to RTIO operations in the Pilbara, however relevant Policies may be gazetted in the future.

5 Environmental Protection Regulations

5.1 Controlled waste

The Environmental Protection (Controlled Waste) Regulations 2004 (**CW Regulations**) regulate the storage and transport of controlled wastes in WA.

A controlled waste is one that is listed by the CW Regulations. Examples of listed controlled wastes that are likely to be relevant to closure planning include:

- battery components such as acid, lead and cadmium;
- containers or drums that are contaminated with residues of a controlled waste;
- waste mineral oils that are unfit for their intended use;
- soils contaminated with a controlled waste; and
- tyres.

The CW Regulations require that licences be obtained:

- by carriers who transport or cause to be transported for gain or reward on a road a controlled waste;
- by a subcontractor of a carrier to transport on a road a controlled waste;
- by a person who is employed or engaged by a carrier to drive a vehicle of the carrier to transport a controlled waste on a road; and
- for vehicles or tanks used by carriers to transport a controlled waste.

The CW Regulations also impose direct obligations on the waste holder or generator to ensure compliance by subcontractors. Alternatively, RTIO may be liable for aiding and abetting a breach by subcontractors. Breaches by a subcontractor may also have reputational risks for RTIO.

The maximum penalty for a company for breaching the CW Regulations is a fine of $25,000. Risk categorisation = extinguishable liability. RTIO's potential liability will be largely extinguished upon expiry of the relevant licences and ceasing to store and transport controlled waste.

5.2 Unauthorised discharges

The *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA) provide for an offence for causing or allowing the discharge of materials listed in schedule 1 into the environment. This regulation operates in addition to the emission based offences under the EP Act. No offence is committed if the discharge was authorised under another written law.

These regulations are likely to capture incidents which are of insufficient environmental impact to constitute emission based offences under the EP Act.

Examples of materials listed in Schedule 1 include:

- acid with a pH less than 4;
- alkali with a pH more than 10;
- compounds or solutions of cyanide, chromium, cadmium, lead, arsenic, mercury, nickel, zinc or copper;
- petrol, diesel or other hydrocarbon; and
- sewage.

The maximum penalty for a company is $25,000.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

6 Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**) contains the Commonwealth regime for environmental impact assessment. The existing operations of RTIO will not require approval under this legislation if the action is a lawful continuation of the use that was occurring or approved before the EPBC Act came into operation (16 July 2000). All other actions that will have or are likely to have a significant effect on a matter of national environmental significance will require assessment. The matters of national environmental significance are identified as:

- listed threatened species and ecological communities;
- migratory species protected under international agreements;
- Ramsar wetlands;
- Commonwealth marine areas;
- World Heritage properties;
- National Heritage places; and
- nuclear actions, including uranium mining.

Assessment or approval is given according to three procedures:

1. an approval by the Commonwealth Minister for the Environment (Ministerial Approval);
2. by approval from another Commonwealth decision maker under a management plan accredited by the Commonwealth Environment Minister for the purposes of Ministerial declaration (Ministerial Declaration); or
3. by State approval made in accordance with a management plan accredited by the Commonwealth Environment Minister for the purposes of a bilateral agreement. An assessment is triggered by referral from the proponent, a Commonwealth or State agency, or called in by the Commonwealth Minister for the Environment.

7 Contaminated Sites Act

The *Contaminated Sites Act 2003* (**CS Act**) and the associated *Contaminated Sites Regulations 2006* (WA) came into effect on 1 December 2006. This Act provides for the identification, recording, management and remediation of contaminated sites.

RTIO should note in its closure plans that the CS Act will have implications for closure liability for RTIO. All identified areas of known and/or potential contamination should be recorded as they will need to be dealt with for closure.

In accordance with the definition of 'contaminated' in section 4 of the CS Act, a site will be considered to be contaminated where the following two elements are satisfied:

(a) there is a substance in or on the land, water or site at above background concentrations; and

(b) the substance presents, or has the potential to present a risk of harm to human health, the environment or any environmental value.

The term 'contaminated' was intentionally defined broadly, so as to support the objects of the CS Act, which are to protect human health, the environment and environmental values by providing for the identification, recording, management and remediation of all contaminated sites in the State. In the Second Reading Speech of the *Contaminated Sites Bill 2002* (WA) the Minister for Environment and Heritage, Dr Judith Edwards, stated that the Bill was intended to address issues including the lack of information around contaminated sites. Dr Edwards went on to state:

> *One might ask: what is a contaminated site? It is important that the definition be broad enough to capture all forms of contamination that pose a problem, but not so broad as to lead to unnecessary bureaucracy where there is no risk. Therefore, the Bill uses a definition of "contaminated" in clause 4 that is risk based. It is not sufficient that a substance is present above a trigger level, there must also be some credible pathway by which it could pose a risk to human health or the environment.*

The DER Fact Sheet, *Mine Sites and the Contaminated Sites Act 2003* states that the duty to report is deliberately broad, to ensure that all contaminated sites are identified and recorded and that there are no exceptions for mining operations. The DER also states that companies ought to take a 'low risk' approach as to what is considered to be a contaminated site.

RTIO is required to report any sites that it knows or reasonably suspects are contaminated in accordance with the CS Act. However, in our experience, the DER has been willing to accept non-reporting of sites that do not require remediation although they may technically be 'contaminated' under the CS Act. Relying on the regulator's guidance in this respect should be carefully considered, Although, in these circumstances, the likelihood of prosecution for failure to report is low unless there is third party interest in the issue.

In particular, acid mine drainage may trigger a reporting requirement. The DER's stated policy is that the presence of naturally occurring acid sulphate soils in an undisturbed state will not make a site contaminated. However, where disturbance has resulted in concentrations of contaminants and/or a level of acidity within soils, sediments and waters that are above background concentrations and present, or have the potential to present, a risk of harm to human health, the environment or any environmental value the site will be 'contaminated'.

Once reported, the sites will be placed on a publicly available database and then dealt with according to the provisions of the CS Act. Of relevance to closure is that:

- a memorial may be placed on the title restricting the use, development and sale of the site;
- various notices may be issued under the EP Act or the CS Act relating to investigation and clean up;
- remediation obligations may be imposed on RTIO; and
- financial assurances may be required from RTIO to meet the closure requirements.

It is important to note that the hierarchy of responsibility under the CS Act means that RTIO may be liable for contamination on sites that it currently owns/occupies **and** sites that it has owned/occupied in the past. RTIO will also be responsible for sites that it has never owner or occupied, but which it has contaminated due to practices on its land that have caused contamination on other land.

Section 29 of the CS Act provides that the State will only be liable to remediate a contaminated site if no other person is responsible for remediation (ie the person who caused or contributed to the contamination, the owner of the contaminated site or a source site or the owner or occupier of a contaminated site who has changed the use of the land) or if the person responsible for remediation for the site cannot be identified or cannot be made to assume responsibility after reasonable attempts have been made to do so. In the mining context this would represent a very small number of sites.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure.

8 Conservation and Land Management Act

The *Conservation and Land Management Act 1984* (WA) requires RTIO to ensure that it does not, in relation to any CALM land, amongst other things:

- unlawfully alter, obliterate, deface, pull up, remove, or destroy any boundary mark, or any stamp, mark, sign, licence, permit or order used or issued by the CEO of the DER or any authorised officer;
- unlawfully cut, break, throw down or in any way destroy or damage any building, fence, or gate, in or enclosing any land; or
- fail or refuse to comply with any lawful direction of an authorised officer (s107).

These obligations apply during the mine closure process, until RTIO has vacated the land. These obligations apply to the 'land based' aspects of the sites. The maximum penalty for a company for failing to comply with these provisions is $50,000.

Risk categorisation = extinguishable liability. RTIO's potential liability will largely be relinquished upon ceasing to occupy the premises.

9 State agreements

All of RTIO's mining, port and rail operations and a significant proportion of supporting infrastructure are situated on State Agreement tenure and operated in accordance with State Agreement provisions rather than the Mining Act. As such, RTIO must identify and comply with any relevant closure obligations in those agreements. Some of these agreements have express closure obligations, or closure obligations may arise through commitments made in required environmental management programmes or development proposals submitted pursuant to those State Agreements. Where this occurs those obligations have been identified in the relevant State Agreement section below.

Each State agreement is different and should be included in the review of the specific closure obligations applicable to particular RTIO mining operations.

RTIO is currently a signatory to the following State agreements:

- *Iron Ore (Channar Joint Venture) Agreement Act 1987;*
- *Iron Ore (Hamersley Range) Agreement Act 1963;*
- *Iron Ore (Hamersley Range) Agreement Act 1968 (Paraburdoo);*
- *Iron Ore (Hope Downs) Agreement Act 1992;*
- *Iron Ore (Mount Bruce) Agreement Act 1972;*
- *Iron Ore (Robe River) Agreement Act 1964;*
- *Iron Ore (Rhodes Ridge) Agreement Authorisation Act 1972;* and
- *Iron Ore (Yandicoogina) Agreement Act 1996*,

a summary of the obligations relevant to mine closure in these agreements is below.

The provisions of a State Agreement entered into after the enactment of the EP Act do not exclude the operation of the EP Act, and do not have the effect of replacing or reducing the general obligations arising under that Act. The RTIO State Agreements have been amended to expressly provide for this. So for example, an approval under the EP Act, such as a Ministerial Statement issued pursuant to Part IV of the EP Act may still require RTIO to submit an MCP even if not required by the terms of the Agreement.

Generally, the approval provisions contained in the Mining Act do not apply to State Agreement operations, however this will depend on the nature or conditions of the mineral lease or other tenure granted pursuant to the State Agreement.

9.1 Iron Ore (Channar Joint Venture) Agreement Act 1987

Clause 7 provides that RTIO must have, by 30 June 1988, submitted to the Minister to the fullest extent reasonably practicable, its detailed proposals with respect to the mining, transport and shipment of iron ore. Those proposals are required to include an environmental management programme as to measures to be taken under the Agreement, for the protection and management of the environment.

Clause 9(7) requires RTIO to implement the approved proposals (as well as any Additional Proposals under clause 10) in accordance with their terms. This could include any closure, rehabilitation or other commitments made in those proposals.

Clause 11 specifies that, in relation to the matters referred to in paragraph (i) of subclause (3) of Clause 7 (ie the environmental management programme) RTIO shall carry out continuous monitoring programme to ascertain the effectiveness of the measures it is taking pursuant to its approved proposals for rehabilitation and protection and management of the environment. RTIO is also required to submit a detailed report to the Minister from time to time.

Furthermore, if RTIO, as a result of this monitoring or otherwise discovers any new information which in order to more effectively rehabilitate the Channar site may necessitate any changes or additions to any approved proposals or require matters not addressed in approved proposals to be addressed, RTIO must inform the Minister. This notification must include a detailed report of the information. The Minister may then require further detailed proposals to be submitted by RTIO. If so, RTIO must then submit such proposals to the Minister within 2 months.

Clause 40 provides that, at the cessation or termination of the Agreement, all buildings, erections and other improvements erected on any land occupied by the Joint Venturers under the mining lease or any other lease, licence, easement, grant or other title made under the Agreement will become the property of the State. If prior to this date the Joint Venturers wish to remove any of their fixed or moveable plant and equipment they may do so, provided they grant the State the right or option within three months to purchase it at a fair value, except where the plant or equipment is on land to be included in Mineral Lease 4SA or otherwise leased or granted by the State to Hamersley pursuant to the provisions of the Agreement dated 30 July 1963 approved by the *Iron Ore (Hamersley Range) Agreement Act 1963*.

Clause 41 provides that:

> Nothing in this Agreement shall be construed to exempt the Joint Venturers from compliance with any requirement in connection with the protection of the environment arising out of or incidental to their activities hereunder that may be made by the State or by any State agency or instrumentality or any local or other authority or statutory body of the State pursuant to any Act from time to time in force.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.2 Iron Ore (Hamersley Range) Agreement Act 1963 and Iron Ore (Hamersley Range) Agreement Act Amendment Act 1968 (Paraburdoo)

The Interpretation clause provides that:

> Nothing in this Agreement shall be construed to exempt the Company from:
>
> (a) 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 by or under the EP Act;
>
> (b) to exempt the State or the Company from compliance with or to require the State or the Company to do anything contrary to any laws relating to native title or any lawful obligation or requirement imposed on the State or the Company as the case may be pursuant to any laws relating to native title; or
>
> (c) the AH Act.

As a result, RTIO must comply with the closure obligations contained in, or arising from approvals granted under the EP Act, any native title legislation and the AH Act.

Clause 10I(2) provides that RTIO must have, by 1 October 1990, submitted detailed proposals to the Minister with respect to the mining of iron ore from the Brockman No.2 Detritals deposit (including for transportation of the ore). This must include an environmental management programme as to measures to be taken, in respect of the Company's activities at the Brockman No.2 Detritals Deposit, for rehabilitation and the protection and management of the environment. Clause 10I(10) provides that if RTIO wishes to significantly modify, expand or otherwise vary the Brockman No. 2 Detritals Deposit, beyond those specified in approved proposals, then it is required to submit a further proposal, which is required to include details of a further environmental management programme, including further details of rehabilitation. Clause 10I(11) specifies that RTIO shall carry out continuous monitoring programme to ascertain the effectiveness of the measures it is taking pursuant to rehabilitation proposals. . Clause 10I(11) also provides that RTIO must submit annual brief reports to the relevant Minister and three-yearly comprehensive reports on possible further implementation measures arising as a result of the monitoring conducted.

Clause 10G provides that should RTIO wish to significantly modify its operations in connection with the provision of services for the Channar Agreement, or enter into an agreement for the mining of iron ore from the mining lease granted under the Channar Agreement,(other than the Brockman No.2 Detritals Deposit), RTIO must submit a proposal to the Minister. This proposal must include environmental management measures, and any other matters as the Minister may require, such as a closure or rehabilitation plan.

Clause 11(e) provides that, at the determination of any lease license or easement granted under the Agreement, the improvements and things erected on the relevant land and provided for in connection therewith must remain or will become the property of the State. However if prior to this date RTIO wishes to remove locomotives, rolling stock, plant, equipment and/or removable buildings it may do so, provided it notifies the State and grants the State the right or option within three months to purchase it at a fair value.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.3 Iron Ore (Hope Downs) Agreement Act 1992

Clause 2A provides that:

> Nothing in this Agreement shall be construed:
>
> (a) 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 by or under the EP Act; or
>
> (b) to exempt the State or the Company from compliance with or to require the State or the Company to do anything contrary to any laws relating to native title or any lawful obligation or requirement imposed on the State or the Company as the case may be pursuant to any laws relating to native title; or
>
> (c) to exempt the Company from compliance with the provisions of the AH Act.

As a result, RTIO must comply with the closure obligations contained in the EP Act, AH Act and any native title legislation.

Clause 3 of the Act provides that the State must give RTIO access to the Crown Land at Hope Downs subject to the adequate protection of the environment and flora and fauna.

Clause 7 provides that RTIO must have by 30 June 1998, submitted to the Minister to the fullest extent reasonably practicable, its detailed proposals with respect to the mining, transport and shipment of iron ore. Those proposals are required to include an environmental management programme as to the measures to be taken under the Agreement, for the protection and management of the environment.

Clause 8(6) requires RTIO to implement the approved proposals (as well as any Additional Proposals under clause 10) in accordance with their terms. This could include any closure, rehabilitation or other commitments made in those proposals.

Clause 15 specifies that, in relation to the matters referred to in paragraph (m) of subclause (1) of Clause 7 (ie the environmental management programme) RTIO should carry out continuous monitoring programme to ascertain the effectiveness of the measures it is taking pursuant to its approved proposals for rehabilitation, protection and management of the environment.

Clause 15 also provides that RTIO must submit annual brief reports to the relevant Minister and three-yearly comprehensive reports on possible further implementation measures arising as a result of the monitoring conducted.

Clause 15(4) further specifies that on or the date occurring 2 years after the East Angelas Deposit is included in the Hope Downs mining lease, RTIO must have submitted to the Minister, to the fullest extent reasonably practicable, its detailed proposals with respect to the mining, transport and shipment of iron ore. Those proposals are required to include an environmental management programme as to the measures to be taken under the Agreement, for the protection and management of the environment.

Clause 38 provides that, upon the cessation or termination of the Agreement, all buildings, erections and other improvements erected on any land occupied by the Company under the mining lease or any other lease, licence, easement, grant or other title made under the Agreement will become the property of the State. If prior to this date the Company wishes to remove any of their fixed or moveable plant and equipment they may do so, provided they grant the State the right or option within three months to purchase it at a fair value.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.4 Iron Ore (Mount Bruce) Agreement Act 1972

Clause 23 provides that, at the cessation or determination of any lease license or easement granted under the Agreement, the improvements and things other than plant, equipment and removable buildings erected on the relevant land and provided for in connection therewith must remain or will become the property of the State. However if prior to this date RTIO wishes to remove locomotives, rolling stock, plant, equipment and/or removable buildings it may do so, provided it grants the State the right or option within three months to purchase it at a fair value.

Clause 30 provides that:

> Nothing in this Agreement shall be construed:
>
> (a) 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 by or under the EP Act; or
>
> (b) to exempt the State or the Company from compliance with or to require the State or the Company to do anything contrary to any laws relating to native title or any lawful obligation or requirement imposed on the State or the Company as the case may be pursuant to any laws relating to native title; or
>
> (c) to exempt the Company from compliance with the provisions of the AH Act.

As a result, RTIO must comply with the closure obligations contained in the EP Act and any conditions which are attached to approvals obtained under that Act, the AH Act and any native title legislation.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.5 Iron Ore (Robe River) Agreement Act 1964

The Interpretation clause provides that:

Nothing in the Act operates:

(a) 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 by or under the EP Act; or

(b) to exempt the State or the Company from compliance with or to require the State or the Company to do anything contrary to any laws relating to native title or any lawful obligation or requirement imposed on the State or the Company as the case may be pursuant to any laws relating to native title; or

(c) to exempt the Company from compliance with the provisions of the *AH Act*.

As a result, RTIO must comply with the closure obligations contained in the EP Act, the AH Act and any native title legislation.

Clause 5(2) provides that RTIO must as soon as practicable after giving notice pursuant to cluse 5(1), submitted to the Minister to the fullest extent reasonably practicable, its detailed proposals with respect to the mining, transport and shipment of iron ore. Those proposals are required to include an environmental management programme as to the measures to be taken under the Agreement, for the protection and management of the environment.

Clause 7A provides that if RTIO proposes to significantly expand its operations under that Agreement, it must provide details in relation to the protection and management of the environment

Clause 7AC(1) provides that RTIO should carry out continuous monitoring programme to ascertain the effectiveness of the measures they are taking pursuant to rehabilitation proposals.

Clause 7AC(2) provides that RTIO must submit annual brief reports to the relevant Minister and three-yearly comprehensive reports on possible further implementation measures arising as a result of the monitoring conducted.

Clause 10(e) provides that, at the cessation or determination of any lease license or easement granted under the Agreement, the improvements and things erected on the relevant land and provided for in connection therewith must remain or will become the property of the State. However if prior to this date RTIO wishes to remove locomotives, rolling stock, plant and /or equipment it may do so, provided it grants the State the right or option within three months to purchase it at a fair value.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.6 Iron Ore (Yandicoogina) Agreement Act 1996

The Interpretation clause provides that:

(2) Nothing in this Agreement shall be construed to exempt the State or the Company from compliance with, or to require the State or the Company to do anything contrary to, any law relating to native title or any lawful obligation or requirement imposed on the State or the Company, as the case may be, pursuant to any law relating to native title.

(3) 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.

(4) Nothing in this Agreement shall be construed to exempt the Company from compliance with the provisions of the AH Act.

As a result, RTIO must comply with the closure obligations contained in the EP Act and any conditions which are attached to approvals obtained under the Act, the AH Act and any native title legislation.

Clause 6 provides that RTIO must have by 31 December 1997, submitted to the Minister to the fullest extent reasonably practicable, its detailed proposals with respect to the mining, transport and shipment of iron ore. Those proposals are required to include an environmental management programme as to the measures to be taken under the Agreement, for the protection and management of the environment.

Clause 7(7) requires RTIO to implement the approved proposals in accordance with their terms. This could include any closure, rehabilitation or other commitments made in those proposals. Clause 9(1) states that if RTIO wishes to significantly modify, expand or otherwise vary its activities RTIO must submit an additional proposal to the Minister. Clause 9(2) provides that the requirements of clause 7(7) will apply to any additional proposals. That is, additional proposals must also be implemented in accordance with their terms.

Clause 13 specifies that, in relation to the matters referred to in paragraph (l) of subclause (1) of Clause 6 (ie the environmental management programme) RTIO shall carry out a continuous monitoring programme to ascertain the effectiveness of the measures it is taking pursuant to its approved proposals for rehabilitation, protection and management of the environment,

Clause 13 also provides that RTIO must submit annual brief reports to the relevant Minister and three-yearly comprehensive reports on possible further implementation measures arising as a result of the monitoring conducted.

Clause 39 provides that, upon the cessation or termination of the Agreement, all buildings, erections and other improvements erected on any land occupied by the Company under the mining lease or any other lease, licence, easement or other title made under the Agreement will become the property of the State. If prior to this date the Company wishes to remove any of their fixed or moveable plant and equipment they may do so, provided they grant the State the right or option within three months to purchase it at a fair value.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

9.7 Iron Ore (Rhodes Ridge) Agreement Authorisation Act 1972

Clause 5.02 provides that the Joint Venturers must, before the fifth anniversary of the commencement date of the Agreement or such later date as the Minister may approve, submit to the Minister detailed proposals which include appropriate plans and (where reasonably required by the Minister) appropriate specifications in respect of mining iron ore and the future development of mining areas and detailed particulars as to the measures proposed to be taken for the protection of the environment (which may include closure and rehabilitation measures).

Clause 7.01 provides that if the Joint Venturers wish to expand their activities beyond those specified in any approved proposal they must submit detailed proposals to the

Minister which includes measures proposed to be taken for the protection of the environment (which may include closure and rehabilitation measures).

Clause 10(e) provides that, at the cessation or determination of any lease, licence or easement granted under the Agreement, the improvements and things erected on the relevant land and provided for in connection therewith must remain or will become the property of the State. However if prior to this date RTIO wishes to remove locomotives, rolling stock, plant and /or equipment it may do so, provided it grants the State the right or option within three months to purchase it at a fair value.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon cessation or determination of this Agreement.

10 Mining Act

The *Mining Act 1978* (WA) (**Mining Act**) and the *Mining Regulations 1981* (WA) (**Mining Regulations**) contain specific requirements for the management of mining leases. Mining Act leases may give rise to the requirements outlined below.

The definition of 'mining proposal' in the Mining Act now includes a MCP. This will apply to all new mining proposals. With respect to existing projects, tenement conditions may be imposed requiring the submission of a MCP. For the majority of RTIO projects which operate on State Agreement tenure, the requirement to submit an MCP pursuant to the Mining Act is not applicable.

In addition to the requirement to submit an MCP, closure may be regulated as a condition of a mining lease imposed at the time approval to mine is granted, or under section 84 of the Mining Act which allows the Minister to impose, at any time, reasonable conditions for the purpose of preventing, reducing, or making good injury to the land.

Further, Regulation 28 of the Mining Regulations states that it is a condition of every mining lease that all holes, pits, trenches and other disturbances to the surface of the land made while mining which, in the opinion of a person holding or acting in the office of Environmental Officer in the Environmental Division of the DMP (**Environmental Officer**) are likely to endanger the safety of any person or animal will be filled in or otherwise made safe to the satisfaction of an Environmental Officer.

Prior to the commencement of mining, it is a common requirement placed on miners to provide a financial security or performance bond to cover the conditions attaching to the mining lease and the relevant provisions of the Mining Act and Mining Regulations including the decommissioning and rehabilitation of mine sites. The bonds are required for the life of the project and are only retired when the lessee submits an audit of compliance with the mine lease conditions that is acceptable to the Minster/DMP (ss 84A and 126).

A breach of the Mining Act or Mining Regulations could expose RTIO to criminal prosecution and may give rise to a cause of action for breach of statutory duty at common law (see part 21 for further details).

Risk categorisation = extinguishable liability. RTIO's liability will largely cease upon sign-off on rehabilitation conditions under the provisions of the applicable tenement and return of the bond under the relevant tenement. This may not occur for some time post closure.

11 Parks and Reserves Act

The *Parks and Reserves Act 1895* (WA) allows local Boards (appointed under the Act) to make and enforce by-laws for a range of matters, including prohibiting damage or injury to and destruction of trees, shrubs, plants and flowers on the land. The scope of powers and obligations under the Act do not impose obligations on RTIO beyond those already imposed under other legislation, such as the EP Act and Mining Act.

RTIO should confirm whether the relevant Boards have made any applicable by-laws under this Act.

Risk categorisation = extinguishable liability. It is likely that any relevant provisions will cease upon relinquishment of land tenure and therefore RTIO is unlikely to have any ongoing liability.

12 Rights in Water and Irrigation Act

Licensing is required under the *Rights in Water and Irrigation Act 1914* (WA) (**RIWI Act**) for the use of all:

- surface water, except where otherwise provided as riparian rights or other domestic and ordinary usage rights;
- artesian underground water; and
- non-artesian underground water, within proclaimed ground water areas.

The licence may be made subject to conditions and will specify the extent to which water may be diverted, taken or used.

A licence may be granted or renewed for a fixed period or indefinite duration. Licences remain in force until terminated (cl 13 Schedule 1), suspended or cancelled (cl 25 Schedule 1) or surrendered (cl 27 Schedule 1).

The licensee may transfer the licence or water entitlements under the licence to a person eligible to hold a licence. This does not apply where relevant by-laws prohibit transfer of licences of that kind. A transfer of a licence or water entitlement cannot be made without the approval of the Minister (cl 31 Schedule 1). A decision of the Minister not to approve the transfer may be reviewed by the State Administrative Tribunal (s 26GG). RTIO should review its water licences and determine whether any of them will be tradeable upon closure of the sites.

RTIO may enter into an agreement with another person (**the third party**) relating to the taking of water under the licence by the third party for a limited period of time. RTIO should review all of its water licences to identify any agreements or obligations it has with third parties.

It is an offence to obstruct, destroy or interfere with any watercourse, race or drain flowing through or over private land, or any dam or reservoir, or the bed of any disused watercourse, race or drain on the land without being authorised to do so under the RIWI Act or any other legislation (s 17). It is also an offence to obstruct, destroy or interfere with any watercourse flowing through or over or any wetland situated on Crown land (s 25). Prosecutions for this offence may only be commenced within 2 years of when the offence was committed (ss 17(5) & 25(3)). If RTIO were to be convicted of such an offence arising during the site closure process, the Minister may require RTIO to carry out remedial works at its own cost (ss 17(6) & 25(4)).

Risk categorisation = ongoing liability. If RTIO was convicted of an offence then there is potential for the Minister to require RTIO to carry out remedial works for interference to watercourses or wetlands. If that is the case, RTIO's potential liability will continue after closure.

13 Wildlife Conservation Act

RTIO must ensure that it does not harm, destroy or take flora and fauna that is protected under the *Wildlife Conservation Act 1950* (WA). This obligation continues until RTIO has vacated the site.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely extinguished upon ceasing to occupy the premises.

14 Indigenous Issues

14.1 Indigenous Agreements

All participation agreements and any other agreements which RTIO has entered into with native title parties in relation to its operations should be reviewed to identify any obligations held by RTIO in relation to closure of those operations. Such obligations, if any, may relate to matters such as interests in land, or transfer of interests in certain infrastructure. While some of these native title claims may have been determined, the precise terms of the agreement between RTIO and the native title party will need to be reviewed in order to confirm whether the agreement will continue to apply.

As part of the review of the participation agreements, consideration should be given to the various "Regional Standards" which form part of the Regional Framework Deed. The standards require RTIO to undertake ongoing and regular consultation with each group (including consultation on closure issues). In particular the Environment and Life of Mine Planning standards should be considered, as both are relevant to closure.

Risk categorisation = ongoing liability. .

14.2 Aboriginal Heritage

(a) State Aboriginal Heritage protection legislation

The *Aboriginal Heritage Act 1972* (WA) (**AH Act**) provides that is an offence to alter an Aboriginal site in any way in the absence of Ministerial consent under section18 of the Act (**Section 18 Consent**), or the permission of the Registrar under section 16 of the Act (**Section 16 Permit**).

A person who, having consent or authorisation under section 18 and section 16 of the Act, is in breach of any condition to which the giving of the consent or authorisation was made subject, commits an offence (s 55). The maximum penalties under the Act range from $20,000 to $100,000, depending on whether it is an individual or body corporate, and whether it is the first or a subsequent offence. There is a daily penalty of $400 for an individual and $1,000 for a body corporate (s 57).

(b) Commonwealth Aboriginal Heritage protection legislation

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) (**Cth Act**) applies to 'significant Aboriginal areas' following a declaration by the Commonwealth Minister under the Act in relation to a specific area. A declaration has the effect of prohibiting injury to, or the desecration of, the particular area, object or class of objects specified in the declaration, wherever it is situated. It is an offence to engage in conduct which contravenes the terms of such a declaration.

(c) The EPBC Act

As referred to in part 6 above, heritage matters, including indigenous heritage, may be matters of national environmental significance under the EPBC Act.

(d) Risk categorisation

Activities associated with the closure of operations should be assessed in terms of potential impact on Aboriginal Heritage, and to the extent that impact upon Aboriginal sites, if any, cannot be avoided then relevant consents should be obtained.

Risk categorisation = ongoing liability. Depending on the sites and consents applicable, RTIO may have ongoing liability post closure.

14.3 Native Title

The *Native Title Act 1993* (Cth) (**NTA**) provides that future acts can be invalid to the extent that they affect native title. If activities associated with closure involve the grant of any land tenure or interests, or any other act, which could affect native title, then it will be necessary to comply with the future act provisions of the NTA.

Risk categorisation = potential ongoing liability. Depending on whether native title claims exist and how they have been progressed, RTIO may have ongoing liability post closure.

14.4 Aboriginal Reserve Lands

Under the *Aboriginal Affairs Planning Authority Act 1972* (WA) (**AAPAA**), land which is reserved for the use and benefit of Aboriginal people may be proclaimed by the Governor as Reserved land to which Part III of the AAPAA applies. The AAPAA provides that it is an offence to enter or remain on land which has been so proclaimed without holding an entry permit issued by the Minister under the AAPAA regulations. If activities associated with closure involve entering or remaining on Aboriginal Reserve lands the then the relevant permits should be obtained.

Risk categorisation = potential ongoing liability depending on whether Aboriginal Reserve lands are impacted.

15 Mines Safety and Inspection Act

15.1 General

The following obligations may apply to all sites.

Occupational safety and health in mining operations is regulated by the *Mines Safety and Inspection Act 1994* (**MSI Act**) and the *Mines Safety and Inspection Regulations 1995* (**MSI Regulations**). RTIO must comply with the provisions of the MSI Act.

15.2 Duties in relation to operations

In relation to the operations for decommissioning or closure, the usual duties under the MSI Act will apply. These include the general duties of care which fall on RTIO as principal employer, employer, deemed employer, person in control of a workplace, etc. As a minimum, RTIO must undertake a hazard assessment of any relevant operations and put in place measures to minimise any identified risks.

15.3 Regulatory requirements for closure

The MSI Act and MSI Regulations also create specific obligations for the abandonment or suspension of mining operations. RTIO must notify the District Inspector for the relevant region in writing in the following circumstances:

- before mining operations are abandoned – section 42(1)(c); and
- before mining operations are suspended – section 42(1)(d).

The notification should be accompanied by evidence which satisfies the District Inspector that the requirements under the Act for the abandonment or suspension of mining operations have been fulfilled. Each notification must include the following details:

- the name and location of the mine – regulation 3.12(a);
- the number of the lease, tenement or other interest – regulation 3.12(b);
- the name and address of the principal employer – regulation 3.12(c);
- what mining operations are to be affected, and whether they are to be commenced, recommenced, abandoned or suspended – regulation 3.12(d); and
- the date on which the mining operations are to be commenced, recommenced, abandoned or suspended – regulation 3.12(e).

On receiving a notification, the District Inspector will inspect the mine and verify the evidence provided with the notice and make a record accordingly. Notification of the suspension of mining operations must also include the following information amongst other matters:

- the reason for the suspension and the planned duration of the suspension – regulation 3.14(a);
- whether the closure is total – regulation 3.14(b);
- the measures that have been taken to prevent unauthorised access or entry to the mine – regulation 3.14(d); and
- an accurate plan or plans of the mining operations to the time of suspension with the plan/s going to the State mining engineer before the mining operations are abandoned or suspended – regulation 3.14(f).

Notification of the abandonment of mining operations at a mine must also include the following information amongst other matters:

- details of precautions taken to ensure that all plant and equipment have been removed or secured and left in a safe condition – regulation 3.16(d);
- details of precautions taken to remove or properly dispose of all hazardous substances at the mine – regulation 3.16(e); and
- an accurate plan or plans of the mining operations to the time of abandonment with the plan/s going to the State mining engineer before the mining operations are abandoned or suspended – regulation 3.16(f).

If mining operations are abandoned or suspended RTIO must keep all record books and log books kept under the MSI Act in respect of the mine for a period for 6 years from the time of abandonment or suspension and take steps to ensure they are kept safe for that period if RTIO appears likely to go into liquidation or receivership (section 89(3) MSI Act).

A breach of the MSI Act or MSI Regulations could expose RTIO to criminal prosecution under the MSI Act and may give rise to a cause of action for breach of statutory duty at common law (see part 21.3 of this review for further details).

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure with respect to ensuring compliance with plans associated with closure.

16 Occupiers Liability Act

The following obligations may apply to all sites in relation to closure (as well as day to day operations).

At common law an occupier of land may owe a duty of care to visitors or the public who access the land. The *Occupiers Liability Act 1985* (WA) (**Occupiers Liability Act**) prescribes the standard of care where an occupier of land can be liable for loss, injury or damage suffered by people visiting the land as a result of dangers arising on the land.

As RTIO owes a duty of care to a person on its mine tenements, section 5(4) of the Occupiers Liability Act provides that consideration must be given to the following factors in determining how to discharge the duty:

(a) the gravity and likelihood of the probable injury;

(b) the circumstances of entry on the premises;

(c) the nature of the premises;

(d) the knowledge which the occupier of the premises has or ought to have of the likelihood of persons or property being on the premises;

(e) the age of the person entering the premises;

(f) the ability of the person entering the premises to appreciate the danger; and

(g) the burden on the occupier of eliminating the danger or protecting the person from entering the premises from danger as compared to the risk of danger to the person.

The Occupiers Liability Act does not expose RTIO to any specific liability, however, it does apply to establish the standard of care that will have to be met in the event that a negligence claim is brought against RTIO.

As a minimum, a risk assessment should be undertaken to determine what steps need to be taken to control relevant hazards. It is important to be aware that the liability extends to cases of an occupier creating dangers, and also failing to remove or warn of relevant dangers. We can provide further advice on this process if required.

Risk categorisation = extinguishable liability. RTIO's potential liability will be largely relinquished upon ceasing to occupy the premises.

17 Criminal Code Compilation Act

The Criminal Code is the Schedule to the *Criminal Code Act 1913*, which is Appendix B to the *Criminal Code Act Compilation Act 1913* (WA) (**Code**).

Section 304 of the Code makes it an offence if a person does an unlawful act or omits to do any act that it is the person's duty to do, as a result of:

(a) bodily harm is caused to any person; or

(b) the life, health or safety of any person is or is likely to be endangered.

The person is guilty of a crime and is liable to imprisonment for 5 years (or a summary conviction of $24,000 or imprisonment for 2 years). A maximum conviction of 20 years applies if the act or omission is committed with intent.

Risk categorisation = ongoing liability. RTIO's potential liability will continue after closure to the extent it remains responsible for certain activities on the premises.

18 Relevant workforce legislation

RTIO will need to comply with the relevant workplace relations legislation as well as employment contracts and industrial instruments in place at the time of closure.

The key issues will arise in relation to any terminations of employment which arise from cessation of mining operations and closure of sites.

RTIO will have obligations to seek to redeploy employees to other operations if possible. Issues may arise under employment contracts and industrial instruments as to who can be redeployed and on what terms.

In the event of redundancies, RTIO will need to comply with relevant legislative and industrial requirements. The *Workplace Relations Act* 1996 (Cth) contains requirements in relation to termination of employment and specifically in relation to terminations arising for genuine operational reasons (ie redundancies). There may also be some requirements arising under State industrial laws.

For example, there may be requirements to inform employees of proposed significant changes to operations and to inform relevant government departments (and possibly relevant unions) of proposed redundancies.

Failure to provide appropriate notice of termination or payment in lieu, payment of accrued leave entitlements, and severance payments may also lead to unfair or unlawful termination claims. It will also be important to ensure that any process for selection for redundancy versus redeployment does not include any prohibited grounds.

19 Agreements, Licences, Permits, Approvals and other tenure

Closure obligations may also be specified in agreements (including joint venture agreements), licences, permits and approvals. Each agreement, licence, permit or approval is likely to be different and should be included in the review of the specific closure obligations applicable to particular RTIO operations.

RTIO has land subject to tenure arrangements other than under State Agreements or the Mining Act. That tenure should be reviewed on a case by case basis to identify and understand any closure obligations that might arise from the tenure arrangements.

20 International Standards – ISO 14001:2004

International Standard 14001:2004 (**the Standard**):

- specifies the requirements for an environmental management system (**EMS**) to allow an organisation to develop and implement policies and objectives which take into account legal and other requirements to which it subscribes; and
- provides information about significant environmental aspects.

The Standard does not state specific environmental performance criteria itself and only applies to environmental aspects that the organisation identifies as those which it can control and influence. The revised ISO 14001:2004 does not make fundamental changes to ISO 14001:1996 but clarifies the purpose of the standard and increases alignment with the ISO 9001 Quality Management Systems standard. The revised ISO 14001:2004 places emphasis on compliance.

The Standard requires organisations to:

- establish, document, implement, maintain and continually improve their EMS and to determine how it will fulfil these requirements;
- implement and maintain procedures to identify the environmental aspects of its activities, products and services that it can control and influence;
- determine those aspects that have or can have significant impact on the environment;
- identify and have access to the applicable legal requirements and other requirements to which the organisation subscribes, and to determine how these requirements apply to its environmental aspects; and
- establish, implement and maintain documented environmental objectives and targets.

The revised ISO 14001:2004 requires organisations to comply with certain processes of implementation and operation of environmental management systems (including resources, roles, responsibility and authority; competence, training and awareness; communication; documentation; control of documents; operational control and emergency preparedness and response).

Further, an organisation must:

- establish, implement and maintain a procedure to monitor and measure, on a regular basis, the key characteristics of its operations that can have a significant environmental impact;
- periodically evaluate compliance with applicable legal requirements and other requirements;
- deal with actual and potential nonconformity and for taking corrective and preventative action;
- keep records as necessary to demonstrate conformity to its environmental management system and to the Standard;

- ensure that internal audits of the environmental management system are conducted; and
- (top management) review the environmental management system.

Effectively, ISO 14001:2004 provides procedures and compliance mechanisms with regards to:

- environmental aspects, objectives, targets and programmes;
- resources, roles, responsibility and authority;
- competence, training and awareness;
- communication;
- non-conformity, corrective and preventative action;
- internal audit; and
- management review.

International standards do not impose legally binding obligations on RTIO. However, compliance with these standards assists in providing evidence of compliance with best practice standards and on that basis, compliance with such standards may assist in a defence to a common law action (see part 21 below). Further, compliance with standards is also likely to assist in establishing that RTIO took all reasonable precautions and exercised due diligence to prevent the commissioning of certain offences under the EP Act (relevant to defences under the EP Act, see part 4.14 above) and other Acts.

21 Common Law Liability

Nuisance, negligence and breach of statutory duty are the three main common law actions which may be taken against RTIO in relation to its environmental or health and safety performance in closing a site. A summary of those actions is provided below.

21.1 Nuisance

Nuisance is based on the infringement of another person's rights to the enjoyment of their property or a public amenity. Liability is decided by whether the alleged nuisance is reasonable in the circumstances of the case. This usually depends on the nature of the locality, the extent of the nuisance and the actual or potential harm caused.

An affected person may take an action in nuisance where the environmental effects of site closure practices have caused or are causing material damage to the use of their property or a public amenity. If an action is taken, RTIO will have to establish that its closure practices were reasonable in the circumstances. It will be able to better do so by reference to a properly implemented closure plan.

21.2 Negligence

Every person owes a duty of care to avoid causing harm to others or their property. Liability is decided on the basis of whether the standard of care attaching to that duty was breached and whether material damage resulted. For example, RTIO owes a duty of care to those persons for whom it is reasonably foreseeable could be harmed by the environmental effects, if any, caused by a closed site.

If a person entered a closed site and suffered harm due to unsafe conditions, RTIO may be liable for harm suffered by that person. To avoid liability for negligence, RTIO must be able to demonstrate that it took reasonable precautionary action to alleviate the risk of harm to others.

21.3 Breach of statutory duty

RTIO's obligations under legislation may also give rise to a statutory duty for which it will be liable if not fulfilled. Liability for breach of statutory duty is distinct from liability for negligence and RTIO may be liable for breach of statutory duty even though it may not be liable for negligence.

The types of statutory duty that courts have held to be actionable by private individuals include the duty not to cause a significant environmental impact and not to compromise industrial safety.

Generally, where a statutory provision prescribes a specific precaution for environmental protection or human safety and a duty of care exists under the general law of negligence, the duty will give rise to a private right of action under the statutory provision. In all cases, questions arise as to whether the statutory duty confers on individuals a private cause of action, whether that duty was breached and whether the duty is in fact owed to the plaintiff (i.e. the particular person bringing the action).

21.4 Summary of common law liability issues

A breach of relevant legislation (eg EP Act, Mining Act, MSI Act or associated regulations under these acts):

- may be evidence of a failure to comply with the duties under the MSI Act;
- may create a duty of care for the purposes of the Occupiers Liability Act;
- may be evidence of negligence or nuisance for the purposes of a common law action in negligence or nuisance; and/ or
- may give rise to a cause of action for breach of statutory duty at common law.

22 Rio Tinto Closure Standard (Version 4, 2012)

This closure standard was created by Rio Tinto to provide a standard to ensure that Rio Tinto managed activities are left in a condition which minimises adverse impacts on the human and natural environment. As such, it does not create legally binding obligations. However, it does set the standard that Rio Tinto aims for when decommissioning and rehabilitating its sites. Internal standards are effectively an undertaking to conduct a process in a certain manner and will provide evidence of the systems within an organisation. They can assist to establish the reasonable precautions defences under the EP Act, but also to assist avoiding potential incidents arising in the first place.

As the standard is applicable to all Rio Tinto managed activities, RTIO should ensure that it is familiar with the closure standard and follows the process for planning and implementing its closure strategy for each particular operation.

Importantly, the planning process has a number of steps including:

- developing and maintaining a knowledge base of the environment in which the operation is being developed and/or operates;

- developing and maintaining a closure strategy that promotes a consolidated multi-disciplinary approach to closure and post-closure obligations. The multi-disciplinary approach includes seeking legal advice where necessary and integrating the full range of social, environmental and economic implications that flow from closure;
- developing and maintaining a closure management plan to describe the operation's 'vision' for closure and associated preferred closure option. At a minimum, performance projections and targets must be set to cover:
  - rehabilitation;
  - bio-diversity;
  - socio-economics;
  - communications; and
  - employee relations.

Identifying and managing the legal requirements for closure are part of this planning process.

The closure standard also requires that the content of the knowledge base is periodically reviewed and updated. RTIO should ensure that it has a system in place for regularly reviewing and updating its knowledge base, including seeking additional legal advice prior to decommissioning sites. The closure plan must be fully updated at least every 5 years. This includes a review of and update of the legal position. The update process must be conducted by a multi-disciplinary team and consider future trends and possible changes in standards or expectations.

We also note that the standard directs RTIO to ensure that there are formal agreements between itself and any purchaser in the case of divestment. In this case the purchaser must agree to fulfil a minimum set of closure requirements and will close the site to an agreed set of closure standards. RTIO should also ensure that agreements regarding closure are made with the relevant government agencies and other stakeholders, as outlined in the Rio Tinto closure standards.

The closure standard lists a number of other relevant documents. We have not been provided with any of these documents and have not included them in our review. Please contact us should you wish us to review these documents and incorporate them into our advice.

23 Future law

We identify below other relevant legislative and policy changes or proposals that may become relevant to closure. Please advise if you require further advice in relation to these items.

23.1 Environmental offsets

An environmental offset is any environmentally beneficial activity undertaken to counterbalance an adverse environmental impact. Environmental offsets enable development to occur, but not at the total expense of the environment.

(a) Commonwealth

DSEWPC has released a draft *Environmental Offsets Policy* (**Policy**). The Policy provides guidance on the determination of suitable offsets during the Part

9 assessment stage of the Commonwealth environmental impact assessment process. The Policy will not be considered at the referral stage. Rather, it is proposed offsets will be used when a proposal is likely to have a significant impact on a matter of NES and despite all reasonable measures been taken to avoid or mitigate the impact, the residual impact from the proposal is still likely to have a significant impact.

The Policy proposes the use of both direct and indirect offsets, the former of these relates to those offsets that amount to on the ground protection, while the later refers to a range of measures including increased knowledge and understanding. Importantly, the Policy also outlines in detail:

- factors to be taken into account when assessing whether an offset is necessary; and
- factors to be taken into account when assessing if a proposed offset is a suitable offset.

It is likely that RTIO proposals will be subject to offset considerations when being evaluated under the impact assessment process.

(b) Western Australia

EPA Position Statement No 9 expresses the need for environmental offsets to have a long-lasting benefit. However, the requirements and guidance set out are uncertain in terms of cost and timeframe. The State Government's position on offsets is very general in its terms and its application is very project specific.

Where relevant, future expansion plans requiring EP Act Part IV approval may have a condition imposed relating to offsets. Offsets will likely have a life beyond operations. That is, depending on the nature of the offset, liability for ongoing maintenance of the offset may remain with RTIO post relinquishment of mining tenements and therefore impact on closure.

23.2 Closure standards

We note that the MOU between the DoIR and EPA in relation to the referral of onshore mineral exploration and mining development proposals requires referral documents to specify closure standards in accordance with the ANZMEC/MCA Strategic Framework for Mine Closure. In particular, that mine closure issues should be considered before mining commences and that mine planning and mine closure are integrated.

Future approvals will therefore entrench closure requirements (and standards) at least to the extent required by the evolving closure standards.

23.3 Proposed changes to the EPBC Act

The Federal Government has recently published a document entitled, *Reforming national environmental law: An overview.* The publication indicates several possible amendments to the EPBC Act, the two most significant are:

- introducing Regional Environmental Plans and Strategic Assessments to allow broad classes of actions to bypass the Commonwealth Impact Assessment process; and
- introducing 'ecosystems of national significance' and 'vulnerable ecological communities' as matters of national environmental significance.

These changes are expected to be tabled in Parliament in 2012.

23.4 Water Act

It is likely that many of the obligations contained in the *Rights in Water and Irrigation Act 1914* will soon be incorporated into the proposed *Water Services Bill 2011*. However, it is unlikely that any of RTIO's positive obligations will change as a result of the new legislation.

24 Regulators

24.1 General statutory obligations

(a) Western Australia

(1) The Environmental Protection Authority and the Office of the EPA are responsible for setting offsets and auditing closure conditions approvals under Part IV of the EP Act.

(2) The Department of Environment and Conservation is responsible for administering the:

- *Environmental Protection Act 1986;*
- *Environmental Protection (Controlled Waste) Regulations 2004;*
- *Environmental Protection (Unauthorised Discharges) Regulations 2004;*
- *Contaminated Sites Act 2003;*
- *Conservation and Land Management Act 1984;* and
- *Wildlife Conservation Act 1950.*

In addition, the Department of Environment and Conservation also administers all licences, approvals, notices and permits granted under the *Environmental Protection Act 1986.*

(3) The Department of Mines and Petroleum is responsible for administering the:

- *Mining Act 1978;* and
- *Mines Safety and Inspection Act 1995.*

(4) The Department of the Attorney General is responsible for administering the:

- *Occupiers' Liability Act 1985;*
- *Criminal Code Compilation Act 1913;*
- *Aboriginal Affairs Planning Authority Act 1972;* and
- AH Act.

(5) The Department of Regional Development and Lands is responsible for administering the *Parks and Reserves Act 1895.*

(6) The Department of Water is responsible for administering the *Rights in Water and Irrigation Act 1914.*

(7) The Department of State Development is responsible for administering State Agreements.

(b) Commonwealth

(1) The Department of Sustainability, Environment, Water, Population and Communities is responsible for administering the:

- *Environment Protection and Biodiversity Conservation Act 1999*; and
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.

(2) The Department of the Attorney General is responsible for the administration of the *Native Title Act 1993*.

24.2 Mine Closure Plans

From 1 July 2011, the EPA will generally not assess mine closure as part of its environmental impact assessment of mining proposals under the Environmental *Protection Act 1986*, where they are subject to the *Mining Act 1978*. The EPA will only assess mine closure in these circumstances if it considers there are particular issues which pose a high environmental risk or where the proponent request parallel assessment. The EPA will consult with DMP before making any such decision.

For mining projects not subject to the *Mining Act 1978* (such as pre- 1899 title or minerals-to-owner tenure, Hampton locations or State Agreement Act projects) the EPA will normally assess mine closure as part of its EIA process. This is likely to be the case for most of RTIO's major Pilbara operations. As a matter of course the EPA will consult with DMP on these assessments.

Where the EPA does assess mine closure, it is likely an approval condition will be applied requiring preparation of a MCP. In this circumstance, it is stated in the Guidelines that compliance monitoring of this approval condition may be delegated to the DMP. However, legally the DMP has no jurisdiction to enforce Part IV approval conditions.

As such the principle regulator for MCPs is the DMP but the Guidelines state that the approval processes for MCPs will often require advice or endorsement from other environmental regulators.

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Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.3 Decommissioning and Rehabilitation	The Yandicoogina Decommissioning and Rehabilitation Plan required pursuant to condition 9-1 shall set out procedures to: (1) manage long-term hydrogeological impacts of mining the channel iron deposit; (2) model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of waste material landforms; (3) manage over the long-term the surface water systems affected by the open pit; (4) progressively rehabilitate all disturbed areas to a standard suitable for the agreed end land use(s), with consideration and incorporation of: (a) the characteristics of the pre-mining ecosystems within the project area (through research and baseline surveys); (b) the performance of previously rehabilitated areas within the mining lease; (c) the performance of rehabilitation areas at the proponent's other operations in the Pilbara; and (d) best practice rehabilitation techniques used elsewhere in the mining industry. (5) develop and identify completion criteria; (6) monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria; (7) report on the rehabilitation and monitoring results; (8) remove all infrastructure; (9) develop management strategies and/or contingency measures in the event that operational experience and/or monitoring identify any significant environmental impact as a result of the proposal; (10) manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates; and (11) develop a 'walk away' solution for the decommissioned mine site.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y	MSR C	30/04/2012	Annual	
Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.4 Decommissioning and Rehabilitation	The proponent shall review and revise the Yandicoogina Decommissioning and Rehabilitation Plan required by condition 9-1 at intervals not exceeding three years.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y	MSR C	30/04/2012	Annual	
Yandicoogina	Yandicoogina Operations	Environment	Approval		Ministerial Statement Number 914	9.5 Decommissioning and Rehabilitation	The proponent shall make revisions of the Yandicoogina Decommissioning and Rehabilitation Plan required by condition 9-1 publicly available.	EP Act Part IV (Ministerial)	Environmental Protection Authority (EPA)	Manager Water Operations and Closure	Closure Specialist	Pre-closure	Operations	DO NOT USE - for data upload only	Y	Y	MSR C	30/04/2012	Annual	

Appendix C

37. Closure knowledge database report summaries

Attachments:

- Extract from the Rio Tinto Iron Ore (WA) closure knowledge database

14 pages

Rio Tinto Yandicoogina 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.

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. Accordingly, some information presented in the closure knowledge database may be obsolete.

Full technical reports supporting the closure of the operation will be presented instead of the closure knowledge database as part of the last plan produced prior to the implementation of closure (the Decomissioning Plan).

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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.

Yandicoogina Mineral Waste Risk Assessment: Acid Rock Drainage Potential

2007

Potential for acid and metalliferous drainage has been assessed for the Yandicoogina mine site.

Internal reference: RTIO-PDE-0033672

For all processed ore and waste at Yandicoogina Junction Central the overall acid and metalliferous drainage (AMD) risk is low to nil. Specifically, the AMD risk at Junction Central, Junction South East and Billiards deposits is considered low and the risk at Junction South West deposit is low to nil. The acid and metalliferous drainage risk is slightly greater (low to medium) at the Yandicoogina Snooker and Meander deposits. Elevated sulfur concentrations were found in the alluvium, weathered channel, alluvials and to a less extent in the Welli Wolli formation. The enriched elements for the various deposits mostly included Fe, As and Sn.

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. It was found that in some cases stilpnomelane or minnesotaite may have been wrongly identified as grunerite using QEMScan and also that this analysis cannot be used to identify the presence of fibres. It was concluded that mineralogical methods may underestimate the acid neutralisation capacity of the sample.

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. The presence of grunerite or other amphibole minerals may indicate asbestiform minerals however further tests would be necessary to confirm risk. Variable textural and mineralogical controls on sulfide mineral occurrence result in decreased accessibility of pyrite to oxidising fluids.

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-PDE-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.

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 Low-Sulphur Waste Minerals (Summary) **2011**

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.

Internal reference: RTIO-PDE-0090689

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.

Preliminary results of geochemical characterisation of Yandicoogina samples **2012**

This memo summarises the results of preliminary solid extra element analysis, short term liquid extract/leach testing and phase 1 acid base accounting (ABA) completed on samples obtained from the Yandi Junction South West (JSW) drilling programme completed in June 2011 and grab samples selected by mine geology in 2009 and 2011 from Junction Central (JC) and Junction South East (JSE).

Internal reference: RTIO-PDE-0109618

The results indicate that soluble metals/metalloids are generally below the trigger values outlined in the ANZECC water guidelines and Yandi background water values. Where there are exceedances, the trigger values (normally associated with ANZECC water guidelines for 95% protection of freshwater species) were lower than the detection limits used in the analysis. All samples were above drinking water trigger values and stock water guideline trigger values.

RTS058 Geochemical testwork on Low Sulfur samples from Yandi (Phase 1 and 2) **2012**

This testwork undertakes geochemical characterisation (ABA and leach testing) on Yandicoogina samples (RC, Grab, tailings) to support the assumption that low grade and waste material is unlikely to pose an environmental risk. This work was conducted to support the Yandi JSW approvals.

Internal reference: RTIO-PDE-0099036

Reverse circulation (Junction SW) and grab (Junction Central/SE) samples had negligible sulfur content (<0.1%) and were confirmed to be Non Acid Forming (NAF) and had little neutralising capacity. The exception were samples from the alluvium, where there is neutralising capacity that could counter any acid formed. All samples were enriched (when compared to the average crustal abundance) in As, Au, Bi, Sb, Se and Hg though static leach testing has indicated that these elements were not readily leached upon contact with water. For waste fine samples there was negligible sulfur (><0.04%) and all were confirmed to be NAF. Similar to the RC and grab samples, the waste fines samples were enriched in As, Au, Se and Hg, though these elements were not readily leached. The supernatant solution from the waste fines samples were also tested. The pH of the solutions were neutral and were chemically similar to leaches of the waste fines solids. High Fe and Al concentrations in the leach tests were deemed to be in excess of the solubility limits and it is assumed that the elements were present as colloids rather than being dissolved. Follow up testing will be conducted to confirm

RTS058 Yandi Project: Geochemical Testwork on Low Sulfur Samples - Supplemental Samples **2013**

This work was carried out to test the assumption that low grade and waste from Yandicoogina is unlikely to pose a risk to the environment. This report discusses the results of 19 additional samples supplementing the initial batch of 95. See RTIO-PDE-0099036 for additional information.

Internal reference: RTIO-PDE-0103854

The 18 waste rock samples submitted for analysis this time around have been characterised as having low sulfur contents ranging from below the detection limit to 0.26%. The sulfur is either present as sulfides or more likely sulfates and were classified as non-acid forming (NAF) or Uncertain (UC-NAF), having little to no neutralising capacity. Minor and trace elements that were enriched compared to the average crustal abundances include As, B, Bi, Sb, Se and Tl, with element leachability generally limited in pH neutral de-ionised water. One (1) tailings sample was submitted with the results similar to the tailings samples submitted initially. The sample had negligible sulfur and was classified as NAF-Barren due to little to no neutralising capacity. The only enriched minor or trace element was Se and once again the leachability of elements was generally low.

Assessment of Yandicoogina water quality at closure **2013**

Internal reference: RTIO-PDE-0113542

This Technical Memorandum addresses the potential leachability of minor and trace element from backfill materials, and the effects of evaporation on the concentrations of these elements. The report includes an overall water quality assessment for the site based on historical minor and trace elements records, a review of leach tests conducted on Yandi materials, and limited conceptual modelling to illustrate the potential effects of evaporation on water quality and minor and trace element concentration.

The 2011-2013 dataset indicates that in general groundwater at Yandi is of HCO3 type with pH values ranging from 6.7 to 8.3. No clear segregation between alluvium and the deeper CID aquifer was observed in terms of salinity. No changes in salinity or major-ion chemistry were observed. Trace elements such as As, Cr, Ni, Sb and Se have been detected. Poor correlation between reported TDS and EC values was identified in the data. Recent nitrogen exceedances observed at the site appears to originate at surface water discharges, potentially from wash down bays. The water quality data suggests Pilbara creeks have different properties; Marillana Creek is circum-neutral to slightly alkaline, Weeli Wolli Creek is slightly alkaline, while Homestead Creek (not located in catchment area) is neutral. Total dissolved solids indicate that Weeli Wolli is slightly fresher than Marillana Creek. Leach test results suggests that most elements will be mobilized in an initial flush of water from significant rainfall events. Modelling results indicated that groundwater is supersaturated with respect to CO2. Thus, degasing of CO2 may occur as groundwater equilibrates with the atmosphere and mixes withh pore waters from backfill materials; which in turn would increase pH from ~7.4 to ~8.6. A second evapoconcetration phase could drive CO2(g) to exsolve, such that pH could increase to as high as 9.1. These conditions would influence trace element mobility.

RTS058 Yandi Project: Geochemical Test work on low sulfur samples – supplemental leach testing **2013**

Internal reference: RTIO-PDE-0110708

This work forms part of ongoing geochemical characterisation. Leach test, work presented in this report, explored contamination under a wider range of geochemical conditions, following work completed in August 2012 and January 2013.

Mineralogical assessment was completed on 11 waste rock samples and 1 tailings sample. The composition of all leachates was comparable, irrespective of test conditions. The solutions were circum neutral (pH between 7.8 and 8.5 for waste rock and pH 6.5 to 7.6 for tailings) and dilute (average EC approximately 650 uS/Cm for waste rock and 70uS/cm for tailings). Readily detectable elements included major elements: Ca, Mg, Na, K, Cl, Si and SO4 and trace elements AL, B, Ba, F, Fe, Sr and Zn. As expected, the highest concentration of elements were recorded in low L:S leach tests, the majority of which were source term limited (ie very low masses were present and are expected to dissolve completely during the test.) Test work and PHREEQC modelling indicated that AL, Ba, F and Si may be subject to a solubility control in the waste rock samples. In the tailings sample, low but detectable concentrations included: Cd, Cu, Pb, Mn and Ni.

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.

Modelling showed that where no sulphides were present on pit walls, dewatered sulphidic material could increase the groundwater solute load (>25% in the scenarios studied). However, solute contributions from sulphide talus was identified as the most significant contributor to pit lake water quality. Oxygen consumption by talus was predicted to be 20 times greater than black shale set back 5m from the pit, behind inert material. Solute contributions from sulphides on the pit wall and from fractures was very low compared to talus (<1% of the total contribution from oxidising sulphides in the scenarios studied). Modelling also showed that leaving a permanent 5m buffer of inert material (eg after erosion is accounted for) between the pit face and sulphide materials could substantially improve water quality (pH improved from 0.4 – 2 to 4.5 - 5.5 in the scenarios

Physical characterisation

Yandi Geology: Stratigraphy, Lithology, Chemistry, Alterations and modelling parameters

2004

This report describes in detail the geology of the Yandi area. Detailed litho-chemical descriptions of each unit are included along with modelling parameters current as of March 2004. Also included are stratigraphic columns, which illustrate the time relationships between the various units. Finally, a table illustrating the main alteration types encountered in the Yandi area, which are routinely logged, are also included for reference.

Internal reference: RTIO-PDE-0012215

The Yandicoogina (Yandi) iron ore reserves form part of an extensive series of Channel Iron Deposits (CID) located in the eastern Hamersley Province of the Pilbara region in northwest Western Australia. The ores commonly outcrop as a series of low mesas beside the Marillana, Yandicoogina and Weeli Wooli Creeks and are commonly referred to as "pisolitic limonites" (England 1998). CID is a collective term allocated to material comprising concentric shells of limonite and vitreous goethite (Fe203.H20) around nuclei of hematite (Fe203), goethite, turgite (Fe203.nH20) and iron oxide replaced wood that have accumulated in palaeo-river channels. CID are characterised by the presence of fossilised wood fragments and absence of lithic rock fragments within ore. HI geologists have subdivided the CID into 6 main material types: Eastern Clay Conglomerate / Laterite - Mottled orange-brown and grey-white clays (after dolerite), BIF and ferricrete fragments. Weathered Channel - Partially lateritised upper surface of the CID, which is silicified and penetrated by clay filled solution pipes, but still retains recognisable CID texture. SiO2 & Al2O3 are elevated at the expense of Fe in the weathering process. Goethite Vitreous Upper (GVU) - The Upper Ore Zone is approximately 20m thick and is moderate in silica and low in alumina. The GVU is slightly magnetic with confirmed presence of kenomagnetite. It is thought this zone was above the palaeo-watertable. Goethite Vitreous Lower (GVL) - The Lower Ore Zone is low in silica, moderate in alumina, and approximately 25m thick. It is thought this zone was below the palaeo-watertable. Limonite Goethite Channel - This material forms the footwall of the orebody. It is a clay-rich, leached, yellow, ochreous goethite (limonite) zone. It contains occasional lenses of CID material. Basal Conglomerate – This basal clastic facies of the channel unconformably overlies the Weeli Wolli Formation. The unit varies in thickness from a few centimetres up to 8m and is generally only present in the centre of the channel. The GVU and the GVL are the only units that currently fall within economic mining parameters.

Groundwater

Hydrogeology review for proposed HI (Yandi) extended mine closure plan

1998

This report reviewed the hydrology and hydrogeology of the eastern section of the Channel Iron Deposit (CID) in the palaeo-valley of Marillana Creek, known as the Junction Deposit mine. (Note: The impacts of several closure options are discussed, but may now be invalidated by subsequent expansion activities.)

Internal reference: RTIO-HSE-0070352

The principal aquifer in the area of the Junction Deposit is the CID itself with a transmissivity of about 3500 m2/d and estimated throughflow of 2.5 to 3 ML/d. Alluvium beneath Marillana Creek is an aquifer of lesser importance, because of a smaller cross-sectional area and lower hydraulic conductivity. Water levels in the CID are controlled by recharge from Marillana Creek. Marillana Creek normally flows for a period of only 30 to 60 days following heavy rain. During these periods the creek loses water to underlying alluvium. In several places the creek alluvium overlies the CID, which is also recharged by the creek flow. Streamflow loss in the area of the Junction mine during the first flow in the wet season is estimated to be at least 100 ML per kilometre of length along the creek bed. The loss of water by evapotranspiration from pools and riparian vegetation near the Junction mine is estimated to be 0.3 ML/d from each kilometre of the creek bed.

HI Yandi: Phil's Creek and Hairpin Dewatering Borefield Installation Program 2002

2002

This report examines the hydrogeological characteristics of the intersection of Phil's Creek CID and Marillana CID within the Hairpin area.

Internal reference: GDSR 4397

The primary targets of new dewatering bores has been cavernous intersects within the Limonite Goethite Unit (situated below the Main Ore Zone) within the Channel Iron Deposit. Transmissivity values derived from the new bores at Hairpin and Phil's Creek indicate that the hydraulic characteristics of the CID aquifer in each of these areas has been influenced by a progressive reduction in the saturated thickness of the aquifer since dewatering commenced. A numerical groundwater model has been constructed based on this field work and is being used to complete a review of the closure impacts at Yandi.

Yandicoogina Water Balance - Pre and Post Mining Hydraulics and Hydrochemistry

2010

The study was undertaken to: update the conceptual hydrogeological model; define the pre mining and current groundwater conditions and hence impacts from mining operations on the flow system; determine the importance of creek seepage into the CID aquifer and mine pits; and provide information on water quality and quantity.

Internal reference: RTIO-PDE-0073467

The groundwater level response to changes in the water budget due to natural and human induced processes is immediate, suggesting good connection between various aquifers and creek systems. Long term observations indicate water levels can rise by up to 10m in the CID aquifer after intense rainfall events. This translates to approximately 16GL of water and can be as high as 30GL per event over a 25km length of Marillana Creek. The chloride (Cl) concentrations show 20% of water discharged from the mine is lost by evaporation and evapotranspiration. As a result CID salinity increased by 20% up to the 12km down gradient from Junction Central, beyond which no increase in Cl concentration was observed.

Yandicoogina hydrogeological assessment of the CID & adjacent floodplain **2010**

This hydrogeological investigation was undertaken to mining at Oxbow, Junction South West (JSW) and the northern end of Junction South East (JSE). The principal objective of the study was to gain a better understanding of the hydrogeological setting of the Yandicoogina region.

Internal reference: RTIO-PDE-0071209

This hydrogeological investigation obtained aquifer parameters for Oxbow and JSW, surface water groundwater interaction, and estimates of dewatering volumes for Oxbow and JSW. Drilling outside the CID aquifer revealed that the material surrounding the CID aquifer in the flood plain is unconsolidated alluvium or in situ weathered Weeli Wolli Formation bedrock. Regardless of the weathering history and origin of the deposits, the material is characterised by hydraulic properties that allow for leakage to the CID, and that this leakage may be greater than previously anticipated. The thickness of the flood plain material at JSW and Oxbow is variable (20 - >50m) depending on elevation and proximity to Marillana Creek.

Yandicoogina hydrogeological assessment of the CID & adjacent floodplain - Bore Installation, test pumping and analyses 2008/09 **2010**

The principal objective of the study was to gain a better understanding of the hydrogeological setting of the Yandicoogina region. The hydrogeological investigation focused on obtaining aquifer parameters at principally Oxbow and JSW, surface water groundwater interaction, and estimates of dewatering volumes for the proposed expansion sites.

Internal reference: RTIO-PDE-0071209

Drilling outside the Channel Iron Deposit (CID) in the floodplain of Marillana Creek revealed that the material surrounding the CID aquifer in the flood plain is unconsolidated alluvium or in situ weathered Weeli Wolli Formation bedrock. Regardless of the weathering history and origin of the deposits, the material is characterised by hydraulic properties that allow for leakage to the CID, and that this leakage may be greater than previously anticipated. The minimum thickness for the floodplain material that occurs adjacent to the CID deposit is estimated from drilling at JSE to be 37m. The thickness of the flood plain material at JSW and Oxbow is variable (20 - >50m) depending on elevation and proximity to Marillana Creek. Hydraulic connection between the flood plain, the weathered basement and the CID aquifer was confirmed during the test pumping program, where constant rate test pumping showed that the bores installed in the flood plain sediments or weathered basement of the Weeli Wolli Formation adjacent to the CID respond to pumping in the CID aquifer. The CID hydraulic conductivity for was calculated between 3m/d and 25m/d, with an average of roughly 9m/d. Specific yield was more difficult to determine from testing but ranged over two orders of magnitude from 0.01 to as high as 0.3. Yield from the constant rate pumping tests ranged from 60L/s up to 100L/s (the upper limit of the pumping equipment).

Yandicoogina Operations Groundwater Operating Strategy **2012**

All water licences contain a set of terms and conditions detailing the licensee's responsibilities and specifying the volume of water that may be taken in any given year (the water entitlement or allocation). This groundwater operating strategy describes how groundwater is managed at the Yandicoogina operation to comply with licence conditions and is a condition of the water licence. As such the report is updated regularly to reflect current operating practice.

Internal reference: RTIO-HSE-0057642

Yandicoogina operate several borefields in order to supply drinking water and dewater aquifers ahead of mining. The volume of water abstracted is in excess of site requirements and several discharge outlets are used to dispose of excess water to adjacent creek systems. The plan specifies monitoring activities to include groundwater water levels, electrical conductivity (EC), pH and temperature sampled from selected bores, and total volumes, nutrients (Total-P, Total-N, NO3 and NH3) and metals (Se and Hg) at discharge outlets. Other parameters sampled include Na, K, Ca, Mg, Cl, CO3, HCO3, SO4 and NO3 from some bores and at some discharge outlets and within the local creek system pH, EC, TDS, TSS, Al, Ca, Mg, Na, K, SO4,Pb, Cu, Fe, Mn, Mo, Zn, As, Cd, Cr, TRH.

Surface water

Marillana Creek catchment hydrology and local catchment impacts Yandicoogina +52 Mtpa Expansion Prefeasibility Junction South West (Stage 1) and Oxbow deposits **2008**

This report describes the hydrology of Marillana Creek past the Oxbow and JSW deposits and provides a conceptual surface water management plan for local, natural surface water runoff.

Internal reference: RTIO-PDE-0047262

Flow volumes along Marillana Creek at Oxbow and JSW deposits range from 60 m3/s for a 1 in 2 year average recurrence interval (ARI) to 4700 m3/s for a 1 in 500 year ARI event. Flood protection for the Oxbow and Junction South West deposits is required to minimise the environmental impacts, continue natural flows where possible and protect the pit and pit walls from surface water runoff. A protection level of between 1 in 20 and 1 in 100 year ARI is recommended. Diversion of natural surface water runoff away from the active mine areas from local catchments will be required as part of the mine plan.

Yandicoogina Surface Water Management Report **2010**

This report describes the interaction between natural surface water runoff, the local environment and the Yandicoogina mine during operations. Closure management is not addressed in this report.

Internal reference: RTIO-PDE-0072516

Environmental issues relating to surface water at the Yandicoogina Operation include the potential for surface water runoff from the operation to become contaminated and discharge into the environment, and alteration of natural surface water flow by structures/operations, thereby affecting downstream vegetation or causing flooding/ponding upstream. Management actions implemented at the mine include treatment of surface water prior to discharge into the natural environment and maintaining natural drainage patterns where possible. Yandicoogina mine activities encroach on regional and local floodplains of Marillana Creek and its tributaries. To manage flood risks during the wet season, Yandicoogina JC and JSE currently employ a combination of "sump and pump" and "diversion" surface water management strategies. Sumps are dewatered with portable and permanent pipe and pumping systems. Diversion levees and channels are employed around the JC and JSE operations to prevent flooding from surface water runoff and to minimise pit wall instability associated with runoff flowing uncontrolled over the pit crest. Expansion of the current mine operation will further encroach into regional and local floodplains of the Marillana Creek, Weeli Wolli Creek catchments and their tributaries, necessitating additional surface water management requirements.

Marillana Creek regional flow balance and catchment hydrology **2010**

At the cessation of mining pit voids adjacent to and intercepting local tributaries to Marillana Creek, Marillana Creek floodplain and possibly Marillana Creek proper may collect or divert tributary flows, while others may only collect local surface water runoff and incident rainfall. This report assess how the hydrological regime of the Marillana Creek catchment will be altered when mine closure and rehabilitation activities are completed at Yandicoogina and BHPIO Yandi mines.

Internal reference: RTIO-PDE-0081939

Modelling suggests that the truncation of local creeks associated with leaving pit voids will change the flood frequency and thus lower flood potential within Marillana Creek. For example, at the terminus of Marillana Creek bank full conditions, the maximum capacity of the creek within the banks, will reduce from a 10 year average recurrence interval (ARI) to a 20 year average recurrence interval; such that overbank flooding will only occur after an event greater than a 1 in 20 year ARI. This flood regime change will affect sections of the creek that support riparian vegetation such as Eucalyptus camaldulensis (River Red Gum), whose existence is associated with surface flooding characteristics.

Marillana Creek Regional Flow Balance – Pre and Post-mining comparison **2010**

A study of the regional flow balance of the Marillana Creek catchment was carried out to identify and compare the response of the catchment to different storm events under pre and potential post-mining conditions. The study presumes BHPIO and RTIO will divert Marillana Creek flows around their deposits while truncating some tributaries.

Internal reference: RTIO-PDE-0072519

It was determined that under pre-mining conditions Marillana Creek would flow on average 200 days per year. Continuous flow was recorded at Flat Rocks between 2000 and 2004, with over 350 flow days recorded per year during that period. This may attribute to creek bed interflow which enables water to return to the surface during dry periods and the potential storage capabilities of the retention basins located in the Upper Marillana Creek catchment. The study demonstrated that the creek system would experience approximately 27% reduction in flow contribution at closure, with the RTIO and BHPIO Yandicoogina mine operations individually accountable for 17% and 10% of the total flow reduction. The flood peaks for all ARI rainfall events would also decrease by approximately 50% at the catchment outlet. The cumulative impacts associated with flow reduction and change in catchment water balance post-mining would modify the flood regime and reduce the flooding potential of the creek system. This may result in decreased water availability for riparian ecosystems on floodplains and ultimately lead to biodiversity change within the creek

Baseline hydrology assessment for Yandicoogina discharge **2012**

This baseline hydrological/hydraulic assessment was carried out to access the existing situation and movement of discharged water along the creek systems and to predict the likely behaviour of the released water for various discharge scenarios. Closure implications are not addressed in this report.

Internal reference: RTIO-PDE-0074001

The assessment demonstrated that historically discharged water would not have extended past the Marillana Creek catchment outlet at the confluence with Weeli Wolli Creek; hence anecdotally no flow contribution to Weeli Wolli would have been expected. This suggests the wetting front in Weeli Wolli Creek is likely to have resulted from surplus water discharged from the Hope Downs 1 mine operation. A discharge footprint of 16.3km down gradient from the Weeli Wolli – Marillana Creek confluence was estimated for the maximum modelled 110GL/year regional surplus discharge (based on existing infrastructure). An option to relocate the discharge location in Marillana Creek down gradient from the mine operations would extend footprint to approximately 6.7km to 17.3km down gradient from the Weeli Wolli – Marillana Creek confluence for modelled volumes of 55GL/year to 110GL/year.

Weeli Wolli Creek hydrology and floodplain assessment **2013**

This flood study defines the hydrological regime and natural flow conditions for Weeli Wolli Creek and investigates several conceptual flood protection levee options for safe mining of the Billiard South deposits within the Weeli Wolli Creek floodplain.

Internal reference: RTIO-PDE-0117748

A RORB rainfall runoff model was developed and calibrated to observed data at gauging stations within the regional Weeli Wolli Creek catchment. The calibrated RORB model was used to simulate design flood peaks and hydrographs for the study area. The expected 2, 1 and 0.5 % AEP flows estimated for Billiard South are 2200 m3/s, 4070 m3/s and 4900 m3/s, respectively. The 0.5 % AEP event was selected as the design standard for the levees based on the expected 20 to 30 years of operational life of the infrastructure. The modelling suggests that flood protection may require levee heights, depending on the alignment, ranging from 4.8 m to 6.5 m.

Water interactions and pit lakes

Impacts of mining and mine closure on water quality and the nature of the shallow aquifer, Yandi Iron Ore Mine. Masters Thesis **2002**

This study was completed as part of a Masters of Science qualification at Curtin University of Technology. The study aimed to: determine the current water quality in the aquifers; predict future water quality after waste rock from the mining has been returned to the channel; and predict the physical properties of the groundwater system after the waste has been returned to the channel, with a focus on assessing changes in permeability occurring as a result of siltation or secondary mineral formation.

Internal reference: GDSR 4746

Overburden material that will constitute the backfill was found to have high concentrations of (by material type) Alluvium - As, Fe, Se, Sb, Ba, Te; Eastern clay conglomerate - Pb, Mo, Fe, As, Se, Te, Sb, Ba; and Weathered channel horizon - Mo, Fe, Sb, As, Se, Ba. The Weathered channel horizon was found to contain bands of smectite clay. This clay is known to swell when wet up to 20 times its dry volume. This may impair the permeability of an aquifer with significant amounts of this clay. A solution with a high sodium chloride concentration may inhibit this swelling. The current groundwater quality is slightly acidic or slightly alkaline, and is typically of calcium/magnesium bicarbonate to sodium carbonate. The majority of the bores sampled met the Australian guidelines for potable water with sample three exceedances noted for pH and Pb. The leachate tests indicated: pH may rise towards 8.4 due to the buffering of carbonate minerals; TDS may increase as soluble minerals dissolve into the groundwater; conditions for anoinic elements such as antimony, arsenic, cobalt, chromium, gallium and molybdenum will become more favourable due to the rise in pH; minerals such as diaspore, leonhardite, quartz, ZnSiO3 and hematite will start to precipitate as they become saturated in solution; some elements will reduce in concentration as minerals are precipitated. (Four backfill and landform shaping options were also reviewed as part of this work, however, these options are invalidated by the expansion of the site.)

Yandicoogina closure options: preliminary water modelling results **2012**

This document intends to provide the basis of a technically defensible, integrated closure plan with respect to managing water quantity and quality post mining at Yandicoogina through the use of water balance modelling. The main objectives for water management at closure will be: to create stable landforms, maintain surface water and groundwater throughflow (albeit with no pre-determined water table elevation), and maintain surface water and groundwater quality to within acceptable limits for the agreed post closure land uses. Salinity levels post-closure were modelled for various scenarios: All pits left open (No Backfill Option) The mining of a complete channel as an open void (Continuous Channel Option) The combination of mining Oxbow, Junction Southwest A and Junction Southwest C pits as open voids and the partial backfilling of Junction Central, Junction Southeast Extension and Billiard South to specified levels (Selected Backfill Option) The mining of individual pits, achieving in-pit backfill to 2m above pre-mining ground water level (Complete Backfill Option)

Internal reference: RTIO-PDE-010361

Water balance modelling results showed the No Backfill Option with open pits act as sinks for groundwater. As such, water cannot leave these pits and salt levels increase, creating a hypersaline environment. The Continuous Channel Option assumes that a creek and lake system is established at the base of the mined out pit from which water would flow into the undisturbed Weeli Wolli Creek channel. Evapo-concentration of salinity is low and the water quality remains fresh—pit salinities of 130mg/L assuming natural creek salinities of 50mg/L. This is because discharge through the system exceeds evaporation. The Selected Backfill Option seeks to optimize the limited backfill material available. Water levels in the backfilled pits reflect the backfill level. After rainfall events, evaporation occurs which quickly reduces water levels back to the backfill level from which no further evaporation occurs. Groundwater throughflow is maintained and the area in which evaporation can occur is reduced, thereby reducing salinity to around 4,800mg/L. However with additional strategic use of remaining backfill, water quality may be improved. Water modelling of the in-pit backfill to 2m above pre-mining water table indicated salinity could increase to 3,800 mg/L at the Billiard pit. This was because the modelling showed the water table would fluctuate and rise more than 2m above the pre-mining water table, exposing the water table to evaporation processes. Diverting surface water into the pits to decrease salinity induced dilution temporarily, but only by 1000mg/L at the Billiard pit. Surface water management studies showed that a combination of diversion drains, bunding and backfilled pit sections (landbridges) will be required to manage surface water drainage during mining. However no recommendations for post-closure management were developed. An internal review of other closure requirements will be necessary to identify the preferred post mining landform option.

"Impacts of mining and mine closure on water quality and the nature of the shallow aquifer, Yandi Iron Ore mine" by Sean Gardiner: Background to study and summary of findings **2012**

This document summaries the background to, findings and / or relevance of a geochemical investigation of waste rock at Yandi that was undertaken as a part of a study conducted by Masters Student Sean Gardiner from Curtin University of Technology.

Internal reference: RTIO-PDE-0103858

The MSc thesis presents considerable information on groundwater quality in the vicinity of Yandi Mine at the time of the study (1998). Whilst, it gives some useful information on the local geochemical background in one area of the Pilbara region it is of insufficient scope to provide meaningful scale to any potential geochemical contamination.

Closure and water strategy synergies at Yandicoogina **2013**

This memo records a facilitated discussion which looked at opportunities for additional or alternative water disposal options that facilitate closure.

Internal reference: RTIO-HSE-0201688

An opportunity to dispose of surplus water by creating pit lakes in the Yandicoogina mined out voids before the planned closure was identified. This concept would require in pit waste dump landscaping / shaping activities to commence as soon as practicable. Water would then be disposed into the void, to create the lake. Appropriate wetland revegetation activities could then commence around the lake fringe. Groundwater re-circulation volume would increase as a result of this activity; however the environmental benefit are anticipated to outweigh the re-circulation impact.

Oxbow Pit Lake – Stochastic salinity and water level conditions post closure **2013**

The report presents the outcomes of a simple water balance developed to simulate the behaviour of water in Oxbow Pit, based on a 2013 Yandicoogina Closure Groundwater Model.

Internal reference: RTIO-PDE-0116562

The predictive model estimates that the steady state water level in Oxbow pit will fluctuate around 514m RL with no likelihood of the pit overtopping. Total Salt Load and salinity continue to slowly rise, reaching approximately 8.7 ×108 kg and 26,000mg/L respectively after 2000 years. If a 30% smaller pit shell is used (within the error range of the groundwater model) values are more likely to fluctuate around 528mRL. It is unlikely the smaller Oxbow pit will overtop; only 14 of the 100 realisations run over a 2000 year period overtopped the pit on at least one occasion. Total salt load and salinity stabilise after 400 years at approximately 1.2 ×108 kg and 2,700 mg/L respectively.

Technical Memorandum: Laboratory modelling for Yandi Selenium concentration **2014**

This study reviews the potential effect of evaporation on selenium concentration increases in surface water environments and/or during development of mine pit lakes based on water samples from the Yandicoogina Oxbow area. The study includes laboratory scale experiments to measure changes in selenium concentrations, with different acidity levels, by simulating the process of evapoconcentration.

Internal reference: RTIO-PDE-0118277

Findings to date show background selenium concentrations on average at<0.002mg/L from Yandicoogina bores. The modelling results showed that Se > 0.01mg/L (the ANZECC 95% limit for the aquatic ecosystems) was measured when evapoconcentration levels exceeded 93.75%. At 98% evaporation Se >0.055mg/L (the ANZECC 80% limit for the aquatic ecosystems) was measured. Changes to pH did not appear to influence the Se results, although a slight increase in general cations was observed under acidic conditions.

Flora

Yandicoogina Railway Drainage Shadow Monitoring 2001 **2001**

Drainage shadow monitoring on Hamersley Iron's Yandi railway commenced in 1998. The monitoring program was designed to assess whether construction and operation of the railway had any indirect impact on the survival and health of Mulga, Acacia aneura. It was postulated that downslope impacts in the drainage shadow area might occur, with limited upslope impacts due to flooding also considered.

Internal reference:

The results show that although numbers of all mulga age classes and dead mature mulga appeared to be higher in the upslope transects in 2001, none of the results could be interpreted as indicating a difference between them and the downslope transects. However, it was not possible to draw any clear links between vegetation dynamics and the presence of the railway line, and it was recommended monitoring continue.

Yandicoogina Railway Drainage Shadow Monitoring 2002 **2002**

Drainage shadow monitoring on Hamersley Iron's Yandi railway commenced in 1998. The monitoring program was designed to assess whether construction and operation of the railway had any indirect impact on the survival and health of Mulga, Acacia aneura. It was postulated that downslope impacts in the drainage shadow area might occur, with limited upslope impacts due to flooding also considered.

Internal reference:

Similar trends were observed to previous years, with few statistical difference upslope and downslope of the railway. The Highway transects appears to have reached a successional stage where the number of mature mulga have increased, dead mature mulga have decreased and there is some recruitment occurring.

Yandi Expansion Areas Rare Flora Survey - Feb 2003 **2003**

This document provides a description of the survey methodology and findings of the rare flora survey of the Yandicoogina expansion area.

Internal reference: RTIO-HSE-0014711

Large portions of the study area had been either burnt or disturbed in the last few years. Vegetation types varied considerably with landform and included Artistida grassland in disturbed borrow pits, mulga shrublands on clayey plains, hummock grasslands with shrub over storeys of varying density on stony hills and eucalypt woodlands within the Marillana Creek. No declared rare fauna were recorded from the 6 areas surveyed. Six priority flora were recorded from the expansion area. Several mounds of the priority 4 Western Pebble-mound Mouse, Pseudomys chapmani, were recorded, some of which may be active. Two uncapped drill holes and a small fenced area containing numerous bags of aboriginal stone artefacts were located during the survey.

Yandicoogina Railway Drainage Shadow Monitoring 2003 **2004**

Drainage shadow monitoring on Hamersley Iron's Yandi railway commenced in 1998. The monitoring program was designed to assess whether construction and operation of the railway had any indirect impact on the survival and health of Mulga, Acacia aneura. It was postulated that downslope impacts in the drainage shadow area might occur, with limited upslope impacts due to flooding also considered. Monitoring of dead Mulga was discontinued as there were problems with species identification, fire, etc. that affected the accuracy of the data.

Internal reference:

Similar trends were observed to previous years. None of the changes, ie recruitment, appear to be linked to any difference between Mulga communities located upslope and downslope of the railway line.

Yandicoogina Railway Drainage Shadow Monitoring 2004 **2004**

Drainage shadow monitoring on Hamersley Iron's Yandi railway commenced in 1998. The monitoring program was designed to assess whether construction and operation of the railway had any indirect impact on the survival and health of Mulga, Acacia aneura. It was postulated that downslope impacts in the drainage shadow area might occur, with limited upslope impacts due to flooding also considered. Monitoring of dead Mulga was discontinued as there were problems with species identification, fire, etc. that affected the accuracy of the data.

Internal reference:

In general the proportion of Mulga in each age class remained unchanged. It was concluded that vegetation dynamic differences between upslope and downs slope populations could be identified. Such that the rail has not influenced the survival or health of the Mulga. Monitoring was discontinued.

Vegetation mapping and rare Flora Searches of Yandi Backfill Hill **2005**

This document provides an account of the methodology, findings and recommendations of the botanical survey of the Backfill Hill, an area of proposed additional source material that would be mined solely to backfill pit voids in the Yandicoogina mine.

Internal reference: RTIO-HSE-0014923

The vegetation types identified at Backfill Hill are comparable with those mapped for the surrounding area and were in very good condition and generally typical of the Newman area. 122 species of flora were recorded. No declared rare flora or priority flora were recorded from the Backfill Hill area, and a single record of Buffel Grass Cenchrus ciliaris in the survey area.

Yandi JSE - Conservation Significant Vegetation, Flora, Fauna and Fauna Habitat Assessment **2005**

This assessment establishes the conservation significance of and impacts to flora and fauna in the Yandicoogina JSE project area.

Internal reference: RTIO-HSE-0059518

None of the 21 vegetation types identified from the area are Threated Ecological Communities, neither are they significant at the level of the Pilbara bioregion. Vegetation of conservation value at the Hamersley subregion comprises vegetation types 1c of breakaways and vegetation types 3c, 3d, 3e, 3f and 3h of major creeklines.

Yandi Riverine Monitoring Data 2005 E. camaldulensis results **2005**

Surplus water obtained from dewatering of Hamersley Iron's Yandi mine is discharged into Marillana Creek. Monitoring commenced in 1997 to determine whether the water discharge is having an impact on sensitive plant species including large Acacias, Atalaya hemicaulca, Eucalypts (E. camaldulensis, E. victrix) and Melaleuca spp.

Internal reference:

Results for 2005 show that the majority of trees at the site are stressed. For example, only 3 of the original 18 trees at the Upstream control site remain alive. However trees in Weeli Wolli and Phils Creek remain in good health.

Yandicoogina Revegetation Reference Sites **2009**

This report documents the establishment and monitoring of baseline (control) vegetation transects in unmined areas adjacent to Yandicoogina operations.

Internal reference: RTIO-HSE-0098922

A total of 82 vascular plant taxa from 45 plant genera and 23 plant families were recorded in the Yandicoogina control transects and one priority flora species. Average plant density and species richness varied between transpects. Although it was noted that recent fire events near transpects C1, C2 and C4 may have contributed to higher species richness. The average foliage cover for each transect varied with no definite pattern in relation to landscape. Pperennial grasses dominated all components of the landscape. Midslope transects recorded the lowest bare ground score while the lower slope/flat transects recorded the highest bare ground score.

Yandicoogina Revegetation Control Transects 2009 — **2009**

Internal reference: RTIO-HSE-0108130

This report summarizes the data collected to date on the transects located on uncleared and less disturbed areas adjacent to the Yandicoogina Mine Site . Data was collected on the range, frequency, density, richness and foliage cover of the species, lifeform, and other components of the physical environment (bare ground and soil analyses).

A total of 82 vascular plant taxa from 45 plant genera and 23 plant families were recorded, one Priority Flora species and no introduced taxa. Relatively recent fire events were observed in the areas of transects. The perennial grasses dominated all components of the landscape with shrubs and trees dominating the remaining lifeforms. Most aspects varied between transects or showed no clear pattern. The midslope transects recorded the lowest bare ground score while the lower slope/flat transects recorded the highest bare ground score.

Yandi Additional Areas Vegetation and Flora Level 2 Assessment — **2013**

Internal reference: RTIO-HSE-0175488

This report describes further botanical survey work completed in 2012 in order to provide additional information on the values associated with the JSW, Oxbow and Billiards project areas.

Sixteen vegetation associations were described for the study area. An additional mapping unit comprised cleared ground. None of the vegetation associations comprise Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). A total of 313 native vascular flora species from 125 genera and 45 families were recorded from the study area. This species richness is within the range expected for an area of this size in this locality. No Threatened flora species were recorded within the study area. Fourteen introduced flora species (weeds) were recorded from the study area, none of which are Declared Plants for the Pilbara bioregion. *Cenchrus ciliaris (Buffel Grass) was the most prolific introduced flora species observed in the study area. This species often formed dense populations along creek banks and in floodplains.

Fauna

Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey — **2004**

Internal reference: RTIO-HSE-0057590

The primary aims of the study were to 1) Collect information on the presence of vertebrate fauna and selected invertebrate taxa (short range endemics); 2) Document the components of the physical environment (ie. the fauna habitats); and 3) Document existing levels of disturbance.

Six major habitat types were identified for the Yandi Expansion area. The habitat types within the Yandi Expansion area do not appear to be unique or significant at the bioregion scale. The riverine habitat is significant on a sub-bioregion scale as it would support a range of species not typically recorded from other habitats in the study area. Short range endemics species identified include: several Araneae (Spiders), six Pseudoscorpionida (Pseudoscorpions), one species of scorpionid, one species of Polyxenid millipede (pin-cushion millipede), one species of land snail (family Pupillidae). Two species of Schedule fauna and one Priority listed species have either been recorded from or are likely to occur in the Yandi Expansion area. One species, the Pilbara Olive Python, is also listed as Vulnerable under the EPBC Act 1999.

Yandi JSE - Conservation Significant Vegetation, Flora, Fauna and Fauna Habitat Assessment — **2005**

Internal reference: RTIO-HSE-0059518

This assessment establishes the conservation significance of and impacts to flora and fauna in the Yandicoogina JSE project area.

Habitat types within the area do not appear to be unique or significant at the bioregional scale. The Major Creek (Riverine) habitat is important at a sub-bioregion scale as it supports a range of species not typically recorded from other habitats, and because all major ephemeral water courses are considered to be ecosystems at risk within the Hamersley subregion (threats from cattle, donkeys and weeds). No gazetted vertebrate fauna species of special conservation significance were recorded. No invertebrate species known to be of elevaated conservation significance were recorded, nor did the targeted Short-range Endemic survey detect any species likely to have an elevated conservation significance. Given these conditions no particular management is required over and above the standard management measures already in place for the project.

Yandicoogina Subterranean Fauna Assessment Phases I-V — **2010**

Internal reference: RTIO-HSE-0101408

The report collates all of the subterranean fauna data collected, including all five phases of stygofauna sampling, and a single troglofauna sampling phase in the Yandicoogina area to date. The report also provides recommendations and direction for how to manage them during operations and describes the mine closure and the rehabilitation option.

A total of 3695 specimens of stygobitic fauna were collected. Specimens represented 6 classes and 9 orders. 35.93% of the total collection are Podocopida. 4 specimens of troglofauna have been collected. The report suggests that on mine closure refuge areas will aid in recolonisation of impacted (dewatered) areas surrounding the mine area. The report comments that salinisation of the groundwater may alter stygal community compositions in favor of those species more tolerant to brackish water and could render groundwater inhabitable for stygobitic fauna; however no limiting water chemistry or salinity values are provided.

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 two 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-PDE-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

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

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.

Internal reference: RTIO-HSE-0134168

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.

Seed Provenance Zones and Supply Requirements **2012**

Commenced in 2010, this research project is undertaking genetic studies on a number of key species, to identify appropriate provenance zones for subsequent rehabilitation. This report documents the seed collection zones developed by RTIO in order to achieve rehabilitation outcomes that are representative of the surrounding local environment.

Internal reference: RTIO-HSE-0094223

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

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.

Internal reference: RTIO-HSE-0164020

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**

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.

Internal reference: RTIO-HSE-0169744

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.

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.

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.

Landform design

Yandicoogina Conceptual Study on Backfilling of Mine Voids — 2009

Internal reference: RTIO-PDE-0068220

This study was undertaken to estimate backfill volumes to 5 m above the average original water level at Junction Central, Junction South East, Junction South West, Oxbow and Billiard South.

A total of 205 million loose cubic metres (LMm3) of material is required to backfill the pits to 5m above the water table: Junction Central requires 72LMm3, Junction South East 86LMm3, Junction South West 34LMm3, Oxbow 38LMm3 and Billiard South 178LMm3. Thus the deficit of 55LMm3 of material would need to be mined from surrounding hills to meet a total target of all pit voids backfilled to 5m above water table.

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.

Yandicoogina JSE pit landform water balance — 2013

Internal reference: RTIO-HSE-0208317

JSE is predicted to form a saline sink unless the pit is backfilled to at least the pre-mining water table. This report presents the outcomes from a GoldSim model that simulates water conditions post-mining to calculate the minimum volume of backfill required to create stable and environmentally acceptable conditions in the long term.

To minimise the duration of ephemeral ponding, the modelling showed that a capping layer (above the waste fines cells 495m elevation) between 2.4m and 3.5m thick is required. However, these conditions were only achieved when ET rates of 1,200mm/yr were used on the capping layer. Lower ET rates could be used on the waste fines cell walls (500m elevation). In the event that the rehabilitation scheme failed and the vegetation reverted to typical Pilbara grass vegetation (300mm/yr), the reduced ET rates would result in ponding occurring typically 5 times longer than the base case.

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.

Yandicoogina Preliminary Site Investigation (PSI) & Sampling and Analysis Plan (SAP) 2010 — 2010

Internal reference: RTIO-HSE-0094696

A preliminary site investigation was carried out to establish potential sources of contamination resulting from the current and historical site activities. Additionally, assess the implications of potential impact to soil, groundwater, environmental and human receptors.

Based on the findings of the preliminary site investigation, the main sources of contamination from the mining operations include; hydrocarbon (mainly diesel) storage / handling facilities and fuel pumps. Other sources of contamination include vehicle wash-down and maintenance facilities, waste oil handling facilities, liquid waste storage facilities, ammonium nitrate and fuel oil, equipment laydown landfilling, wastewater treatment and land farm facilities. Risk ranking analysis identified four facilities as "potentially high risk". On the basis of the preliminary conceptual site model, it is recommended that a ground investigation is undertaken.

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

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.

Internal reference: RTIO-PDE-0101903

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**

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.

Internal reference: RTIO-PDE-0101903

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.

Appendix D

38. Conceptual landform design closure options

This section summarises the discussion, considerations and anticipated outcomes of conceptual landform combinations have been developed and reviewed by Rio Tinto over recent years. Any of the scenarios presented below could be adopted at the current stage of mining, but could result in different economic, environmental and social impacts, opportunities and / or outcomes than presented in the Yandicoogina Closure Plan.

38.1 Considered options

The following closure scenarios present different landforms options have been developed by Rio Tinto, taking into consideration the location of CID beneath the existing creek systems and potential expansion activities. Each closure scenario presented below has the potential to influence the surface and ground water systems in different ways, and thereby has the potential to achieve different environmental and social closure outcomes.

As part of Rio Tinto's internal review, it was recognised that landform stability and the management of mineral waste, which can be moved and shaped to control water movement, comprise some of the larger closure cost aspects. While the cost implications of the closure scenarios have been reviewed by Rio Tinto, the cost implications are not discussed in this report.

38.1.1 Closure scenario 1 No backfill

Mining activities to date have maintained a minimum 200m standoff from the existing creeks[180], to preserve the creek ecosystem wherever possible. In the "no backfill" scenario, mineral waste would nominally be used to stabilize pit walls where a high risk of wall collapse is identified, to prevent flood water from entering the voids. Mineral waste not used would remain external to the pit. This would leave large voids exposing the groundwater table (Figure D1).

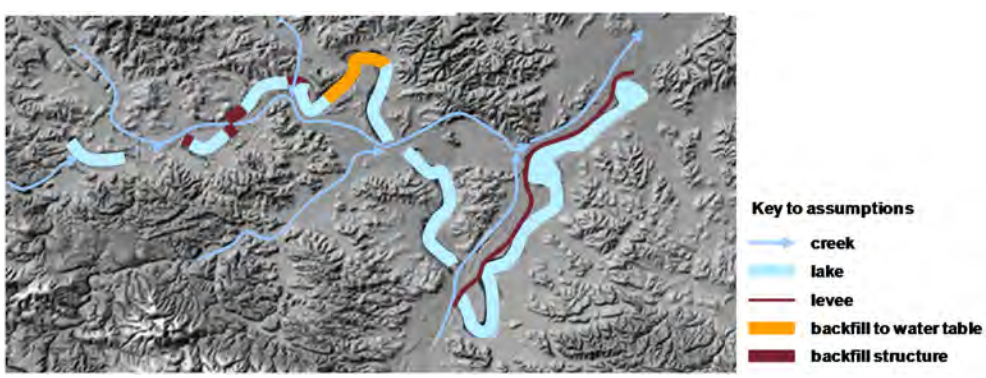

Figure D1: No backfill closure scenario.

Conceptual modelling[181] suggests that due to the strong creek recharge mechanisms, water levels in the voids upstream of JSE would recover in less than 5 years, creating a chain of lakes that are disconnected from the creek system. Water lost through evaporation would result in the water table recovering to a level that is less than 10m below the pre-mining water levels with water quality of less than 1000mg/l (although the cumulative impact of the upstream mining activities has not been accounted for and could result in a doubling of the water salinity[182]).

[180] With the exception of Phils Creek for which mining approval for the removal and realignment of the creek has been approved under Ministerial Statement 914.

[181] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

[182] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

At JSE, however, the water table would recover to 15m or more below the original water table. The 15m drop results from a combination of the decreasing water level from the upstream voids in Marillana Creek, limited connection to local creek systems and the large surface area subject to evaporation. The evaporation rates would keep the water table suppressed, even though the water table would be higher on both the northern (Marillana Creek) and southern (Weeli Wolli Creek) extents. The change in groundwater gradient draws water from under both the Marillana Creek and Weeli Wolli Creeks, creating a permanent cone of depression under both creeks. Salts[183] would continuously accumulate within the JSE pit, such that the water quality would eventually be classified as hypersaline. Salts trapped within the void would be permanently removed from the water systems.

Regional groundwater flows would be unaffected by the saline sink at JSE. Groundwater flow would be maintained down the alluvial systems associated with Marillana Creek and Weeli Wolli Creek[184]. However, because the groundwater table would not recover to the original levels, the riparian community structure would be permanently changed.

Development of the Billiards deposits, if following this same closure concept of no backfill with the separation of pit void and creek system, would result in similar conditions as JSE – a hypersaline lake with cone of depression permanently extending under Weeli Wolli Creek. However, the Billiards void would have a larger and longer connection to the remaining CID and alluvial aquifers. This would allow more water to be drawn from the regional groundwater system and could terminate groundwater flow from the Weeli Wolli Catchment to the Fortescue Marsh.

38.1.2 Closure scenario 2 Backfill to pre-mining water table

Backfilling mine voids to the pre-mining water table level aims to cover the groundwater table and thereby stop evaporation processes and preserve water quality. As there is insufficient mineral waste generated through the act of mining to cover the groundwater table, it is assumed that the hills adjacent to the voids would be mined to fill the voids (Figure D2). Filling the voids to groundwater level does not, however, reinstate the original topography or create a free draining surface. As such, the pit walls adjacent to the pit are not stabilised and the pit void continues to capture runoff.

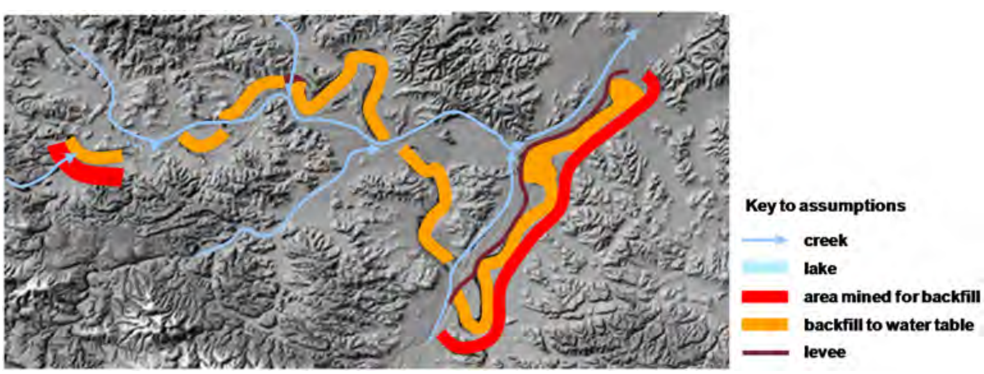

Figure D2: Backfill to pre-mining water table closure scenario. Locations illustrated as "area mined for backfill" (in red) do not represent an intention to mine these areas, and are supplied only to indicate the magnitude of the area required to be mined to achieve this outcome.

Conceptual modelling[185] suggests backfill to the original groundwater table level would facilitate the recovery of the water table to pre-mining levels. However, due to the strong

[183] All salts accumulated within the voids in the closure scenarios are derived solely from groundwater constituents. Mineral waste characterisation shows there are no salts that will be leached from mineral wastes under neutral or acidic conditions.

[184] Additional groundwater modelling is required to verify this conclusion as it was not a factor assessed as part of previous modelling activities.

[185] RPS Aquaterra (2012) Yandicoogina closure options: Preliminary water modelling results. Prepared for Rio Tinto Iron Ore, 22 December 2011. RTIO-PDE-0103618.

creek recharge mechanisms, the water table would fluctuate significantly (up to 10m). When the water table fluctuates above the backfill level shallow pit lakes would be formed. (Backfill to 10m above the pre-mining was estimated to be required to completely suppress the groundwater table.)

The lakes would be subject to evapoconcentration processes, causing salts to build up in the void soils. The salts, combined with regular inundation and prolonged water logging, would generate conditions that would not be favourable to vegetation growth.

Groundwater salinity would remain relatively similar from Oxbow through JSW and JC, but would increase by around 60 percent at JSE. If this same scenario was continued through to Billiards, salinity within the Billiards void would increase seven-fold due to the large potential exposure area.

Backfilling above the pre-mining water, to ensure no ephemeral lakes form, would substantially reduce groundwater quality issues and improve the growing conditions within the voids.

Several studies have been undertaken to determine the potential source of material to achieve the necessary backfill. Colloquially referred to as “backfill hill”, the volume of material required to backfill the voids to the water table[186], in addition to the mineral waste generate through mining, is over 55 million m^3. This equates to excavation of an additional +400ha of undisturbed land and hills adjacent to the mine. Backfilling to the water table will still leave shallow (up to 20m deep) pits. Additional excavation would be required if backfill to above the water table was preferred.

Groundwater through flow to Fortescue Marsh would be maintained under this scenario, and no drawdown would be experienced in the alluvial aquifers under the creeks. However, the level of backfill would not stabilise the pit walls. Only a few centimetres of wall failure / erosion on the top of the pit wall could be sufficient to allow flood water to flow into the voids, and start the processes that lead to creek capture. If the voids capture the creek, the frequency of surface water low flow and flood events would change. This could have an impact on the creek flow regimes and ecosystems (as previously discussed).

38.1.3 Closure scenario 3 Maintaining creek flows

The “maintaining creek flows” scenario prioritises the use of available mineral waste to stabilise the pit walls, strengthen flood bunds and thereby preserves the creek systems as far as practicable. No attempt to suppress the groundwater table is made. Instead deep lakes are encouraged to form, and excess mineral waste not required to support the creek system is placed to reduce the surface area of the lakes, rather than reduce the depth of the lake (Figure D3).

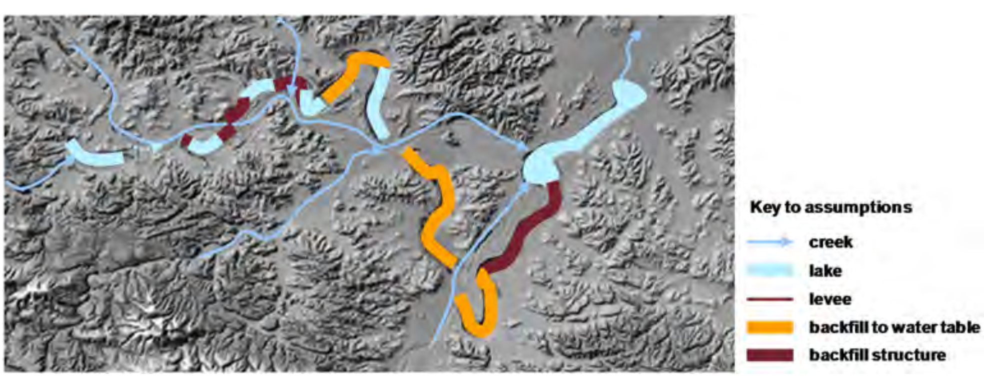

Figure D3: Maintaining creek flows closure scenario.

[186] Rio Tinto (2009) Yandi Conceptual Study on Magnitude of works to Backfill Voids, June 2009, RTIO-PDE-0068220.

Mineral waste priority locations were identified (from high to low) to minimise the potential for pit walls to collapse and to increase resilience to large flood events:

- Phils Creek reconstruction. Phils Creek is removed as part of the JSW pit development. Additional mineral waste would be used to strengthen the land bridge (constructed during operations) by increasing the buttressing either side of the land bridge. This configuration would minimise the potential for pit walls to collapse and increase resilience to large flood events.
- Marillana Creek between the JSW A and C areas. The area where Marillana Creek divides the JSW –A (southern) deposit from the JSW-C (northern) deposit restricts surface water flows between two flood bunds. Once the ore is removed, the bridge of CID ore and alluvium that remains under Marillana Creek has the potential to collapse into the void. Mineral waste would be used here to strengthen the pit walls and, leaving the flood bund in place, strengthen the flood bund. This configuration would increase resilience to large flood events.
- JSW area A adjacent to Marillana Creek. This pit wall is also located in the floodplain. Mineral waste would be used here to strengthen the pit walls and again, leaving the flood bund in place, strengthen the flood bund. This configuration would increase resilience to large flood events.
- JSE waste fines cover. Mineral waste is placed over the JSE waste fines cells to prevent the creation of a lake. This would prevent the permanent drawdown of the groundwater table under Marillana and Weeli Wolli Creek adjacent to the JSE deposit.
- Billiards southern expansion. The Billiards expansion intersects the Weeli Wolli Creek floodplain and could potentially mine through Weeli Wolli Creek. The long pit wall parallel to the creek has a high potential to fail. The mineral waste estimated to be generated from mining the northern portion of the Billiards deposit would allow the entire southern portion of void to be backfilled to surface to reinstate a floodplain.

In this scenario lakes will form in the Oxbow, JSW, JC and Billiards areas.

Modelling suggests the groundwater table would recover to approximately pre-mining levels in spite of the creation of several lakes. This situation evolves due to several different water interactions.

At Oxbow, the lake would behave as sink and water quality would deteriorate over time as a consequence. However, recharge from local runoff (terminating in the lake) would sustain the water levels around the pre-mining level. By behaving as a sink, salts would be prevented from interacting with the downstream alluvial and lake systems.

The JSW lakes would have a strong connection to the alluvial aquifers beneath Marillana Creek and would be rapidly recharged with the fresh alluvial waters. The surface area of the lakes would be relatively small in relation to the through flow rates, enabling the water to stay relatively fresh.

The JC lake would behave as a sink. However, because the lake is fed via water travelling through the CID from the JSW area, the salt content would be relatively low and the lake would take longer to become saline than Oxbow. The water level at JC would not recover to pre-mining level and a cone of depression would extend from JC under Marillana Creek into the JSE area.

The cone of depression at JC would cause the water flow direction to reverse through the JSE area, when compared to the pre-mining flow direction. This would pull the fresh groundwater in the Weeli Wolli aquifers through the JSE area, achieving approximately the pre-mining water levels.

Downstream of the JC cone of depression in Marillana Creek, the alluvial aquifer would be rapidly recharged from the surface water flows. This would sustain the pre-mining water table, in this sensitive riparian area, at the pre-mining water quality.

In the southern backfilled portion of the Billiards expansion area water levels and water quality would be returned to pre-mining conditions. Around the Billiards lake a small cone of depression may form during periods of prolonged dry weather. However, because this lake would receive all flows from Weeli Wolli Creek, the water levels would fluctuate with rainfall and overtop following large flood events (possibly every two to three years or so).

38.1.4 Closure scenario 4 Multiple small, deep lakes

This scenario is the same as scenario 3, with the exception of the Billiards expansion area. In this scenario multiple small, deep lakes are encouraged to develop through the Billiards void by placing the waste back into the void at staggered intervals as well as diverting Weeli Wolli Creek through the void (Figure D4).

This configuration would create a chain of lakes down Weeli Wolli Creek. During dry periods the lake water levels would drop, creating a groundwater cone of depression in the adjacent remnant alluvials aquifer. Because surface water flows are diverted into the voids, filling each void in sequence before overtopping the backfill then filling the next void, the alluvial aquifers would no longer be regularly recharged and the low flow channel and flood plain outside of the mined area could cease to function. As a result the composition of the riparian vegetation adjacent to the Billiards deposit could be significantly altered.

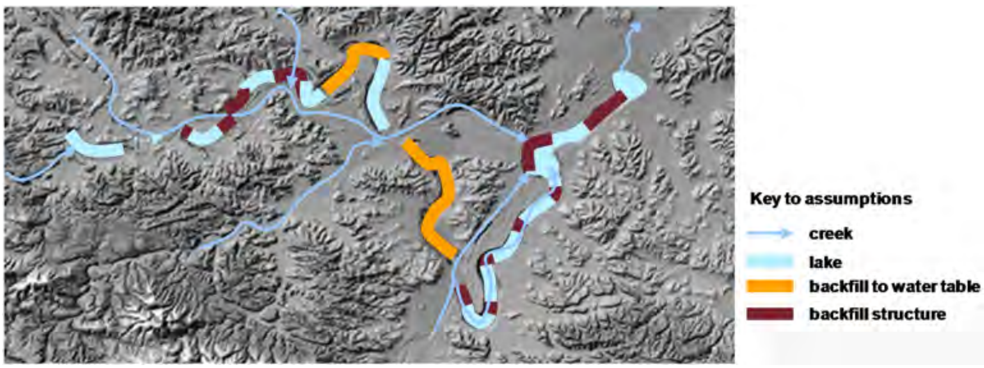

Figure D4: Multiple small, deep lakes closure scenario.

The mineral waste between each lake would be vegetated to create artificial wetlands with waterways to allow the flood water to pass between voids.

As with scenario 3, the water quality would remain relatively fresh as the accumulated surface water area is roughly the same. Similarly, the flood frequency through to Fortescue Marsh would be akin to scenario 3 (overtopping every two to three years).

38.1.5 Closure scenario 5 One permanent lake

This scenario is the same as scenario 3, with the exception that an additional CID deposit located between the existing JSE area and the Billiards expansion area, under Weeli Wolli Creek, is mined. Little to no backfill occurs within the Billiards area, such that waste dumps are left external to the mine area. Weeli Wolli Creek is diverted into the void, creating one long, continuous lake.

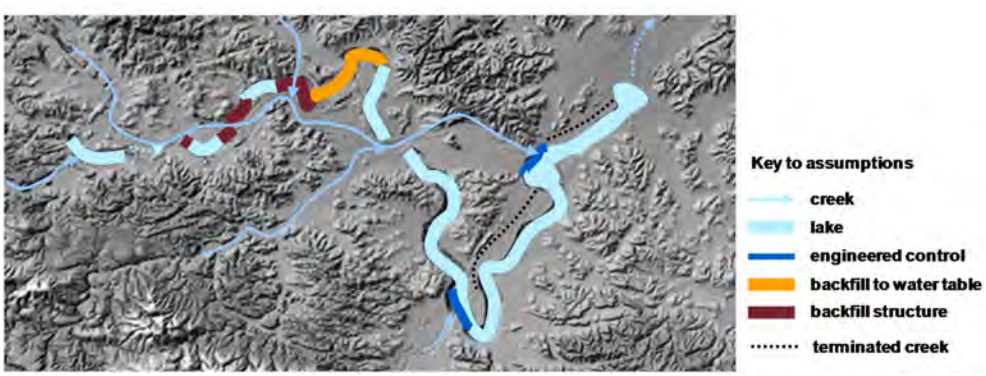

Figure D5: One permanent lake closure scenario.

As with scenario 4, the lake would capture all flows along Weeli Wolli Creek, and the riparian community adjacent to the mined area would experience similar impacts (changes to the vegetation community). The contribution of fresh surface water flows would maintain fresh water quality within the lake for most of the time. During periods of sustained drought, however, the water quality would be expected to diminish.

Due to the magnitude of the surface water volumes during flood events, the flood frequency through to Fortescue Marsh would be akin to scenario 3 (overtopping every two to three years).

38.1.6 Closure scenario 6 Continuous channel

Unlike all of the other scenarios consider, the “continuous channel” scenario does not seek to preserve the existing ecosystem. This scenario was designed to answer the question “can we create a stable alternative ecosystem if we mine the entire CID”. The scenario assumes mining activities remove all of the economic ore within the mapped CID (from Oxbow to Billiards) to create a singular, continuous pit. In this scenario Marillana and Weeli Wolli Creeks and their tributaries are diverted into the mined void and mineral waste is use at strategic locations to control the water movement into the void (Figure D6).

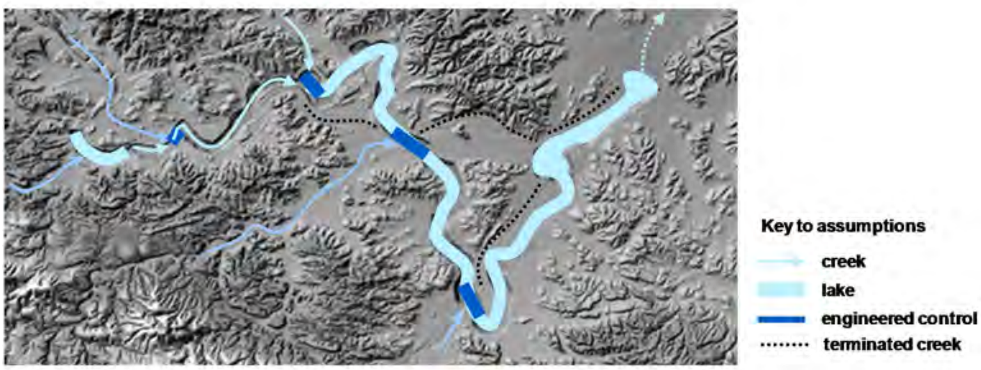

Figure D6: Continuous channel closure scenario.

In Weeli Wolli, surface water would cascade 30m over the edge of the void directly into the lake. In Marillana, surface water would be conveyed over the edge of the pit, and continue to flow along the clay base of the void before merging with the lake. In both creeks, the increase in flow velocities as water enters the voids could cause considerable erosion of the in situ alluvial soils up stream of the void and some degradation or change in the creek bed, banks and riparian community could occur.

Diverting all surface water flows into the void would enable the pit lake water quality to remain permanently fresh (at around 100mg/l to 200mg/l). The lake would extend from the middle of the JC area to Billiards. Groundwater would sustain the freshwater lake throughout the dry season. When the creeks flow, the lake level would rise (up to 6m) and fall, occasionally overtopping to send water through to Fortescue Marsh. A cone of groundwater depression would extend out around the void, such that riparian communities up gradient of the void would also be impacted.

The lake would include a large shallow area of water. The shallow water would encourage a littoral zone to form, which would help regulate the health of the lake by providing habitat for aquatic flora and fauna.

Diversion of the surface water flows into the void would deprive the remnant creek sections, downstream on Oxbow on Marillana Creek and areas adjacent to the Billiards deposit, of flood water. The vegetation community would be substantially altered, which would result in significant habitat loss. However, the creation of permanent freshwater lake could create a new fauna refuge.

Due to the magnitude of the surface water volumes during flood events, the flood frequency through to Fortescue Marsh would be akin to scenario 3 (overtopping every two to three years). However, the total volume of water that would report to Fortescue Marsh is expected to be substantially reduced in comparison to scenario 3.

Appendix E

39. Closure issues identification tracker

The following closure tasks have been completed and the results integrated into the closure plan OR have been retired as the task is no longer relevant to the current strategies or the task is now adequately managed through a standard work practice.

Ref	Issue	Action	Status	Comment
YA-3	Closure landform	Undertake drilling to determine ore quality in currently un-mined areas.	Complete	-
YA-4	Water	Develop a closure water model to predict impacts of the channel configuration.	Complete	2011 Hydrogeology modelling
YA-6	Cultural heritage	Undertake heritage surveys across the length of the Yandicoogina mining operation, including currently undisturbed and un-surveyed areas along creek lines, to identify cultural heritage implications of the channel configuration and closure plan	Retired	Channel configuration no longer strategy Closure plan reviewed through task YA-24
YA-8	Other	Confirm the channel configuration as the preferred closure option, or develop an alternative option if required.	Complete	Alternative developed
YA-20	Cultural heritage	Finalise site salvages audit and register, and implement a method to maintain and update data.	Retired	Action is part of a standard work practice
YA-22	Cultural heritage	Undertake an annual review of Heritage approval consents and ensure statutory obligations and conditions have been met.	Retired	Action is part of a standard work practice
YA-26	Cultural heritage	Regularly update RTIO and DIA heritage site and report registers with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	Retired	Action is part of a standard work practice
YA-27	Cultural heritage	Regularly update Gumala Aboriginal Corporation and traditional owners with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	Retired	Action is part of a standard work practice

Appendix F

40. Register of non-substantial changes to the Closure Plan

This table will be used to track any change(s) made to the closure plan between versions, in accordance with recommendations from the *Guidelines for Preparing Mine Closure Plans* (2011).

This is the first version of the report to conform to the Guidelines, thus the table is blank. Due to the substantive changes, no effort has been made to reconcile changes between this and previous closure plans.

Table 23: Closure plan change tracker.

Date	Change	Description	Degree of change